KSÜ Tarım ve Doğa Derg 25 (2): 392-399, 2022
KSU J. Agric Nat 25 (2): 392-399, 2022
https://doi.org/10.18016/ksutarimdoga.vi.896094

Impact of Contract Farming on Beef Cattle Farmers' Income: A Propensity Score Matching Analysis

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ABSTRACT

This study aims to investigate the impact of contract farming participation on the income of beef cattle farmers. For this purpose, the data was collected from 155 farmers by face-to-face questionnaires in Adana province in 2016. The impact of contract farming on farmers' income was identified using Propensity Score Matching. The results show that farmers who participate in the contract have more assets and mostly have a larger herd in comparison with non-contract. Further, contract participation entails a 10.04% increase in income ($p<0.01$). Given that most of the contract farms are large-scale, it can be said that this gain in income is not enough for encouraging smallholders to participate in contract farming. The evidence from this study suggests that policymakers should focus on providing appropriate technical assistance, giving price premiums and bonuses inversely proportional to farm-scale and improve extension services to enhance the rate of smallholder contract participation.

Research Article

Article History
Received : 12.03.2021
Accepted : 03.06.2021

Keywords
Contract farming
Beef cattle
Treatment effect
Propensity score matching

Sözleşmeli Üretimin Besi Sığırı Üreticilerinin Geliri Üzerine Etkisi: Eğilim Skoru Eşleştirme Yöntemi

ÖZET

Bu çalışma, sözleşmeli üretime katılımın besi sığırı üreticileri gelirleri üzerine etkisini araştırmayı amaçlamaktadır. Bu bağlamda, veriler 2016 yılında Adana ilinde 155 üreticiden yüz yüze yapılan anketlerden elde edilmiştir. Sözleşmeli üretimin üretici geliri üzerine etkisi Propensity Score Matching (Eğilim Puanı Eşleştirme) kullanılarak belirlenmiştir. Sonuçlara göre, sözleşme yapan üreticilerin sözleşme yapmayanlara göre daha fazla varlığa ve çoğunlukla daha büyük bir sürüye sahip olduğunu saptanmıştır. Ayrıca, sözleşmeye katılım, üretici gelirinde %10.04'lük bir artış sağlamaktadır ($p<0.01$). Sözleşme yapan işletmelerin çoğunluğunun büyük ölçekli işletmeler olduğu göz önüne alındığında, gelirdeki bu artışın küçük işletme sahiplerini sözleşmeli üretime katılmaya teşvik etmek için yeterli olmadığı söylenebilir. Bu bağlamda, politika yapıcıların işletme ölçeğine uygun teknik yardım sağlamaya odaklanmaları, küçük üreticilerin sözleşmeye katılım oranını artırmak için işletme büyüklüğü ile ters orantılı bir sözleşme fiyatı belirlemeleri ve yayım hizmetlerini artırmaları gerekmektedir.

Araştırma Makalesi

Makale Tarihçesi
Geliş Tarihi : 12.03.2021
Kabul Tarihi : 03.06.2021

Anahtar Kelimeler
Sözleşmeli üretim
Besi sığırı
Muamele etkisi
Eğilim Skoru Eşleştirme

To Cite: Ağır HB., Akbay C 2021. Impact of Contract Farming on Beef Cattle Farmers' Income: A Propensity Score Matching Analysis. KSU J. Agric Nat 25 (2): 392-399. https://doi.org/10.18016/ksutarimdoga.vi.896094.

INTRODUCTION

Along with globalization and liberalization efforts, changes in consumer and retailer demand, technological developments, food safety concerns and related regulations have led transformation in the agri-food system profoundly (Rehber, 2007). By the transformation of the agri-food system into a high-value supply chain, small-scale farms in developing countries are at risk of exclusion from high-value production opportunities of regional and international markets (Setboonsarng et al., 2008) due to new challenges such as quality and delivery requirements (Wang et al., 2014). Contract farming (CF) - a form of vertical coordination mechanism - has been largely believed as an efficient way to ensure integration between small-scale farms and markets. It has been established since 1885 and at the end of the 20th

century, spread widely in the food industry of developing countries (Bijman, 2008).

