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Determinants of Dairy Contract Farming Adoption and Differences in Household Food Insecurity among Smallholder Farmers in Malang, East Java

Aminah Happy Moninthofa Ariyani[1]*, Mohammad Wahyu Firdaus[2], Taufik Rizal Dwi Adi Nugroho[1], Mardiyah Hayati[1], Desi Ramadhani[2], Moh. Rizal[3], Syauqi Agung Firmanda[2]

[1]Agribusiness Department, Faculty of Agriculture, Universitas Trunodjoyo Madura, Bangkalan
[2]Agriculture Socio-Economic Department, Faculty of Agriculture, Universitas Brawijaya, Malang, Indonesia
[3]Department of Agronomy, Faculty of Agriculture, Universitas Brawijaya, Malang, Indonesia

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ABSTRACT

Food insecurity remains a persistent challenge among rural agricultural households, particularly among smallholder farmers whose livelihoods depend on unstable agricultural markets and limited institutional support. In dairy-producing regions of Indonesia, contract farming has emerged as a potential institutional mechanism to improve farmers' market access and stabilize income. However, empirical evidence on how participation in dairy contract farming affects household resilience to food insecurity remains limited. Therefore, this study aims to analyze the factors influencing smallholder dairy farmers' decisions to participate in contract farming and to examine differences in household food insecurity between contract farming participants and non-participants in Malang Regency, East Java. This study uses primary data collected from 100 smallholder dairy farming households through direct interviews using a multistage sampling technique in two dairy production centers: Pujon and Jabung. A Probit regression model was applied to analyze the determinants of contract farming adoption, and an independent-samples t-test was used to examine differences in household food insecurity, measured using the Food Insecurity Experience Scale. The results show that education and access to credit significantly influence farmers' participation in contract farming. Education has a negative and significant effect, indicating that farmers with higher levels of formal education are less likely to participate in contract farming, whereas access to credit has a positive and significant effect, suggesting that financial resources facilitate farmers' engagement in contractual production systems. Furthermore, the results reveal that dairy farmers participating in contract farming experience significantly lower levels of food insecurity compared to non-contract farmers. These findings highlight the importance of strengthening institutional market arrangements and improving farmers' access to financial services to enhance the resilience of smallholder dairy farming households to food insecurity.

Keywords: Contract farming; Dairy farmers; Food insecurity; Smallholder households

INTRODUCTION

Food insecurity remains a persistent challenge affecting many rural households in developing countries, particularly those whose livelihoods depend heavily on small-scale agricultural activities (Pelletier et al., 2016). Although

*Corresponding author:
Email: happy@trunojoyo.ac.id

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global food production has increased significantly over the past decades, many households still face difficulties in accessing sufficient, safe, and nutritious food on a regular basis (Balafoutis et al., 2017; Pe'er et al., 2020). This condition is often driven not only by food availability but also by household income instability, limited market access, and vulnerability to economic shocks. Agricultural households that rely on smallholder production systems are especially susceptible to these challenges because their income and consumption patterns are closely linked to the performance of their agricultural activities. As a result, strengthening rural households' resilience to food insecurity has become an important priority in both academic research and development policy (Tambo et al., 2023).

In Indonesia, agriculture continues to play a central role in supporting rural livelihoods and household welfare. One important agricultural subsector is dairy farming, which provides a regular source of income for smallholder farmers through daily milk production. East Java, particularly Malang Regency, is one of Indonesia's major dairy production centers, where smallholder farmers dominate the production system. Despite its potential to provide stable income compared to seasonal crop farming, smallholder dairy production still faces several structural constraints, including price fluctuations, limited bargaining power, and dependence on market intermediaries (Toiba et al., 2024). These challenges can lead to income instability and may ultimately affect farming households' ability to maintain adequate food consumption. Consequently, improving institutional arrangements that strengthen farmers' market access and income stability is considered essential for enhancing household resilience to food insecurity (Kapari et al., 2023).

