Impact of Contract Farming and Risk Preference on Food Security: The Case of Organic Basmati Rice Smallholders

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Abstract:

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JEL Codes: C21, D13

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Keywords: Contract farming, risks, yield, organic rice, India

JEL codes: C21, Q12, D13

1. Introduction

India has the world's largest harvested area of rice, with 44 million hectares (more than one-quarter of the global rice acreage), and contributes nearly one-quarter of the world's rice production. As a staple, rice represents a primary source of calories for many smallholder families in India and plays a vital role in food security, and its cultivation is a primary source of income for these families (Naresh et al., 2013). India also remains one of the world's largest exporters of rice, contributing significantly to global food security. The biggest successes in rice production have come from the improvement of total farm factor productivity; the development and adoption of climate-smart varieties; the vertical integration of stakeholders in the value chain; and the transformation of the basmati rice industry.[1] Improved technologies, improved management practices, upgrading of post-harvest technology (drying, storage, milling, and processing), improved packaging, and improved branding as well as marketing strategies have increased the visibility of India's basmati industry. In recent years, as Wani et al., (2015) pointed out, India has become a leading exporter of basmati rice to the world market.

As India became a leading exporter, though, the indiscriminate use of chemical fertilizer, pesticides, and water during the Green Revolution resulted in serious health and environmental issues. These uses have led to a loss of soil fertility and biological activities, increased soil salinity, and lower water tables. Concern for deteriorating environmental health, the growing demand from consumers and importers for safe and high-quality products, and opportunities for premium returns have motivated farmers to look to sustainable agriculture[2], also known as organic farming[3]. In 2004-05, India launched the National Project on Organic Farming (NPOF)

[1] Until the economic reforms of India (early 1990s), Pakistan dominated the world basmati rice market.
[2] Enhancement and maintenance of system productivity and resource quality is essential for sustainable agriculture.
[3] Defined as production system that largely excludes the use of fertilizers, pesticides, growth hormones and soil health is maintained by organic sources.

to further boost organic farming in the nation.[4] As a result, acreage in organic farming has increased from 0.2 million hectares (ha) in 2005-06 to 1.49 million ha in 2015-16[5]. Nevertheless, farmers are reluctant to adopt organic agriculture, due to lower yields and higher production costs, in India and throughout the world (Offermann and Nieberg, 2000; Uemastu and Mishra, 2012; Crowder and Reganold, 2015). Crowder and Reganold (2015) also noted that the growth of organic agriculture is frequently limited by inadequate marketing and technical skills, by inadequate infrastructure, and by government policies.

Contract farming (CF) may be able to relax the above constraints and provide farmers with higher prices for high-quality outputs and timely delivery. Government policies, such as India's 2003 Agricultural Produce Marketing Committee[6] (APMC) Act, also created opportunities for CF, which had been hindered by the Land Ceilings Act, which prohibits agribusiness firms from farming.[7] The 2003 act has drawn several corporate groups, multinational corporations, agricultural-input agencies, and other organizations to enter into contract farming (CF). Additionally, CF can play a significant role in reducing post-harvest losses and easing liquidity constraints (Mishra et al., 2016; Kumar et al., 2010). Contracts can be used to manage production and marketing risks (Allen and Leuck, 1995; Kohl and Uhl, 1985). Theory predicts that risk-averse farmers would adopt CF; however, the literature on this issue is scant, and results are mixed (Guo, Jolly, Zhu, 2005). Although India's rice sector achieved

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[4] Organic farming in India also is being promoted by National Horticulture Missions (NHM) and Rashtriya Krishi Vikas Yojana (RKVY).

[5] Total area under organic certification is 5.71 million ha, which includes 4.22 (74%) million ha of forest and wild area for collection of minor forest produces.

[6] APMC ensures that farmers are not exploited by intermediaries or middlemen and that all produce should first be brought to a place and then sold through auction.

[7] This APMC Act allows processors and contractors to procure raw materials directly from the farmers' field and the government to make agricultural production more profitable and competitive (Singh, 2005). Moreover, food safety and quality requirements in domestic and international markets raise formidable challenges to the growers to participate in the value chain. Contractors are better able to handle these responsibilities.

astounding success in the past, the challenges and opportunities for future OBR production are enormous, arising from both demand and supply sides (Surekha et al., 2010).

The objective of this study is twofold. First is to assess the impact of the perception of production risk, specifically, weather risk and pest and disease risk (biotic risk), on the probability of smallholders' adopting CF in OBR. Second is to analyze CF's impact on productivity (yield), prices received, and the livelihood of OBR producers. We account for observed and unobserved heterogeneity by using the endogenous switching regression (ESR) method (see Wollni and Brummer, 2011). However, the treatment-effect model may not capture potential heterogeneous impacts due to factors generating differential impacts, like endowments (human capital, land quality), of the adoption of CF. Finally, we examine CF's contribution to productivity, prices received, and smallholders' livelihood by their revealed risk preferences. We use data from a farm-level survey of smallholders in three states of India, namely Punjab, Haryana, and Uttarakhand.

This study is timely and relevant because it addresses two of the main issues related to India's organic farming industry. The government of India under its National Trade Mission has outlined several policy initatives, including (1) the enhancement of organic basmati production, improved nutritional security, and income support to smallholder households; and (2) an end-to-end holistic approach covering production, post-harvest management, processing, and marketing to ensure appropriate returns to producers. This study provides the tools to address the above government policy concerns. Finally, findings from this study will have a wider impact because poverty and low incomes are major problems for rural households that are trying to achieve higher productivity, better livelihoods, and food and nutritional security in India and other South and Southeast Asian countries.

2. Organic Agriculture and India's Organic Rice Sector

Organic farming in India has taken shape for three reasons. First, organic farming has emerged in areas of low-input where organic farming is a way of life and where one could say smallholders have practiced organic farming as a tradition. Second, farmers started practicing organic farming in response to the ill effects of the Green Revolution. Third, smallholders have recognized the benefits (market demand and premium prices of growing organic foods. As a result, the total area under certified organic farming (organic and in the process of converting to organic) has increased from 42,000 hectares (ha) in 2003-04 to about 4.43 million ha in 2011-12 (Yadav, 2012). According to the Agricultural and Processed Foods Products Export Development Authority (APEDA), 50% of the world's certified organic producers, or about 597,873 smallholder farms, reside in India. Additionally, India exported about 69,837 million metric tons of organic agricultural products in 2012 to various destinations in the Gulf countries, Germany, Switzerland, the United Kingdom, Netherlands, Japan, and the United States.

The above trend toward organic farming is rooted in the economics of production. For instance, a study by Ramesh et al. (2010) compared the productivity, costs of production, and net returns of organic and conventional crops, and found some striking differences.[8] The productivity of crops in organic farming was lower (about 9.2%) than that of crops in conventional farming. However, the average cost of cultivation in organic farming was lower (about 12%) than in conventional farming. Finally, the authors noted that organic growers received price premiums of about 20-40% and that their average net profit was about 22% higher compared to conventional growers. Several studies (Petersen et al., 1999; Reganold et al., 2001; Paul et al., 2002) have shown a combination of lower input costs and favorable price premiums make organic farms equally as profitable as conventional farms, and often more profitable.