Generally, CF is defined as an agreement that a farmer guarantees to produce a given product in a given manner, and the buyer commits to purchasing it (Minot, 2007). Processing or marketing firms often provide technical assistance, inputs, new technologies, and credits to farmers (Eaton and Shepperd, 2001) for increasing their productivity and income. Key and Runsten (1999) stated that CF could lead to risk sharing between farmers and agribusiness firms. On the contrary, it is also argued that large firms manipulate contract agreements and use CF as a tool to cheat farmers (Little and Watts, 1994; Porter and Phillips-Howard, 1997). In Turkey, the first legislation about contract farming was issued in the form of a communiqué by the Ministry of Agriculture and Forestry in 1996. After that, CF started to spread rapidly and today it is applied in cut flowers, tobacco, potatoes, fruit and vegetables, meat and milk production.

Beef cattle production plays a vital role in red meat production and remains an important source of livelihood for farmers in Turkey. In the year 2019, through 3.6 million slaughtered beef cattle, and 1.07 million tonnes of production quantity, 87.7% of total red meat production has been provided from beef cattle farming (Turkstat, 2019). Although beef cattle farming has a significant role in red meat production, there are challenges in the sector due to economic and structural problems. In Turkey, cattle breeding has been carried out on small scale farms. According to the Agriculture Farm Structure Survey in 2016, only 4.5% of cattle-breeding farms have 50 or more animals. On the other hand, the production costs especially feed and breeding material is another important issue in cattle breeding activities. Despite the increase in input prices over the years, the sales price does not increase at the same rate which affects the profitability and productivity of the farms negatively. Also, the increase in the production costs pushes up product prices that resulted in a negative effect on the consumers. As a result of high prices, the government had to import live animal or beef meat which caused rising import rates since 2010.

The government has been started CF as a strategy to integrate small scale farms into the market through the General Directory of Meat and Milk Board (GDMMB) since 2011. It was founded as a State Economic Enterprise and manages 13 processing plants and 16 outlets for sustainability in the beef cattle sector. Through a written agreement signed between GDMMB and farmers, GDMMB offers a stable price and purchasing guarantee and farmers supply the product at a predetermined quality and quantity at the end of the fattening period. In this agreement, farmer remains responsible for management decisions during the production period. Also, farmers must slaughter a minimum of five animals and have to be a member of the Red Meat Producers Association.

The literature shows that studies related to contract farming are generally focused on crop production (Mwambi et al., 2016; Maertens and Welde, 2017; Benmehaia and Brabez, 2018), poultry production (Ramaswami et al., 2006; Begum et al., 2012). Also, there are studies about contract hog production (Key and Mcbride, 2003; Costales et al., 2006), and dairy production (Birthal et al., 2008). On the one hand, many studies stated that CF had a positive effect on farmers' income and welfare (Bijman, 2008; Miyata et al., 2009; Bellemare, 2012; Maertens and Velde, 2017). On the other hand, several authors of previous studies argued that CF participation does not improve farmers' income (Abdulai and Al-Hassan, 2016; Mwambi et al., 2016). Contrary to the international literature, previous studies in Turkey mostly have primarily concentrated on economic analysis of contract farming (Engindeniz, 2008; Gümüş, 2009; Alici et al., 2011), however, the impact of CF remains unexplored.

A review of the literature reveals that the impact of contract farming on the beef cattle sector has not been thoroughly investigated and limited studies are available on beef cattle production. Furthermore, no study presents the impact of CF on beef cattle production in Turkey. Accordingly, the present study focuses on a relevant and important topic for contemporary rural studies, especially when analyzing the CF in cattle breeding, a practice with few records which needs studies. In this respect, the aim of this study is to evaluate the impact of contract participation on beef cattle farmers' income by using the Propensity Score Matching (PSM) method. The findings of this study will contribute to policy-makers to develop strategies for the effectiveness of the existing contract farming in beef cattle production. Also, this study will serve as an important source for future studies and researches.

MATERIAL and METHOD

The primary material of this study consists of the original data obtained from face to face questionnaire with beef cattle farmers in Adana province of Turkey in 2016. Adana Province is located between latitudes 35-38 and longitudes 34-46 and in the Mediterranean Region. The area of the province is 17.253 km^2 which is 2.2% of the total area of Turkey.

A total of 155 beef cattle farms were selected from 3734 beef cattle farms by using the proportional sampling method (Newbold, 1995). The sampling method was determined with 95% confidence interval and 10% margin of error. The sample includes 61 contract farmers and 94 non-contract farmers.