One institutional mechanism that has received considerable attention in addressing market and income constraints in agriculture is contract farming (Braimah, 2016). Contract farming refers to a production and marketing arrangement between farmers and buyers or processing companies in which specific conditions regarding production, quality, price, and marketing channels are agreed upon before production begins. In the dairy sector, such arrangements commonly involve partnerships between smallholder farmers and dairy cooperatives or milk processing companies that organize milk collection, quality standards, and market distribution (Dedehouanou et al., 2013). Through these contractual relationships, farmers may obtain more secure market access, guaranteed product absorption, and, at times, additional services such as technical assistance, access to inputs, or credit facilities (Hanani AR, Rahman, Toiba, et al., 2024; Khalili et al., 2017). These benefits are expected to reduce marketing uncertainty and improve farmers' economic stability.

From a household welfare perspective, contract farming can improve food security by stabilizing farm incomes and strengthening market integration (Bezabeh et al., 2020). Stable and predictable income from dairy sales may allow households to better manage their consumption expenditures and allocate resources toward adequate food consumption (Bezabeh et al., 2020; Braimah, 2016; Hanani et al., 2024). Increased income stability may also help households cope with unexpected shocks that could otherwise disrupt their ability to access food. Therefore, participation in contract farming arrangements may not only affect agricultural production outcomes but also influence broader household welfare dimensions, including resilience to food insecurity. However, the extent to which contract farming actually contributes to improved household food security outcomes remains an empirical

question that requires further investigation (Mishra, Kumar, Joshi, & D'souza, 2018).

Previous empirical studies on contract farming have largely focused on its economic impacts, particularly on farmer income, productivity, and market participation (Igweoscar, 2014; Mulatu et al., 2017; Phong Tuan, 2012). Many studies have shown that contract farming can improve farmers' access to markets, reduce transaction costs, and increase farm profitability (Chen & Chen, 2021; Mishra, Kumar, Joshi, & D'Souza, 2018b; Mwambi et al., 2016; Ton et al., 2018). Nevertheless, most of this literature focuses primarily on crop-based contract farming systems, such as vegetables, fruits, and export commodities (Chen & Chen, 2021; Mishra, Kumar, Joshi, & D'Souza, 2018b; Mwambi et al., 2016; Ton et al., 2018). Fewer studies have examined contract farming in the dairy sector, especially in developing countries where smallholder dairy farming is widely practiced. Moreover, research explicitly linking contract farming participation to household food insecurity outcomes remains limited, particularly in Southeast Asian agricultural systems.

In Indonesia, the majority of dairy farmers operate at a small scale and often rely on cooperative-based marketing systems to sell their milk. While previous studies have discussed the role of dairy cooperatives and milk marketing systems in improving farmer income and strengthening supply chains, relatively little attention has been given to the implications of these institutional arrangements for household food security (Chen & Chen, 2021; Mishra, Kumar, Joshi, & D'Souza, 2018b; Temesgen Gelata et al., 2024). In particular, empirical evidence on how participation in dairy contract farming affects the food insecurity experiences of farming households is still scarce. This gap is particularly important in regions such as Malang Regency in East Java, where dairy farming constitutes an essential livelihood activity and where institutional partnerships between farmers and milk buyers play a significant role in shaping farmers' market participation.

Addressing this gap, the present study examines the impact of dairy contract farming adoption on household resilience to food insecurity among smallholder dairy farmers in Malang, East Java. Specifically, this research has two main objectives: first, to identify the socio-economic factors influencing farmers' decisions to participate in dairy contract farming arrangements; and second, to compare household food insecurity levels between farmers who participate in contract farming and those who do not. Household food insecurity is measured using the Food Insecurity Experience Scale (FIES), which captures households' experiences related to food access constraints. By linking institutional market participation to household-level food insecurity outcomes, this study contributes to the broader literature on agricultural commercialization and rural welfare, while providing empirical evidence to inform policies aimed at strengthening the resilience of smallholder dairy-farming households.