[8] The survey was conducted in Maharashtra, Karnataka, Tamil Nadu, Kerala, and Uttarakhand.

Basmati rice and organic rice (basmati and non-basmati) have garnered significant attention from producers, markets, and policymakers when it comes to price premiums, productivity, and trade.

Basmati Rice

Basmati rice, a high-value crop, has been grown by Indian farmers for centuries and has been mentioned in ancient literature. Basmati rice has several characteristics that distinguish it from common rice, including aromatic, super-fine grains and extra-long, super-fine, slender grains with a length-to-breadth ratio of more than 3.5 mm. It is cultivated primarily in India, Pakistan and the Himalayan foothills. The states of Haryana and Punjab accounted for about 72 % of its production in India, followed by Uttar Pradesh and Uttarakhand. Interestingly, India accounts for about 70% of the total output of basmati rice and exports about 45% of the world's total output market (APEDA, 2017). The values and quantities of basmati rice account for almost all rice exports from India. Recognizing the importance of basmati rice in the Indian economy, the government of India has declared 24 districts in the states of Punjab, Haryana, Uttar Pradesh, and Uttarakhand have been declared Basmati Export Zones.

{Table 1 here}

Organic rice (both basmati and non-basmati) is the fourth-largest organically produced commodity in India, behind cotton, cereals, and millets. APEDA estimates that in 2011-12 about 22,674 million metric tons of organic rice was produced in India. According to APEDA, in 2012, about 5,243 million metric tons of OBR was exported from India. Because of its high production and export volumes, OBR has received much attention from both growers and policymakers. Ramesh et al. (2012) found that growers of organic rice (both basmati and non-basmati) had slightly lower yields (3.77 vs. 3.82 tons/ha), significantly lower costs of production (Rs. 18,000/ha vs. Rs. 20,7000/ha), and much higher returns (Rs. 28,000/ha vs. Rs. 17,750/ha) than growers of conventionally produced rice. Though states like Punjab, Haryana, and Uttarakhand have been at the forefront of basmati rice farming, Uttarakhand has been emphasizing organic farming in the recent decade. For instance, the government of Uttarakhand has taken steps to promote organic farming by establishing the Uttarakhand Organic Commodity Board (UOCB) and export zones.[9] As a result, the total area in organic production in Uttarakhand has increased from 5,916 ha in 2005-06 to 37,221 ha in 2015-16. OBR production accounts for about one-third of the area and about 50% of the total value of organic products in the state (ncof.dacnet.nic.in; Punjabi, 2015).

3. Literature Review

Contract farming (CF) has been used in different forms, including sharecropping contracts. Sharecropping contracts which began in the 16th century, were regarded as a feudal form of agriculture because of the dominant nature of absent or underdeveloped markets (Eswaran and Kotwal, 1985). The role and impact of CF in developing countries have been discussed extensively in the literature (*see* Masakure and Henson, 2005; Winters et al., 2005; Oya, 2012; Prowse, 2012; Otsuka, Nakano, and Kazushi, 2016). Most of the empirical literature on CF focuses on investigating the two primary aspects of CF: drivers of participation in CF, and the impact of CF on farms and households. In assessing the drivers of participation in CF, several socioeconomic and demographic variables have been examined. However, the literature has failed to provide a consensus on the sign (that is, the direction) and the significance of these variables.

[9] UOCB was established in May 2003 and is acting as the nodal agency of the state in enhancing organic activities in agriculture and allied sectors. Currently, UOCB has 25,000 registered farmers with 11,000 hectares under organic certification.

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% of the rural population, include access to credit, inputs, and extension services; another benefit is the linkage between input markets and providers and the international markets by organizing the production of high-value food crops (HVF), which in our case is basmati rice. The evidence of CF's impact in the context of India has been mixed. For instance, Dev and Rao (2005), Nagraj 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 et al., (2002) all found that contract producers earned profits almost three times higher than independent producers, due to higher yields and assured output prices. On the other hand, Singh (2002) and Opondo (2000) found negative impact of CF on the environment, welfare of farmers, and the power structure between contractors and farmers

Besides the above mixed findings of factors affecting CF's adoption and impact on outcomes variables, two issues have received little or no attention in the CF literature. First is the impact of perception of weather and pest risk[10] on the adoption of CF. Note that basmati rice crops (and by extension OBR crops) are highly sensitive to flooding, pests, and diseases affecting growth and yield. We found two studies in developing countries that provide conflicting results on the issue of risk. On one hand, Wainaina et al. (2012) found a positive relationship between the risk attitudes of poultry producers in Kenya and their willingness to participate in production contracts. On the other hand, Wang, Zhang, and Wu (2011) found that

[10] Supply of agricultural products is affected by production risks like weather (abiotic risk) and pest (biotic) risks (*see* Baquet et al., 1997; Hurine et al., 2000; Bray et al., 2000; Musser and Patrick, 2001; Hardaker et al. 2004 for a discussion on sources of agricultural risks).

risk-loving Chinese farmers in the Shandong province tended to participate in contracts but risk-averse farmers did not. Second, literature fails to provide evidence of CF's impact on outcome variables by farmers' risk attitudes. In particular, literature fails to provide evidence of how outcome variables (yield, prices received, and livelihood) vary in magnitude when taking into account farmers' risk attitudes. This study bridges the above gaps in the literature and explicitly addresses the heterogeneity of productivity and the impact on livelihood impact that arises due to differential endowments.

4. Conceptual Model and Econometric Framework

Let the adoption of contract farming (CF) be a binary choice, where CF is adopted when the net benefit from adopting CF is greater than not adopting CF. The difference between the net benefit from adoption and non-adoption may be denoted as NB^*, such that $NB^* > 0$ indicating that the net benefit from adoption exceeds that of non-adoption. However, NB^* is not observable but can be expressed as a function of observable factors in the following latent variable model:

$$NB_i^* = \beta X_i + \eta_i, \qquad NB_i = 1\left[NB_i^* > 0\right] \tag{1}$$

where NB_i is a binary indicator variable, =1 for smallholder household i in the case of adoption; 0 otherwise. β is a vector of parameters to be estimated; X_i is a vector of farm, operator, household, and other local characteristics; and η_i is an error term assumed to be normally distributed. Therefore, the probability of adoption of CF can be represented as:

$$\begin{aligned} \mathbf{Pr}\left(NB_i = 1\right) &= \mathbf{Pr}\left(NB_i^* > 0\right) = \mathbf{Pr}\left(\eta_i < -\beta X_i\right) \\ &= 1 - F\left(-\beta X_i\right) \end{aligned} \tag{2}$$

where F is the cumulative distribution function for η_i. The adoption of CF is expected to affect the demand for inputs such as fertilizer and pesticides, productivity, and net returns. To link the CF adoption decision with these potential outcomes, let us consider a risk-neutral smallholder farm that maximizes net returns (profits), π, subject to competitive input and output markets and a single-output technology that is quasi-concave in the vector of variable inputs, W and can be expressed as:

$$Max\ \pi = PQ(W, X) - IW, \tag{3}$$

where P is the output price and Q is expected output level; I is a column of input prices; W is a vector of input; and X is a vector of the farm, operator, household, and other local characteristics. Hence, net returns can be expressed as:

$$\pi = \pi(NB, I, P, X). \tag{4}$$

Using Hotelling's Lemma to Equation 4 yields a reduced form equation for input demand and output supply:

$$W = W(NB, I, P, X) \tag{5}$$

$$Q = Q(NB, I, P, X) \tag{6}$$

Equations 4-6 indicate that contract farming (CF), inputs, and output prices, as well as farm, operator and household attributes, tend to influence net returns, demand for inputs, farm-level productivity.