In observational studies, when assignment units to treatment or control groups are not random, it is not possible to estimate an unbiased treatment effect by comparing outcomes between treatment and control groups (Austin, 2011). In other words, it is not possible to observe a subject has received the treatment and not received the treatment. When the assignment is not random, the estimation of the treatment effect may be biased due to the existence of confounding factors (Katchova, 2010). There are several methods to address selection bias like Heckman two-step and Instrumental Variable (IV), but these models require assumptions to meet for the analyzes (Mendola, 2007). In this context, PSM which is a nonparametric method, extensively used in observational studies was employed to estimate the treatment effect.

PSM creates a comparison group by matching each observation on treatment group with a control group by similar characteristics which provide the conditions of a random experiment to assess a causal effect, as in a controlled trial (Rosenbaum and Rubin, 1983). PSM based on a balancing score called the propensity score which is the conditional probability of a unit receiving the treatment given a vector of observed covariates formulated as;

$e(x)=$ pr $(z=1 \mid x)$ and pr $(z_1,\ldots,z_n \mid x_1,\ldots,x_n)=$ $\prod_{i=1}^{N} \mathbf{e}(\mathbf{x}_i)^{zi}\{\mathbf{1}-\boldsymbol{e}(\boldsymbol{x}_i)\}^{\mathbf{1}-\boldsymbol{z}_i}$ (1)

where zi: treatment status (0: control, 1: treated), x: the vector of observed covariates and e(x): propensity score (Rosenbaum and Rubin, 1983).

PSM is based on Conditional Independence (CI) and common support or overlap condition assumptions. CI states that only the given observed covariates X affect both the treatment and the outcome and expressed as: $Y(1), Y(0) \perp Z \mid X$,

The second assumption is common support or overlap condition implies that the propensity score ranges from 0 to 1 and shown as: $0 < P(Z=1 \mid X) < 1$. As the assumptions hold, the PSM estimator for Average Treatment Effect on Treated (ATT) can be written as (Guo and Fraser, 2015):

$ATT= E\ p(X) \mid Z=1\ (E[Y(1) \mid Z = 1, p(X)] - E[Y(0) \mid Z = 0, p(X)])$ (2)

Here, Y(0) denotes the outcome for control and Y(1) denotes the outcome for treatment group.

Propensity score can be estimated by using logit or probit regression or discriminant analysis. Since the logit distribution has more density mass in the bounds (Caliendo and Kopeinig, 2008), the logit model has been preferred. The next step is to match the treatment and control groups with similar propensity score by a matching algorithm such as Nearest Neighbor, Caliper and Radius, Stratification and Interval, Kernel and Local Linear and Weighting.

In this study, Kernel Matching (KM) which uses a weighted average of all farms in the control group that are inversely proportional to the distance between the p-scores of the treatment and control groups was employed (Caliendo and Kopeinig, 2008). After matching, it is important to check whether the differences in the covariates of treatment and control groups in the matched sample have been eliminated by balancing test (Caliendo and Kopeinig, 2008). One of the balancing test is the standardised mean difference between groups known as Rubin's B which should be less than 25. The other is the ratio of variances called Rubin's R should be between 0.5 and 2 (RUBIN, 2001). Also, comparison of pseudo-R2 should be low after matching to ensure no systematic differences between two groups (Sianesi, 2004).

Finally, it is crucial to perform a sensitivity test to put forth that the results are not sensitive to unobservable variables which means there should be no hidden bias. If there is hidden bias depending on unobserved variables, matching estimators are not robust (Rosenbaum, 2002). There are two sensitivity tests. For continuous outcomes, Wilcoxon sign rank and the Hodges-Lehmann point and interval estimate, and for binary outcomes the Mantel-Haenzsel (MH). For more information and details about the implementation of the sensitivity analysis see Rosenbaum (2002) and Becker and Caliendo (2007).

It is important to note that, for reducing bias, the choice of the variables for estimating the propensity score is crucial. Bergsta et al., (2019) stated that propensity score aims to balance all covariates, not to predict treatment perfectly. Also, Brookhart et al., (2006) recommended that variables that related to outcome, or both to outcome and treatment should be included in the model. Furthermore, using many variables in the model can result higher standard errors for the estimated propensity score (Khandker et al., 2010). Based on this issue six variables are included in the model to estimate the propensity score.