RESEARCH METHOD

Location and Data

This study was conducted in Malang Regency, East Java, Indonesia, one of the country's main dairy production centers, where smallholder dairy farming plays an important role in rural livelihoods (Kristiansen & Sulistiawati, 2016). The study area was selected purposively due to its high concentration of dairy farmers and the presence of institutional marketing arrangements between farmers and milk buyers. Specifically, the research was carried out in two sub-districts, namely Pujon and Jabung, which are recognized as important dairy farming clusters in Malang Regency. These areas were chosen because a large proportion

of households depend on dairy farming as their primary livelihood, and farmers are actively involved in milk marketing systems that often include cooperative-based or contractual arrangements.

The study employed a multistage sampling technique. In the first stage, Malang Regency was purposively selected due to its significance in the dairy sector in East Java. In the second stage, the sub-districts of Pujon and Jabung were selected because they have a high density of smallholder dairy farmers. In the third stage, several villages within these sub-districts were selected based on the presence of dairy farming households. The sampling frame of dairy farmers was obtained from the local Livestock Service Office (Dinas Peternakan) to ensure the representativeness of the respondents. Based on this list, a total of 100 dairy farming households were selected as respondents. The sample included farmers who participate in contract farming arrangements and those who operate independently, allowing comparison between adopters and non-adopters.

Primary data were collected through face-to-face interviews with structured questionnaires administered to the household head or a household member responsible for dairy farming activities. The survey collected data on several key variables relevant to the study's objectives. First, data on household socio-economic characteristics were gathered, including age, education, farming experience, household size, and other relevant characteristics that may influence farmers' decisions to participate in contract farming. Second, information regarding participation in contract farming was collected to identify whether farmers had contractual relationships with dairy cooperatives or milk buyers. Third, the study collected data on household food insecurity, measured using the Food Insecurity Experience Scale (FIES) to capture households' experiences with food access constraints. These data were used to analyze the determinants of contract farming adoption and to compare the level of food insecurity between contract farming participants and non-participants.

Key Variables

The key explanatory variable in this study is participation in dairy contract farming, which reflects a household's decision to enter contractual arrangements with milk buyers, such as dairy cooperatives or processing companies. This variable is treated as a binary (dummy) variable indicating whether a household participates in contract farming. A value of 1 is assigned if the dairy farming household participates in a contract farming arrangement, meaning that the farmer sells milk through a formal or organized agreement with a cooperative or milk processing institution. Conversely, a value of 0 is assigned if the household does not participate in such arrangements and sells milk independently through informal marketing channels or local traders. This binary specification allows the variable to serve as the dependent variable in a Probit model to analyze the socio-economic factors influencing farmers' decisions to adopt contract farming (Mishra, Kumar, Joshi, & D'Souza, 2018a; Phong Tuan, 2012; Selorm et al., 2023). The dummy-variable structure also facilitates comparisons between contract farming adopters and non-adopters when evaluating household food insecurity outcomes.

Household food insecurity is measured using the Food Insecurity Experience Scale (FIES), an experience-based indicator developed by the Food and Agriculture Organization (FAO) to assess households' access to adequate food (FAO, 2017). The FIES consists of eight questions reflecting different levels of food access constraints experienced by

households during a specified reference period. These questions capture experiences such as worrying about not having enough food, being unable to eat healthy, nutritious food, reducing food portions, skipping meals, or going without eating due to limited resources. Each affirmative response ("Yes") is coded as 1, while negative responses ("No") are coded as 0. The total FIES score is calculated by summing all affirmative responses across the eight items, which can be expressed as follows:

$$\mathrm{FIES_i} = \sum_{j=1}^{8} \mathrm{R_{ij}} \quad (1)$$

Where $\mathrm{FIES_i}$ represents the food insecurity score for household i, and $\mathrm{R_{ij}}$ denotes the response to question $\mathrm{j}$for household i, with $\mathrm{R_{ij}} = 1$ if the response is "Yes" and $\mathrm{R_{ij}} = 0$ if the response is "No". The resulting FIES score ranges from 0 to 8, with higher values indicating greater household food insecurity. In this study, the FIES score is used to compare the level of food insecurity between households participating in contract farming and those that do not, thereby providing an empirical measure of household resilience to food access constraints.