Endogenous switching regression

We use the endogenous switching regression (ESR) framework to estimate our empirical model, in which adoption is treated as a regime shifter. Additionally, ESR accounts for observed and unobserved differences between smallholders in the adoption scheme. The ESR regime consists of two steps. The first step is a selection equation, a binary choice criterion function. In this case, the smallholder will assess whether to adopt CF based on available resources and management options. Specifically, the smallholder compares the expected utility of CF adoption (net benefit), $NB^*_{i,\text{CF}}$, to the expected utility of no adoption ($NB_{i,\text{NCF},}$ or conventional technology).

Smallholders will adopt if $NB^{*}_{i,\,\mathrm{CF}} > NB_{i,\,\mathrm{NCF}}$ and will not adopt if $NB_{i,\,\mathrm{NCF}} < NB^{*}_{i\ \mathrm{CF}}$. NB^{*}_{i} is the adoption dummy variable that is unobservable, but we do observe NB_i. In the first step, we estimate with probit

$$\boldsymbol{NB}^{*}_{\boldsymbol{i}} = \boldsymbol{Z}_{i}\alpha + \zeta_{\boldsymbol{i}} \quad \text{with } \boldsymbol{NB}_{\boldsymbol{i}} = \begin{cases} 1 \text{ if } \boldsymbol{NB}^{*}_{\boldsymbol{i},\,\mathrm{CF}} > \boldsymbol{NB}_{\boldsymbol{i},\,\mathrm{NCF}} \\ 0 \text{ if } \boldsymbol{NB}^{*}_{\boldsymbol{i},\,\mathrm{CF}} < \boldsymbol{NB}_{\boldsymbol{i},\,\mathrm{NCF}} \end{cases} \tag{7}$$

The vectors $\boldsymbol{Z}_{\boldsymbol{i}}$ include farm, household, and village attributes. α is a vector of parameters to be estimated, and ζ_i is a random error $\zeta \sim \boldsymbol{N}\left(0,\sigma^2\right)$. In the second step, based on the results of the criterion function—selection function, two regime equations are specified explaining the outcome of interest (yield, food security, and employment, in our case). The relationship between a vector of explanatory variables X and the outcome R can be represented by $R = f\left(X\right)$. Specifically, the two regimes are:

Regime 1: $R_{i,CF} = X_i{}'\beta + \psi_{i,CF}$ if $NB_{\ i} = 1$,

Regime 2: $R_{i,NCF} = X_i{}'\gamma + \psi_{i,NCF}$ if $NB_i = 0$, (8)

where β and γ are a parameter to be estimated. Additionally, as noted by Fuglie and Bosch (1995), variable in Z_i, and X_i can overlap; errors terms $\zeta_i, \psi_{i,CF}$, and $\psi_{i,NCF}$ have tri-variate normal distribution with zero mean and non-singular covariance matrix (see Fuglie and Bosch, 1995, for details). Greene (2012) noted that since Regime 1 and Regime 2 are not observed simultaneously, the covariance between $\psi_{i,CF}$, and $\psi_{i,NCF}$ is not defined; since the correlation between the error term of the selection equation (1) and the expected values of $\psi_{i,CF}$, and $\psi_{i,NCF}$ which are conditional on selection and are non-zero. We assume that σ^2_{ζ} =1(α is estimable only up to a scalar). For additional assumptions on the disturbance terms, see Maddala (1986).

σ_1^2 and σ_2^2 are variance terms of the disturbance terms in the continuous equation; σ_{21} is a covariance of ζ_i and σ_{21} is a covariance of ζ_i and $\psi_{i,NCF}$. Finally, Fuglie and Bosch (1995) noted that expected values of the error terms in Equation (2) are non-zero because of the correlation between the error terms in the selection Equation (7) and regime Equations (8), which are evaluated as truncated error terms. In such a case, Greene (2012) and Fuglie and Bosch (1995) concluded that the expected value is a product of the variance and Inverse Mills Ratios (IMRs) evaluated at $Z_i\alpha$.

The ESR model can be applied using the two-stage procedure, and IMRs are included in the regime equations. Following Lokshin and Sajaia (2004), we use the full information maximum likelihood (FIML) method in our study. For the ESR model to be correctly specified, the factors affecting the selection Equation (7) should contain at least one instrument in addition to the factors affecting outcome variables in Equation (8) that are correlated with the adoption of CF but uncorrelated directly with outcome variables. In our study, we use the ESR model to compare the expected outcome variables (yield and food expenditures' share of total expenditures) of CF adopters and non-adopters (NCF)[11] and to assess the expected outcomes in the hypothetical counterfactual cases that adopter smallholders had not adopted, and that non-adopter smallholders had adopted OBR. Specifically, the conditional expectations in these four cases are defined as follows:

Smallholder households with the adoption of CF (observed):

$$E\left(R_{CF} \mid NB=1\right) = X'\beta + \sigma_{\zeta\psi CF}\lambda_{\psi CF} \qquad (9a)$$

[11] Several studies have used ESR framework, including Di Flaco, Veronesi and Yesuf, 2011; Doss, 2011; Lapple and van Rensburg, 2011; Alene and Manyong, 2007.

Smallholder households without the adoption of CF (or counterfactual):

$$E\left(R_{NCF} \mid NB=1\right)=X'\gamma+\sigma_{\zeta NCF}\lambda_{\psi CF} \tag{9b}$$

Smallholder households without the adoption of CF (observed):

$$E\left(R_{NCF} \mid NB=0\right)=X'\gamma+\sigma_{\zeta\psi NCF}\lambda_{\psi NCF} \tag{9c}$$

Smallholder households with the adoption of CF (counterfactual):

$$E\left(R_{CF} \mid NB=0\right)=X'\beta+\sigma_{\zeta\psi CF}\lambda_{\psi NCF} \tag{9d}$$

Besides the marginal effects of X on productivity and livelihood, we are interested in estimating the treatment effects of CF adoption. Following Greene (2012) and Alene and Manyong (2007), equations 9(a) to 9(d) can be used to estimate the net impact of adoption for adopters of CF (average treatment effect on the treated, or ATT) and average treatment effects on the untreated (ATU). Specifically, we can derive ATT and ATU from:

$$\text{ATT} = E\left(R_{CF} \mid NB=1\right)-E\left(R_{NCF} \mid NB=1\right) \tag{10}$$

$$\text{ATU} = E\left(R_{CF} \mid NB=0\right)-E\left(R_{NCF} \mid NB=0\right) \tag{11}$$

We estimate the model using simultaneous equations model of adoption of CF and productivity, CF and prices received, and CF and livelihood, with exogenous switching by full information maximum likelihood (FIML). We use an exclusion restriction for the model to be fully identified using variables that directly affect the selection variable (adoption of CF), but not the outcome variable. Table A1 of the appendix shows the variables that can be considered valid instruments, and the results show that the variables are jointly significant drivers of the decision to adopt CF or not to adopt it (Model 1, χ^2 =76.38; p=0.000; Model 3 χ^2 =25.69; p=0.000; Model 5 χ^2 =53.43) but not for the other three outcome models (Model 2, Model 4, and Model 6). Finally, recall that we also are interested in the heterogeneity effects of CF on outcomes, and to accomplish that goal, we use the expected outcome in equations 9a-9d. The heterogeneity effect between adopters can be obtained by taking the difference between (9a) and (9d), and the effect between non-adopters can be obtained by taking the differences between (9b) and (9c).