RESULTS and DISCUSSION

Table 1 represents the socio-demographics of farmers by participation status. For the entire sample, the average age of the farmers is 45.1 years. On average, contract farmers' education is higher compared to non-contract farmers and the difference is statistically significant (p=0.006). The number of cattle (CCU) and total crop area (da) of contract farms are approximately two times higher than non-contract farms. The difference is statistically significant ($p<0.05$). Gross production value (GPV) was calculated 2 680.18 $/head for contract farms and 2413.54 $/head for non-contract farms and the difference is statistically significant (p=0.000).

The average variable costs are 1891.71 $/head for all beef cattle farmers. The mean of variable costs of contract and non-contract farms is calculated as 1975.69 $/head and 1837.21 $/head, respectively (Table 1). On the other hand, the gross margin was 704.48 $/head for contract farms, 576.33 $/head for non-contract farms and the difference is statistically significant (p=0.002). According to the results, contract farmers are more educated, have more cattle, more crop and forage area, higher gross production value and gross margin compared to non-contract farmers. This shows that contract farmers are socio-economically advantageous, and large scale compared to non-contract farms.

Table 1. Socio-demographic characteristic of non-contract and contract farmers
Çizelge 1. Sözleşme yapan ve yapmayan üreticilerin sosyo-demografik özellikleri

	Non-contract		*Contract*		*Total*	
	Mean	*Std. Error*	*Mean*	*Std. Error*	*Mean*	*Std. Error*
Farmers' age (year)	*45.53*	*0.98*	*44.39*	*1.28*	*45.08*	*0.78*
Education level of farmers (year)	*7.24*	*0.30*	*8.77*	*0.49*	*7.84*	*0.27*
Livestock experience (year)	*20.54*	*0.91*	*19.87*	*1.10*	*20.28*	*0.70*
Household size(person)	*5.15*	*0.27*	*4.72*	*0.21*	*4.98*	*0.18*
Persons work in agricultural production	*2.30*	*0.21*	*1.89*	*0.15*	*2.14*	*0.14*
Number of cattle(CCU)	*48.07*	*4.81*	*85.28*	*22.82*	*62.72*	*9.51*
Total crop area (da)	*67.32*	*12.21*	*173.55*	*49.72*	*109.13*	*21.24*
Forage crop area (da)	*30.69*	*7.61*	*58.55*	*19.92*	*41.66*	*8.91*
Gross production value ($/head)	*2413.54*	*39.45*	*2680.18*	*42.51*	*2518.48*	*93.44*
Variable costs ($/head)	*1837.21*	*35.58*	*1975.69*	*45.35*	*1891.71*	*10.24*
Gross margin ($/head)	*576.33*	*27.44*	*704.48*	*29.76*	*626.76*	*20.90*

1 $= 3.02 TL in 2016, CCU: Cattle Count Unit was used to homogenize the cattle number of farm

In this study, PSM analysis is carried out using psmatch2 (Leuven and Sianesi, 2003) module. As shown in Table 2, some variables are statistically significant which are the determining factors of contract farming participation. Education status is one of the effective factors in contract farming participation ($p<0.05$). The findings are consistent with early studies about contract farming in the literature (Hu, 2013; Mwambi et al., 2016; Maertens and Velde, 2017). Farm type has a significant and positive impact, which means that farms specialized only in beef cattle breeding are more likely to participate in contract farming. This result is in line with the findings of research conducted in China by Guo et al., (2005). Another critical factor is the dressing percentage which has a positive and significant effect (Table 2). In Bangladesh, Sarma et al (2014) determined that an increase in beef cattle production by one kilogram has a significant and positive influence on contract participation.

Table 2. Logistic regression results for estimating the propensity score
Çizelge 2. Eğilim skoru tahmini için Lojistik regresyon analizi sonuçları

Variables		*Coefficient*	*p-value*	*Odds ratio*
	secondary school	*-0.314*	*0.601*	*0.730*
*Education****	*high school*	*0.169*	*0.720*	*1.184*
	*university **	*1.446*	*0.045*	*4.247*
Household size		*-0.006*	*0.953*	*0.994*
Number of cattle (CCU)		*0.001*	*0.619*	*1.001*
Livestock experience		*-0.007*	*0.803*	*0.993*
Total crop area (da)		*0.002*	*0.300*	*1.002*
*Farm type***		*1.318*	*0.001*	*3.735*
*Dressing Percentage (%)***		*0.240*	*0.000*	*1.272*
Constant		*-15.209*	*0.000*	-

p<0.01, *p<0.05, Hosmer Lemeshow p=0.681, Negelkerke R^2=0.348. * The reference category is primary school, Dressing Percentage (DP)= (Warm carcass weight/Live weight) x 100

Checking the overlap or common support region for the groups is an important assumption to meet for a good match. Common support is based on deleting observations from treatment group whose propensity score is smaller or larger than the control group's minimum or maximum score. Based on KBM, four farmers have been removed from the analysis to ensure a proper match. The region of common support ranges between 0.1273 and 0.9946.