Analysis Method

To address the first research objective, which is to identify the factors influencing dairy farmers' decisions to participate in contract farming, this study employs a Probit regression model. The Probit model is appropriate because the dependent variable, participation in contract farming, is a binary variable that takes the value 1 if the household participates and 0 otherwise. The model estimates the probability that a dairy farming household adopts contract farming as a function of several socio-economic characteristics. The Probit model can be expressed as follows:

$$\mathrm{P(Y_i = 1 \mid X_i)} = \Phi(\beta_0 + \beta_1 \mathrm{X_{1i}} + \beta_2 \mathrm{X_{2i}} + \cdots + \beta_k \mathrm{X_{ki}}) \quad (2)$$

Where $\mathrm{P(Y_i = 1 \mid X_i)}$ represents the probability that household i participates in contract farming, Φ denotes the cumulative distribution function of the standard normal distribution, $\mathrm{X_{1i}, X_{2i}, \ldots, X_{ki}}$ represent the explanatory variables related to household socio-economic characteristics, and $\beta_0, \beta_1, \ldots, \beta_k$are parameters to be estimated. This model allows the study to analyze how different household characteristics influence the likelihood of adopting dairy contract farming (Bezabeh et al., 2020; Loquias et al., 2022).

To address the second research objective, which is to compare the level of household food insecurity between farmers participating in contract farming and those who do not, this study applies an independent sample t-test. The t-test is used to determine whether there is a statistically significant difference in the mean Food Insecurity Experience Scale (FIES) score between the two groups of households. The t-test equation is expressed as follows:

$$\mathrm{t} = \frac{\bar{\mathrm{X}}_1 - \bar{\mathrm{X}}_2}{\sqrt{\frac{\mathrm{S}_1^2}{\mathrm{n}_1} + \frac{\mathrm{S}_2^2}{\mathrm{n}_2}}} \quad (3)$$

Where $\bar{\mathrm{X}}_1$and $\bar{\mathrm{X}}_2$represent the mean FIES scores of households participating in contract farming and those not participating, respectively; S_1^2 and S_2^2 denote the variances of the two groups; and $\mathrm{n}_1$and $\mathrm{n}_2$represent the number of observations in each group. This analysis allows the study to examine whether participation in dairy contract farming is associated with differences in household food insecurity levels, thereby providing insight into the role of contract farming in strengthening household resilience to food insecurity.

RESULTS AND DISCUSSION

Descriptive Statistics

Table 1 presents the descriptive statistics of the variables used in this study. The results show that 54% of the sampled dairy farmers participate in contract farming arrangements, while the remaining 46% operate independently without formal contractual agreements. This indicates that contract farming is relatively common among dairy farmers in the study area. The mean age of the household head is 47.92 years, suggesting that dairy farming is largely managed by individuals in their prime. In addition, farmers have an average of 21.5 years of dairy farming experience, indicating that most respondents have substantial practical knowledge and long-term engagement in dairy production.

Table 1.
Descriptive Statistics

Variable	Measurement	Mean	Std. dev.
Contract Farming	Dummy (1 = farmer participates in contract farming, 0 = otherwise)	0.540	0.501
Age	Years of household head	47.920	12.138
Experience	Years of dairy farming experience	21.500	13.083
Education	Years of formal education	7.350	2.524
Family Size	Number of household members (persons)	3.550	1.123
Live Stock Size	Number of dairy cattle owned (head)	4.810	2.440
Cage Area	Total cattle shed area (m²)	50.760	30.067
Land Agriculture Ownership	Dummy (1 = own agricultural land, 0 = otherwise)	0.460	0.407
Internet	Dummy (1 = farmer has internet access, 0 = otherwise)	0.920	0.273
Credit	Dummy (1 = farmer has access to credit, 0 = otherwise)	0.434	0.498

Source: Primary Data Processed, 2025

In terms of human capital characteristics, the average level of formal education among respondents is 7.35 years, which corresponds approximately to junior secondary education. The average household size is 3.55 members, indicating that dairy-farming households in the study area are relatively small to medium in size. Regarding farm resources, the average number of dairy cattle per farmer is 4.81, reflecting the typical smallholder scale of dairy farming operations in Indonesia. Furthermore, the average cage area is 50.76 m², suggesting that farmers maintain relatively modest livestock housing facilities consistent with smallholder production systems.