5. Data and Descriptive Statistics

The study is based on a primary survey of smallholder households. The study was conducted during March-April 2016 in the Indian states of Punjab, Haryana, and Uttarakhand. We surveyed 245 OBR growers, including 94 contract OBR growers and 151 independent organic basmati growers. Reflecting the concentration of OBR growers in the three states, we surveyed 174 farmers in Uttarakhand, 59 farmers in Punjab, and 12 farmers in Haryana. The sample districts in these three states were chosen because of their high intensity of OBR cultivation. Accordingly, Dehradun district, which has the highest concentration of organic basmati growers, was selected from Uttarakhand; Amritsar, Hoshiarpur, Jalandhar and Patiala districts were chosen from Punjab; and Kaithal and Karnal districts were selected from Haryana.

In Uttarakhand, we surveyed 94 contract OBR growers in the Doiwala, Raipur, Sahaspur and Vikas Nagar blocks of Dehradun district. The contracting firm Kohinoor Foods Ltd. contracted farmers for the purchase of OBR. The contracted OBR growers in Dehradun district had organized themselves into a federation called Kisan Ekta Samiti. The Kisan Ekta Samiti collectively bargained with the contractor firm on the terms of the contract. The Uttarakhand Organic Commodity Board (UOCB), a government entity responsible for promoting organic farming in the state, facilitated the contract arrangement with Kohinoor Foods Ltd. Since OBR cultivation is in a nascent stage in Punjab and Haryana, the sample size was relatively smaller in the sample districts. In Punjab, we surveyed six farmers in the Baba Bakala and Amritsar blocks of Amritsar district, 17 farmers in the Dasuya and Mukerian blocks of Hoshiarpur district, 16 farmers in the Bhogpur and Shahkot blocks of Jalandhar district, and 20 farmers in the Patiala and Nabha blocks of Patiala district. In Haryana, we surveyed seven farmers in the Kaithal and Pundri blocks of Kaithal district and five farmers in the Nilokheri and Gharounda blocks of Karnal district. The survey collected data on various aspects of the farming business, including the assets, costs, income, expenditure, the economics of cultivation, social network, and risk perception and risk attitudes of smallholders. Finally, the survey collected information on farm and farmer characteristics and information on good agricultural practices.

Comparison of contract and non-contract OBR producers

The characteristics of contract and independent OBR producers are shown in Table 2. Interestingly, the average farm size for independent OBR producers (13 acres) is significantly higher than for contract OBR producers (about 8 acres). Heads of household averaged about 56 years of age and had about 28 years of farming experience, though independent OBR producers were slightly younger (55 years) than contract OBR producers (58 years) and contract producers had more (22 years) experience in basmati rice farming than independent producers (18 years.) The average household comprised about seven members, a variable that does not differ between contract and independent OBR producers. Table 2 shows that contract OBR producers had significantly lower yields (990 Kg. per acre) compared to independent OBR producers (about 1,438 Kg. per acre). However, contract OBR producers received higher prices for their output (Rs. 30.37/acre) compared to independent organic basmati producers (Rs. 24/acre). Finally, compared to independent OBR producers, contract OBR producers have higher educational attainment.

{Table 2 here}

Some other differences between contract and independent OBR producers are significant at the 1% or 5% level. For example, compared to independent OBR growers, a higher share of contract basmati rice producers are members of cooperatives (81%) and have higher soil quality (alluvial soil, 50%). Regarding the use of extension services, Table 2 reveals that contract basmati rice producers receive more visits from government extension officials (1 visit) than independent producers receive. Table 2 shows that contract basmati producers have less access to institutional credit (about 63%) than independent OBR producers have. Finally, contract basmati rice producers cover greater distances when it comes to banking (3.4 kilometers), post office (2 kilometers), police station (9.6 kilometers), collection centers (4 kilometers), compared to independent OBR growers.

6. Results and Discussion

Table 3 presents the parameter estimates of the endogenous switching regression (ESR) model estimated by full information maximum likelihood using the Lokshin and Sajaia (2004) procedure in STATA. The second column shows the estimation of productivity (organic basmati yield per acre) function with no switching, including a dummy variable, equal to 1 if the smallholder adopted CF, 0 otherwise. The third, fourth, and fifth columns show estimated coefficient from selection Equation (7), adoption of CF or not, and organic basmati productivity function Equation (8) for smallholder households that adopted CF and those that did not, respectively.

Turning our attention to the perception of production risk (weather and pest), results in Table 3 reveal that OBR producers who perceive high pest risk are more likely to adopt CF than are OBR producers whose perception of weather and pest risk is neutral. Our finding is consistent with the agronomy literature (see Meena and Sharma, 2015) that cites disease and pest issues in

OBR production. The results of the adoption equation (Table 3, Column 3) suggest that the positive drivers of OBR producers' decision to adopt CF include the operator's farming experience in basmati, the operator's membership in a cooperative, and visits by extensions services, both government agents and peers (other farmers). We also find that OBR producers who face greater distances to post offices, police stations, and collection centers are more likely to adopt CF in OBR production that are OBR forwers who enjoy shorter distances. Finally, results show that OBR producers who have access to institutional credit[12] are less likely to participate in CF than are producers without access to such credit. This finding underscores the importance of CF for farmers who may be credit-constrained and for whom CF may be able to relax those constraints.

{Table 3 here}

We now turn our attention to the implications of CF adoption on productivity (yield per acre). The OLS estimates, with a dummy variable of CF adoption as an explanatory variable, provide the effect of CF adoption on productivity (Table 3, Column 2). The coefficient on adoption is negative and significant at the 1% level of significance. The OLS approach, in this case, would lead us to conclude that there is a difference in the quantity produced (per acre) by OBR producers who adopted CF and the quantity produced (per acre) by independent OBR producers. Note that the OLS approach assumes that CF adoption is exogenously determined, although it is endogenously determined. Therefore, the OLS approach here will lead to biased and inconsistent estimates.

[12] We investigated the poetical endogeneity of access to institutional credit and output. We rejected the endogeneity at the 1% level. We used the share of smallholders with credit as instrument at the district level. Note that share of smallholders with credit is a strong predictor of access to institutional credit.