Covariate means, t-test results, the percentage of bias before and after matching and the percentage of bias reduction are given in Table 3. According to the t-test,

there are significant differences before matching in some covariates (education, farm type, number of livestock, total crop area, and dressing percentage) while after matching the t-test results are insignificant. In other words, there are no differences between contract and noncontract groups after matching implying that the matching has been valid.

According to Table 4, low Pseudo R^2, insignificant likelihood ratio, and lower standardized bias after matching implies that there are no systematic differences based on covariates between contract and non-contract farmers that means the matching procedure has sufficiently balance the samples.

Table 3. Covariate balancing tests
Çizelge 3. Değişken dengeleme testi sonuçları

Variables	*Unmatched Matched*	*Mean Treated*	*Control*	*% bias*	*% reduction*	*t-test*	*p>|t|*
Secondary school	*U*	*0.098*	*0.159*	*-18.7*	*89.6*	*-1.08*	*0.280*
	M	*0.105*	*0.111*	*-1.9*		*-0.11*	*0.914*
High school	*U*	*0.262*	*0.223*	*9.0*	*31.3*	*0.55*	*0.582*
	M	*0.263*	*0.236*	*6.2*		*0.33*	*0.745*
University	*U*	*0.196*	*0.042*	*48.5*	*65.1*	*3.16*	*0.002*
	M	*0.175*	*0.121*	*16.9*		*0.80*	*0.424*
Household size	*U*	*4.721*	*5.148*	*-19.0*	*55.8*	*-1.11*	*0.270*
	M	*4.789*	*4.600*	*8.4*		*0.56*	*0.575*
Livestock experience	*U*	*19.869*	*20.543*	*-7.7*	*80.9*	*-0.47*	*0.642*
	M	*20.211*	*20.339*	*-1.5*		*-0.08*	*0.936*
Total crop area (da)	*U*	*173.56*	*67.324*	*37.0*	*89.5*	*2.48*	*0.014*
	M	*105.91*	*94.71*	*3.9*		*0.35*	*0.730*
Number of cattle (CCU)	*U*	*85.28*	*48.07*	*75.6*	*84.5*	*1.93*	*0.056*
	M	*67.98*	*59.28*	*-11.7*		*0.48*	*0.635*
Farm type	*U*	*0.639*	*0.340*	*62.2*	*98.0*	*3.79*	*0.000*
	M	*0.631*	*0.637*	*-1.2*		*-0.07*	*0.948*
Dressing Percentage	*U*	*59.103*	*56.479*	*75.6*	*84.5*	*4.51*	*0.000*
	M	*58.874*	*59.280*	*-117*		*-0.66*	*0.514*

Table 4. Covariate balancing indicators before and after matching
Çizelge 4. Eşleşmeden önce ve sonra değişken dengeleme göstergeleri

	Pseudo R^2	*LR chi^2*	*p>chi^2*	*Mean bias*	*Median bias*	*B*	*R*
Before Matching	*0.224*	*46.54*	*0.000*	*34.0*	*28.6*	*118.6*	*1.12*
After Matching	*0.009*	*1.41*	*0.998*	*6.5*	*6.2*	*22.1*	*0.95*

Table 5 presents the impact of contract farming participation on farmers' GPV. The results show that the GPV of farmers who participated in contract farming is 244.01 $/head higher compared to non-contract farmers. In other words, participation in contract farming has increased the GPV by 10.04%. This result supports previous findings of the literature (Miyata et al., 2009; Bellemare, 2012; Maertens and Velde, 2017).

The final step of PSM is sensitivity analysis which addresses hidden bias depends on the unobservable covariates. The bounding approach was employed which was proposed by Rosenbaum (2002) using rebounds package (Diprete and Gangl, 2004). As shown in Table 6, the upper bound is significant through gamma level 2 and there is no negative value between Hodges-Lehmann point estimates and confidence interval implies there is no hidden bias due to unobserved covariates.