Access to productive assets and institutional resources also varies among respondents. Approximately 46% of farmers own agricultural land, while the remaining farmers rely primarily on livestock farming and have little land ownership. Access to digital technology appears relatively high, with 92% of farmers reporting internet access, which may facilitate access to information, extension services, and market-related knowledge. Meanwhile, about 43.4% of farmers have access to credit, indicating that financial services are available to a

portion of the farming population, though not universally. Overall, these descriptive statistics provide an overview of the socio-economic characteristics of dairy farming households in Malang Regency and offer important context for understanding the factors influencing contract farming adoption and household food insecurity outcomes.

Factor Determinant Contract Farming Dairy Farmers

The results of the Probit regression analysis presented in Table 2 indicate that several socio-economic variables influence farmers' decisions to participate in dairy contract farming, though only a few are statistically significant. Among the explanatory variables included in the model, education and access to credit are found to significantly affect the adoption of contract farming, whereas other variables, such as age, farming experience, family size, livestock size, cage area, land ownership, and internet access, do not show statistically significant effects. The coefficient signs indicate that education has a negative and significant effect, whereas credit access has a positive and significant effect on farmers' decisions to participate in contract farming. These results suggest that financial accessibility and human capital characteristics play different roles in shaping farmers' participation in contractual market arrangements.

The results show that education has a negative, statistically significant effect on contract farming adoption (coef. = -0.192; $p < 0.01$). This finding suggests that farmers with higher levels of formal education are less likely to participate in contract farming arrangements. One possible explanation is that more educated farmers may have better access to market information, wider social networks, and stronger bargaining power, allowing them to sell their milk independently without relying on contractual agreements with cooperatives or milk buyers. As a result, they may prefer more flexible marketing channels that allow them to negotiate prices or select buyers based on market conditions (Hoang & Nguyen, 2023). This finding contributes to the ongoing academic debate regarding the role of education in farmers' market participation decisions. While many studies argue that higher education facilitates the adoption of institutional innovations, other studies have found that more educated farmers may avoid contractual arrangements if they perceive them as restrictive or less profitable (Abdulai & Al-hassan, 2016; Hoang & Nguyen, 2023; Wang et al., 2014). In this context, the negative relationship between education and contract farming participation suggests that contractual systems may be more attractive to farmers facing greater market constraints and requiring institutional support for marketing their products (Abdulai & Al-hassan, 2016).

Access to credit is found to have a positive and statistically significant effect on contract farming adoption (coef. = 0.565; $p < 0.05$). This result indicates that farmers who have access to financial resources are more likely to participate in contract farming arrangements. Access to credit can improve farmers' ability to finance production activities, invest in livestock inputs, and maintain stable dairy operations that meet contractual production requirements (Bidzakin et al., 2019). Contract farming arrangements often require farmers to maintain certain production standards, such as consistent milk supply and quality, which may require financial investment in feed, veterinary services, and livestock management. Therefore, farmers with access to credit are better positioned to meet these requirements and are more likely to enter contractual relationships with milk buyers or cooperatives (Onyango et al., 2023; Purwanti et al., 2023). This finding is consistent with previous studies emphasizing the importance of financial

capital in facilitating farmers' participation in modern agricultural markets (Bidzakin et al., 2019; Gelata & Han, 2024; Jagri Binpori et al., 2021). Access to credit reduces financial constraints and enables farmers to adopt institutional arrangements that may improve income stability and market access, thereby supporting their participation in structured agricultural value chains. Meanwhile, other variables included in the model, such as age, farming experience, family size, livestock size, cage area, land ownership, and internet access, do not show statistically significant effects, indicating that these factors do not play a decisive role in determining farmers' participation in dairy contract farming within the study area.