To correct for the above weaknesses, Column 4 and 5 of Table 3 provide parameter estimates for the endogenous switching in the OBR productivity function. Note that the estimated coefficient of correlation term ρ_j in both functions is not statically significant. This finding suggests that we fail to reject the null hypothesis—absence of sample selectivity bias in both equations. Nonetheless, we find differences in the coefficients of the OBR productivity equation between OBR farmers adopting CF and their counterparts. The productivity of OBR smallholders who adopted CF is significantly different (at the 1% level) from the productivity of independent OBR growers. Finally, consistent with economic theory, we find that inputs, such as seeds, are significantly associated with an increase in OBR output per acre for smallholders who adopted CF. Another interesting difference between smallholders who adopted CF and independent producers relates to their perception of production risk (weather and pest) and the quantity of OBR they produced. For example, Table 3 reports that OBR producers who perceived low pest risk are significantly associated with higher OBR output, and OBR producers who perceived high weather risk are significantly associated with lower OBR output. On the other hand, OBR producers who perceived high pest risk and high weather risk had significantly lower OBR production.

Tables 4a, 4b, and 4c present the expected quantity of OBR produced under actual and counterfactual conditions and by three categories of OBR producers' revealed risk attitudes—risk-neutral, risk-averse, and risk-loving. Tables 4a and 4b measure productivity and prices received, and Table 4c looks at the livelihood (food expenditures' share of total expenditures) of OBR producers. Interestingly, the quantity of OBR produced (per acre) by smallholders who adopted CF, regardless of revealed risk attitudes, was significantly lower than independent OBR producers. Risk-neutral smallholder OBR producers with CF produced the lowest output (965

Kg/acre), followed by risk-loving smallholders with CF (974 Kg/acre) and risk-averse smallholders with CF (1,005 Kg/acre). This simple comparison, however, could be misleading and drive researchers and policymakers to conclude that on average, a risk-neutral farmer who adopted CF in OBR produced about 442 Kg/acre (965-1449 = -484, or about 33%) less than the independent risk-neutral OBR producer.

{Table 4a here}

The last column of Table 4a presents the treatment effects of CF adoption on OBR output. In the counterfactual case, risk-neutral OBR growers, for example, who actually adopted CF would produce about 442 Kg/acre, which is about 45% more if they did not adopt CF. Our findings are consistent with Crowder and Reganold (2015). This is plausible because CF requires producers to meet quality standards and provide timely delivery of the product. Risk-loving and risk-averse OBR growers who adopted CF would produce about 32% (465/1,469) more organic basmati rice if they did not adopt CF (Table 4a, last column). In the other counterfactual case, risk-neutral OBR growers who did not adopt CF would have produced about 837 Kg/acre (about 58%)[13] less if they had adopted CF. This effect is lower for risk-averse and risk-loving OBR growers.

The above results imply that adoption of CF in OBR decreases productivity, but the transitional heterogeneity is positive, indicating that the effect is significantly smaller for OBR growers who did not adopt CF than for those who did adopt CF. Also, the last row of Table 4a adjusts for potential heterogeneity in the sample. In the counterfactual case that OBR producers who actually adopted CF, they could have produced the same (see Table 4a, Column 4, heterogeneity effect "-42.33") as the OBR producers who did not adopt. The findings suggest the existence of potential heterogeneity that makes independent OBR producers better producers

[13] See Table 4a last column, TU=837, row tow of panel 1 (risk-neutral). 837/1449=58%.

than contracted OBR growers. Finally, in the counterfactual case that the independent OBR producers had adopted CF, they could have produced significantly less (see Table 4a, Column 3, heterogeneity effect “352.41”) than the OBR producers who actually adopted.

However, looking at the prices received by OBR producers, Table 4b shows the opposite effect. For instance, the table demonstrates that farmers who adopted CF in OBR received higher prices regardless of their revealed risk attitudes. However, the magnitude of the prices received was higher for risk-averse OBR farmers with CF, followed by risk-neutral and risk-loving OBR producer with CF. For example, risk-neutral OBR producers with CF received higher prices (about Rs. 30/Kg) and risk-loving OBR producers with CF received lower prices (about Rs. 29/Kg) than their counterpart. In the counterfactual case, risk-neutral OBR growers, for example, who actually adopted CF would receive lower prices, about Rs. 4.40/Kg (about 15%--4.40/30.27 see last column row 1 of panel), if they did not adopt CF. In the other counterfactual case, risk-neutral OBR growers who did not adopt CF would have received higher prices, about Rs. 6.05/Kg. (about 24%) if they had adopted CF. Note that this effect is lower for risk-loving OBR growers (about 16%--6.05/25.24). These results imply that adoption of CF in OBR farming increases prices received by OBR farmers with CF; the transitional heterogeneity is negative and not significant.

{Table 4b here}

Finally, Table 4c presents the impact of CF in OBR production on livelihood (food expenditures as a share of total expenditures, a measure of food security). Note that a lower food-expenditure share indicates better livelihood. Findings in Table 4c show that risk-loving OBR producers with CF have the lowest share of food expenses (0.22), followed by risk-averse OBR producers with CF (0.23), and risk-neutral OBR producers with CF (0.24). The last column of

Panel 2, Table 4c presents the treatment effects of CF adoption by OBR producers on livelihood. In the counterfactual case, risk-neutral OBR growers, for example, who actually adopted CF would have increased the share of food expenditures by 7% if they did not adopt CF. The counterfactual case, independent OBR producers who did not adopt CF would reduce the share of food expenditures by 5%, if they had adopted CF.

Finally, findings in Table 4c indicate that the transitional heterogeneity effect is negative and statistically significant, albeit small, for OBR growers who adopted CF relative to those who did not adopt CF. The last row of Table 4c adjusts for potential heterogeneity in the sample. Interestingly, in the counterfactual case, take the case of risk-averse OBR farmers who actually adopted CF would have significantly higher livelihoods (see Table 4c, Column 4, heterogeneity effect "0.11") than the OBR producers who did not adopt CF in the counterfactual case. Findings suggest the existence of potential heterogeneity that makes adopters of CF in OBR production better off with respect to livelihood than independent OBR producers. Finally, in the counterfactual case that the independent OBR producers had adopted CF, they could have significantly higher livelihoods (see Table 4c, Column 3, heterogeneity effect "0.08") than the OBR producers who actually adopted CF.

{Table 4c here}

7. Conclusions and Policy Implications

Although organic foods have health and environmental benefits, they are losing propositions for farmers when it comes to production costs and profit margins. Organic agriculture also produces lower yields. Nonetheless, the appetite for organic foods has been increasing in North America and Europe. Producers in developing countries like India are increasingly attracted to organic food production. For example, organic basmati rice (OBR) is in high demand in Europe and

North America but is produced only on small-scale farms in India and Pakistan. The production of OBR is complicated as it is susceptible to pests, diseases, and waterlogging problems. Indian government policies along with contract farming may prove fruitful in encouraging OBR producers to increase yields and receive price premiums.

The objective of this study was to analyze the factors affecting the decision to adopt CF in OBR production, with particular attention to perceived abiotic and biotic risks, and to investigate CF's impact on productivity, prices received, and livelihood of OBR producers in the states of Punjab, Haryana, and Uttarakhand in India. Changes in domestic and international demand for organic basmati rice, farmers' willingness to take up organic basmati production (partly due to higher returns), favorable policies and private companies actively pursuing CF are all trends that favor CF adoption in OBR. We use farm-level survey data from smallholders in Punjab, Haryana, and Uttarakhand states to estimate a simultaneous equations model with the endogenous switching regression method to account for unobservable factors influencing productivity, prices received, livelihood and the decision to adopt CF in OBR.