CONCLUSION

The present study was designed to determine the impact of contract participation on beef cattle farmers' income by using the PSM. Moreover, this study is conducted to investigate whether contract farming applying in the beef cattle sector is beneficial for farmers or not.

Table 5. Estimates of ATT ($/head)
Çizelge 5. ATT Sonuçları ($/baş)

	Contract farmers' GPV	*Non-contract farmers' GPV*	*ATT*	*Standard Error*	*t-statistics*
KBM	*2673.74*	*2429.73*	*244.01****	*72.69*	*3.36*

***p<0.01

Table 6. Rosenbaum bounding sensitivity analysis results
Çizelge 6. Rosenbaum duyarlılık analizleri sonuçları

	Wilcoxon' signed rank test		*Hodges-Lehmann point estimates*		*95% confidence interval*	
Gamma (Γ)	*sig+*	*sig-*	*t-hat+*	*t-hat-*	*CI+*	*CI-*
1	*3.1e-06*	*3.1e-06*	*732.34*	*732.34*	*444.68*	*1017.46*
1.1	*0.0000*	*6.7e-07*	*693.47*	*778.88*	*390.10*	*1061.70*
1.2	*0.0000*	*1.4e-07*	*647.49*	*812.02*	*341.08*	*1111.84*
1.3	*0.0001*	*3.0e-08*	*618.69*	*837.82*	*317.20*	*1150.47*
1.4	*0.0002*	*6.3e-09*	*587.67*	*874.61*	*278.52*	*1179.68*
1.5	*0.0005*	*1.3e-09*	*554.09*	*905.48*	*253.17*	*1213.40*
1.6	*0.0010*	*2.8e-10*	*527.45*	*935.90*	*212.64*	*1257.21*
1.7	*0.0017*	*6.0e-11*	*490.40*	*981.99*	*180.582*	*1285.76*
1.8	*0.0029*	*1.3e-11*	*462.48*	*1006.02*	*149.14*	*1314.90*
1.9	*0.0045*	*2.7e-12*	*429.84*	*1034.12*	*129.57*	*1337.91*
2	*0.0067*	*5.7e-13*	*396.19*	*1049.10*	*105.34*	*1357.99*

* gamma - log odds of differential assignment due to unobserved factors, sig+ - upper bound significance level sig-, - lower bound significance level

One of the more significant findings to emerge from this study is that contract farms are mostly large-scale and have more assets than non-contract farms. This result indicates that the scale is preponderant in this process, as the contract is for a small number of animals and not for the entire herd. This is easier to do when having a larger herd and economic advantages. But smallholders prefer to avoid situations of uncertainty, so as not to run the risk of not fulfilling the contract.

The second major finding was that participating in contract farming increases the farmers' GPV by 10.04% on average compared to non-contract farmers. It is a fact that the contract price, herd size and farm type, quality and quantity of feed and race of cattle were effective factors in the emergence of a higher income. However, as the contract farms are mostly large-scale, this gain from contract farming is not enough to satisfy smallholders to sign a contract. In considering the gain from contract participation, policymakers should focus on enhancing the inclusion of small-scale farmers. From this point of view some policy implications can be made as follows;

On one hand, giving price premiums and bonuses inversely proportional to farm-scale to reduce the participation rate of CF of larger farms. This allows more smallholders to be included in the contract farming system. Another important thing is small-scale farms are financially constrained for necessary farm investments for improving farm capacity. Providing low interest and easily accessible credits for farmers will encourage them to participate in CF.

On the other hand, it is imperative to provide extension services to inform smallholders about the benefits and terms of the contract agreement. Most of smallholders lack understanding existence, benefits and terms of CF. Also, GDMMB should strengthen its capacity by encouraging big processors, exporters, and chains of supermarkets to organize CF operations. Investments from the private sector and cooperatives are a necessary pre-condition for the development of private CF schemes. In conclusion, implementing policies that provide small-scale farms an acceptable level of risk associated with contract farming would make significant contributions to farmers' welfare in the future.

ACKNOWLEDGEMENTS

This study is derived from the data of the Ph.D. thesis of the first author. This research did not receive any specific funding.

Researchers Contribution Rate Declaration Summary

The authors declare that they have contributed equally to the article.

Conflicts of Interest

The authors declare that there are no financial or non-financial interests that have influenced the manuscript

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