The study found that smallholders who perceived high pest risk and received more extension advice from government officials and peers were more likely to adopt CF in OBR production than smallholders who perceived low risk and received less advice. Therefore, developing better and timely information on weather and disease conditions may benefit smallholders, insurance companies, and contract providers. Such findings underscore the importance of governmental extension service providers and a farmer-to-farmer extension service model in enhancing the adoption of CF. OBR producers who belong to a cooperative and have experience in basmati rice production are more likely to adopt CF than their counterpart. Good soil type and access to institutional credit have an adverse effect on the adoption of CF in OBR farming.

Finally, we draw some conclusions on the effects of CF adoption in OBR on productivity, prices received, and livelihood. First, OBR growers who adopted CF have systematically different attributes than independent OBR growers. Second, contrary to popular belief, adoption of CF in OBR decreases productivity, regardless of the growers' revealed risk attributes. For example, when we analyzed the results for two different groups of OBR growers, we found that adopters, regardless of their revealed risk attitudes, tend to produce significantly less than their counterparts in the counterfactual case who did not adopt CF. We also find that independent OBR producers have attributes like skills, knowledge or a preference for independence that lead them to higher output productivity.

When it comes to prices growers received, however, the findings are the opposite. Our study finds a significant impact of CF adoption on adopters and non-adopters, regardless of revealed risk. Adoption of CF in OBR increases prices received by OBR producers. We find no transitional heterogeneity in prices received by OBR producers. Finally, we find that livelihood, as measured by food expenditures' share of total expenditures, has a significant impact of the adoption of CF on both groups, regardless of OBR growers' revealed risk attitudes. Interestingly, we found that the impact of CF adoption on livelihood was larger for OBR producers who fully adopted CF than for OBR producers who did not adopt CF. Food expenditures' share of total expenditures declined about 7%, for the counterfactual case if OBR producers adopted CF, for all risk attitude groups. We also find potential heterogeneity that makes CF adopters better off with respect to livelihood than independent OBR producers. Finally, in the counterfactual case that the independent OBR producers had adopted CF, they could have significantly higher livelihoods than the OBR producers who actually adopted CF.

Findings from this study are particularly relevant to policymakers in designing incentives for effective adoption of CF in OBR with potential impacts on productivity, prices received by farmers, and livelihood of OBR producers. Public policies, especially in a developing country like India, can play a major role in helping OBR producers adopt CF. CF can provide OBR producers with the latest technology, provide credit and good extension services, and link them to the international markets. It has the potential to augment revenues, livelihood, and prices received by smallholder OBR producers. Policymakers can facilitate the access to extension services, human capital investment, and access to membership in cooperatives. The lack of access to output markets and collection centers can be addressed easily by CF. Availability of timely information on weather and pest risks and the risk attitudes of OBR growers are important factors in determining the adoption of CF and its impact on productivity, prices received, and livelihood of OBR producers. Three-fourths of the world consumes rice, and the adoption of organic agriculture in rice could help promote sustainable production, reduce soil degradation, and lower environmental damages.

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Table 1: Basmati rice production, by top states, India; Exports and value of exports of Basmati rice, 2010-2014.

State	2010	2011	2012	2013	2014
	Thousand Tonnes				
Punjab	2,831.26	2,832.12	2,282.15	2,292.75	3,498.88
Haryana	2,751.63	2,676.77	2,261.26	2,898.98	3,701.88
Uttar Pradesh	1,442.77	2,066.23	1,428.48	1,270.09	1,260.69
Uttarakhand	97.06	80.13	53.9	54.16	66.41
Jammu & Kashmir	79.7	94.9	96.13	92.66	240.77
Himachal Pradesh	10.32	42.80	5.70	3.40	2.15
Delhi	4.93	6.0	6.0	4.09	3.0
Total	**7,217.67**	**7,798.95**	**6,133.62**	**6,616.13**	**8,773.78**
	Export of Basmati Rice				
Quantity of exported (1,000 tonnes)	2,016.87	2,370.68	3,178.24	3,459.92	3,757.38
Percent change (%)	29.58	17.54	34.06	8.86	8.86
Value of Basmati exports (Rs. 1,000 crores[1])	10,889.46	11,354.77	15,449.69	19,409.39	23,300.12

Source: AgriNet, GoI (2017).
Source: Agricultural and Processed Foods Products Export Development Authority (APEDA). Accessed at www. APEDA.gov.in Accessed on June 5, 2017.
[1] Rs. 1 crore= $10 million.

Table 2: Descriptive Statistics, All, Organic Basmati Farmers With and Without Contracts, India

Variable	Total Sample	Smallholders ***with*** contract farming	Smallholders ***without*** contract farming
	Mean (Std. Dev.)	Mean (Std. Dev.)	Mean (Std. Dev)
Dependent Variables			
Yield (*Kg. per acre*)	1,261.93 (26.13)	989.87*** (27.87)	1,438.30 (31.39)
Share of food expenditure in total expenditures	0.20 (0.007)	0.21 (0.01)	0.21 (0.01)
Prices received (*Rs. per Kg.*)	26.50 (0.52)	30.37*** (0.60)	24.09 (0.68)
Explanatory Variables			
Age, household head (*years*)	55.95 (0.84)	57.62 (1.36)	54.90 (1.07)
Education, household head (*years*)	8.49 (0.27)	9.29*** (0.43)	7.99 (0.33)
General caste (%)	2.04 (0.90)	5.31*** (2.32)	0.00 (0.00)
Scheduled caste, Scheduled tribes [b] (SCST) (*%*)	75.51 (2.75)	78.72 (4.24)	73.50 (3.60)
Other backward caste[c] (OBC) (*%*)	22.04 (2.65)	15.95* (3.79)	25.82 (3.57)
Experience, farming HH (*years*)	27.51 (0.96)	29.76 (1.52)	26.11 (1.24)
Experience, HH in Basmati farming (*years*)	19.40 (0.76)	22.08*** (1.32)	17.66 (0.89)
Land owned (*acres*)	11.01 (0.89)	7.64*** (0.99)	13.11 (1.28)
Households size (*Nos.*)	7.00 (0.21)	7.28 (0.42)	6.83 (0.22)
Credit in last five years (*%*)	20.40 (2.58)	13.82*** (3.57)	24.50 (3.51)
Credit, informal source (*%*)	3.26 (1.13)	3.19 (1.82)	3.31 (1.46)
Credit, formal source (*%*)	46.12 (3.09)	45.74 (5.16)	46.35 (4.06)
Member, cooperatives (*%*)	62.85 (3.09)	80.85*** (4.08)	51.65 (4.08)
Soil fertility, Alluvial soil (*%*)	29.38 (2.91)	50.26*** (2.30)	44.37 (4.05)
Extension visits, govt. agents (*Nos.*)	0.70 (0.11)	0.94* (0.22)	0.55 (0.11)
Extension visits by other farmers (*Nos.*)	0.34 (0.07)	0.48 (0.14)	0.25 (0.07)

Cost of labor (*Rs. per acre*)	5,87.81 (193.82)	5,423.39 (316.15)	5,041.16 (245.34)
Cost of seed (*Rs. per acre*)	1,027.50 (33.40)	1,229.29** (50.10)	901.89 (41.25)
Total revenues (*Rs. per acre*)	30,125.52 (482.55)	32,115.21*** (783.46)	28,859.36 (590.45)
Perceiving high weather risk (*%*)	28.97 (2.90)	21.27*** (4.24)	33.77 (3.86)
Perceiving high pest risk (*%*)	63.67 (3.07)	68.08 (4.83)	60.92 (3.98)
Perceiving high weather and pest risk (*%*)	67.34 (3.00)	69.14 (4.83)	66.22 (3.86)
Perceiving low weather risk (*%*)	18.77 (2.50)	24.46** (4.45)	15.23 (2.93)
Perceiving low pest risk (*%*)	8.97 (1.83)	9.57 (3.05)	8.60 (2.29)
Perceiving low pest and weather risk (*%*)	26.53 (2.82)	32.97*** (4.87)	22.51 (3.41)
Irrigation available for last five years (*%*)	95.91 (1.26)	98.94* (1.05)	94.03 (1.93)
Access to institutional credit (*%*)	69.83 (2.95)	62.76*** (5.01)	73.50 (3.60)
Access to personal transport (*%*)	90.02 (1.83)	92.55 (2.72)	90.06 (2.44)
Access to public transport (*%*)	61.22 (3.11)	68.08* (4.80)	56.95 (4.04)
Tehsil [d] (Gharounda and Doiwala)	22.44 (2.67)	30.85** (4.78)	17.21 (3.80)
Distance of road (*Km.*)	0.51 (0.06)	0.35*** (0.04)	0.61 (0.09)
Distance to banking facility (*Km.*)	3.04 (0.13)	3.39** (0.17)	2.82 (0.19)
Distance to village leader's home (*Km.*)	1.20 (0.07)	1.69*** (0.13)	0.89 (0.07)
Distance of post office (*Km.*)	1.72 (0.08)	2.00*** (0.13)	1.54 (0.10)
Distance of police station (*Km.*)	7.59 (0.30)	9.62*** (0.57)	6.32 (0.28)
Distance of collection center (*Km.*)	2.15 (0.27)	4.37*** (0.55)	2.41 (0.16)
Sample Size	**245**	**94**	**151**

Source: IFPRI-India survey. ***Note:*** [a] Indian rupee; exchange rate was USD 1=65 India rupee at the time of the survey.
[b] Includes designated groups of historically disadvantaged indigenous people in India. The terms are recognized in the Constitution of India, and the various groups are designated in one or other of the categories. Since independence, the Scheduled Castes and Scheduled Tribes were given Reservation status, guaranteeing political representation.
[c] Includes castes which are socially and educationally disadvantaged. [d] Base group is Tehsils in Punjab and Haryana.
*Significant at the 10%; **Significant at the 5%; ***Significant at the 1% level.

Table 3: Parameter Estimates of Contract Farming and Productivity of OBR, OLS and Endogenous Switching Equation

		Endogenous Switching Regression		
Model	OLS	Adoption of Contract farming	Adoption= 1 (Smallholders adopting contract farming	Adoption= 0 (Smallholders NOT adopting contract farming
Dependent Variable	Yield (*Kg. per ace*)	(1/0)	Yield (*Kg. per ace*)	Yield (*Kg. per ace*)
Adoption (1/0)	-341.25*** (48.02)			
Ln_ age of HH	-53.74 (256.83)	0.45 (2.15)	-393.51 (437.71)	254.21 (290.05)
Ln_ education, HH	-2.56 (8.18)	0.04 (0.05)	-3.47 (13.79)	1.26 (9.44)
Schedule caste & tribe	44.80 (48.29)	0.49 (0.33)	-105.94 (73.97)	127.60** (59.70)
Experience, farming HH	.0002 (0.04)	-0.00 (0.00)	0.02 (0.08)	-0.04 (0.05)
Experience, basmati rice HH	-2.06 (2.24)	0.02** (0.01)	5.34* (3.19)	-4.32 (2.88)
Ln_ land cultivated	47.27 (27.45)	-0.10 (0.20)	-29.15 (45.47)	83.82** (33.71)
Ln _households size	-43.49 (56.30)	0.17 (0.39)	-55.58 (80.05)	-95.90 (72.35)
Wealth Index[a]	34.94 (33.21)	0.01 (0.24)	106.32** (50.87)	5.81 (41.34)
Credit in last five years	-96.60 (59.10)	-0.38 (0.49)	-7.73 (109.11)	-144.09** (68.83)
Credit, informal source	-37.04 (113.70)	0.34 (0.85)	49.75 (200.45)	-81.96 (135.18)
Credit, formal source	22.77 (53.71)	0.29 (0.39)	-38.83 (84.84)	99.93 (66.82)
Member of cooperative	-57.08 (50.62)	1.65*** (0.37)	112.81 (93.86)	-90.48 (71.96)
Access to personal transport	144.25* (79.97)	-0.26 (0.58)	17.99 (122.58)	130.29 (100.29)
Access to public transport	-8.34 (42.61)	-0.50 (0.32)	29.65 (71.00)	61.13 (54.83)
Soil fertility (alluvial)	227.65*** (58.63)	-1.85*** (0.53)	-212.94 (153.22)	149.97* (78.32)
Extension visits, govt. officials	17.39 (12.08)	0.31** (0.13)	11.10 (12.53)	23.64 (24.50)
Extension visit by farmers	29.25 (18.32)	0.21* (0.12)	46.48** (21.87)	49.12 (32.76)
Ln_ cost of labor per acre	-14.50** (7.15)	-0.06 (0.05)	-13.33 (10.21)	-11.97 (8.52)

Ln_ cost of seed per acre	-50.14**	0.20	134.55*	-87.25
	(24.23)	(0.22)	(79.09)	(53.48)
Perceiving high weather risk	-37.83	-0.28	-190.10**	21.58
	(56.03)	(0.35)	(79.40)	(68.90)
Perceiving high pest risk	-192.20*	0.90**	24.21	-200.85*
	(110.63)	(0.38)	(276.54)	(114.37)
Perceiving high weather & pest risk	-228.52	-0.32	62.56	-274.47***
	(122.74)	(1.43)	(285.24)	(134.13)
Perceiving low pest and weather risk	-185.90	0.71	-331.38	-25.94
	(197.16)	(1.29)	(264.72)	(242.82)
Perceiving low weather risk	143.06	-1.13	201.61	133.19
	(191.57)	(1.26)	(255.19)	(239.42)
Perceiving low pest risk	259.83	-0.44	521.32**	58.77
	(184.18)	(1.23)	(248.76)	(216.35)
Irrigation available, last five years	893.31	0.73	-1,720.83	1,019.37***
	(191.85)	(2.31)	(1,115.09)	(189.79)
Distance to road (Km.)		-0.90***		
		(0.29)		
Distance to post office (Km.)		0.49***		
		(0.13)		
Distance to police station (Km.)		0.08**		
		(0.03)		
Distance to collection center (Km.)		0.14***		
		(0.05)		
Dehradun: Tehsil (Vikashnagar)[b]	-39.47	0.77**	89.05	16.82
	(54.98)	(0.39)	(77.27)	(82.01)
Institutional credit (%)	-27.69	-1.02**	-46.69	-66.91
	(59.29)	(0.42)	(90.27)	(76.70)
Constant	1102.77	-5.72	3,326.16**	120.45
	(944.51)	(7.59)	(1,601.74)	(1,102.30)
Observations	245	245	94	151
σ_i			237.00***	272.61***
			(26.91)	(18.34)
ρ_j			0.81	0.35
			(0.17)	(0.45)

Note: Numbers in parentheses are standard errors.

*Significant at the 10%; **Significant at the 5%; ***Significant at the 1% level.

[a] Includes ownership of number of cows, number of buffalo, sheep, hen, no. of rooms, television, mobile phone, fridge, tube well, power tiller, tractor, threshing machine, sprayer, chaff cutter, car, jeep, van, motor cycle. Principal Component Analysis (PCA) was used to calculate the wealth index.

[b] Base is Tehsils of Punjab, Haryana, Uttarakhand.

Table 4a: Average Expected Yield of Contract and Non-Contract, Organic Basmati Farms, by Risk Attitude of Smallholders

Risk index	Sample	Decision Stage: **Output** *Yield* *(Kg. per acre)* Adopting contract farming	***Not*** adopting contract farming	Treatment effects
Risk neutral	Smallholder *with* CF	965.23 (41.93)	1,407.16 (48.14)	TT= -441.93*** (74.52)
	Smallholder *without* CF	612.82 (42.76)	1,449.49 (36.70)	TU=-836.67*** (69.88)
	Heterogeneity effects	352.41*** (69.14)	-42.33 (63.14)	TH= 394.74*** (102.15)
Risk averse	Smallholder *with* CF	1,004.80 (23.83)	1,468.65 (23.60)	TT= -463.85*** (32.65)
	Smallholder *without* CF	693.84 (45.14)	1,452.01 (34.45)	TU= -758.16*** (73.65)
	Heterogeneity effects	310.96*** (56.68)	16.64 (45.11)	TH= 294.31*** (80.56)
Risk loving	Smallholder *with* CF	973.88 (40.75)	1,441.07 (39.73	TT= -467.18*** (59.22)
	Smallholder *without* CF	587.93 (36.28)	1,376.26 (39.87)	TU= -788.33*** (67.73)
	Heterogeneity effects	385.95*** (40.75)	64.80 (58.29)	TH= 321.15*** (89.96)

Note: Numbers in parentheses are standard errors.
*Significant at the 10%; **Significant at the 5%; ***Significant at the 1% level.

Table 4b: Prices Received by Contract and Non-Contract Organic Basmati Smallholders, Across Risk Attitude of Smallholders

Risk index	Samples	Decision Stage: **Prices received** (*Rs. per kg*) Adopting contract farming	***Not*** adopting contract farming	Treatment effects
Risk neutral	Smallholder *with* CF	30.27 (0.60)	25.87 (0 .74)	TT= 4.40*** (1.13)
	Smallholder *without* CF	31.30 (0.66)	25.24 (0.71)	TU= 6.05*** (1.24)
	Heterogeneity effects	-1.03 (0.89)	0.33 (1.02)	TH= -1.65 (1.67)
Risk averse	Smallholder *with* CF	31.08 (0 .29)	25.75 (0.36)	TT= 5.32*** (0.55)
	Smallholder *without* CF	30.48 (0.75)	24.56 (0.63)	TU= 5.92*** (0.80)
	Heterogeneity effects	0.60 (0.80)	1.19 (0.75)	TH= -0.6 (0.97)
Risk loving	Smallholder *with* CF	28.82 (1.62)	25.18 (.88)	TT= 3.64*** (1.18)
	Smallholder *without* CF	30.51 (0.67)	26.39 (0.99)	TU= 4.12*** (1.56)
	Heterogeneity effects	-1.69 (1.75)	-1.21 (1.32)	TH= -0.48 (1.95)

Note: Numbers in parentheses are standard errors.
*Significant at the 10%; **Significant at the 5%; ***Significant at the 1% level.

Table 4c: Livelihood (food expenditure shares in total expenditures) of Contract and Non-Contract OBR Smallholders, Across Risk Attitudes

Risk index	Sample	Decision Stage: **Livelihood** (*Share of food expenditure in total expenditure*)		Treatment effects
		Adopting contract farming	***Not*** adopting contract farming	
Risk neutral	Smallholder *with* CF	0.24 (0.01)	0.31 (0.02)	TT= -0.07*** (0.02)
	Smallholder *without* CF	0.18 (0.02)	0.23 (0.02)	TU= -0.05*** (0.01)
	Heterogeneity effects	0.05** (0.02)	0.07 (0.03)	TH= -0.02** (0.002)
Risk averse	Smallholder *with* CF	0.23 (0.02)	0.29 (0.01)	TT= -0.07*** (0.01)
	Smallholder *without* CF	0.12 (0.01)	0.18 (0.01)	TU= -0.06*** (0.01)
	Heterogeneity effects	0.08*** (0.02)	0.11*** (0.01)	TH= -0.01*** (0.001)
Risk loving	Smallholder *with* CF	0.22 (0.02)	0.29 (0.01)	TT= -0.07*** (0.02)
	Smallholder *without* CF	0.21 (0.02)	0.24 (0.01)	TU= -0.03*** (0.01)
	Heterogeneity effects	0.01 (0.03)	0.05 (0.01)	TH= -0.04*** (0.02)

Note: Numbers in parentheses are standard errors.
*Significant at the 10%; **Significant at the 5%; ***Significant at the 1% level.

Appendix Table A1: Parameter Estimates-Test on the Validity of the Selection Instruments

Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	Contract farming (1/0)	Yield of smallholders ***Without*** CF	Contract farming (1/0)	Share of food expenditures total expenditures by smallholders ***Without*** CF	Contract farming (1/0)	Prices received smallholders ***Without*** CF
Distance to police station (Km.)	0.05***	-2.51	-	-	-	-
	(0.02)	(12.32)				
Distance to post-office (Km.)	0.27***	-54.29*	0.20***	0.01	-	-
	(0.07)	(25.69)	(0.07)	(0.01)		
Distance to collection center (Km.)	0.16***	4.71	-	-	-	-
	(0.03)	(12.32)				
Distance to road (Km.)	-0.50***	7.11	-0.54***	-0.01	-0.32***	-0.20
	(0.18)	(28.69)	(0.17)	(0.01)	(0.15)	(0.94)
Distance to extension office (Km.)	-	-	0.04***	-0.003		
			(0.02)	(0.002)		
Distance to telephone booth (Km.)	-	-	-	-	0.16***	0.13
					(0.02)	(0.25)
Constant	-1.32	1527.91**	-0.79***	0.21	-0.84***	24.79***
	(0.23)	(75.22)	(0.19)	(0.02)	(0.16)	(1.10)
Wald test χ^2 /or F-Stat	76.38***	1.24	25.69***	1.32	53.43***	0.15
Observations	240	144	240	144	240	144

Note: Numbers in parentheses are standard errors.
*Significant at the 10%; **Significant at the 5%; ***Significant at the 1% level.