Table 2.
Factor Determinant Contract Farming using Probit Regression

Contract Farming	Coefficient	Std. err.	P>|z|
Age	-0.004	0.017	0.806
Experience	0.001	0.015	0.943
Education	-0.192	0.068	0.005***
Family Size	0.004	0.142	0.979
Live Stock Size	0.008	0.082	0.919
Cage Area	0.010	0.007	0.165
Land Agriculture Ownership	-0.309	0.353	0.381
Internet	0.358	0.590	0.544
Credit	0.565	0.283	0.045**
_cons	0.733	1.022	0.474
Pseudo R2	0.1035		
Observation	100		

Note : ***,** significant at 1% and 5%

Source : Primary Data Processed, 2025

Differences in Food Insecurity Levels of Dairy Farmers

Table 3 presents the results of an independent-samples t-test comparing the level of household food insecurity between dairy farmers who participate in contract farming and those who do not. The results show a statistically significant difference in food insecurity levels between the two farmer groups. Farmers participating in contract farming exhibit lower food insecurity scores than non-contract farmers, indicating that contract farming is associated with better household food access. The mean FIES score for contract farmers is 8.611, while non-contract farmers have a higher mean score of 9.543. The mean difference between the two groups is -0.932, and the result is statistically significant at the 1% level ($p < 0.01$). This finding suggests that contract farming participation may improve household resilience to food insecurity among dairy farming households.

The statistical results indicate that the difference in food insecurity levels between contract farmers and non-contract farmers is negative and statistically significant (diff = -0.932; $p < 0.01$). This means that dairy farmers who participate in contract farming experience significantly lower levels of food insecurity compared to those who operate independently. One possible explanation is that contract farming arrangements

provide farmers with more stable and predictable income through guaranteed milk marketing channels (Tricarico et al., 2020). Stable income from daily milk sales enables households to maintain more consistent food consumption and reduces the risk of experiencing food shortages (Akter & Basher, 2014; Megersa et al., 2014; Tricarico et al., 2020). In addition, contract farming relationships with cooperatives or milk processors may provide farmers with additional support, such as access to technical assistance, input services, and institutional networks, thereby indirectly strengthening their economic stability (Hung Anh et al., 2019).

Table 3.
Differences in Food Insecurity Levels of Dairy Farmers

Variabel	Obs	Mean	Std.Error
Contract	54	8.611	0.110
Non Contract	46	9.543	0.180
diff		-0.932	0.204
Pr ([T] > [t])		0.0000***	

Note : *** significant at 1%
Source : Primary Data Processed, 2025

This finding contributes to the broader academic discussion on the welfare implications of agricultural commercialization and contract farming. Previous studies have shown that participation in contract farming can improve farmers' income, market access, and production efficiency, which may subsequently influence household welfare outcomes (Chen & Chen, 2021; Mishra, Kumar, Joshi, & D'Souza, 2018b; Mwambi et al., 2016; Ton et al., 2018). Some studies argue that contract farming can enhance household food security by stabilizing income and reducing market risks faced by smallholder farmers (Akter & Basher, 2014; Megersa et al., 2014). However, other scholars highlight that the benefits of contract farming may vary depending on institutional arrangements, contract terms, and farmers' capacity to meet production requirements. In the context of smallholder dairy farming in Malang Regency, the findings of this study provide empirical evidence that participation in contract farming is associated with lower household food insecurity, supporting the argument that institutional market arrangements can play an important role in strengthening the resilience of rural households to food access constraints (Akter & Basher, 2014; Megersa et al., 2014).

CONCLUSION

This study examines the determinants of dairy farmers' participation in contract farming and analyzes differences in household food insecurity between contract farmers and noncontract farmers. The research was conducted among smallholder dairy farmers in Malang Regency, East Java, one of Indonesia's major dairy production areas. Using primary data collected from 100 farming households through direct interviews, this study applied a Probit regression model to analyze factors influencing farmers' decisions to adopt contract farming, and an independent-samples t-test to compare food insecurity levels measured using the Food Insecurity Experience Scale (FIES). The empirical results show that education and access to credit significantly influence

farmers' participation in contract farming. Education has a negative and significant effect on contract farming adoption, suggesting that farmers with higher levels of formal education are less likely to participate in contractual arrangements, possibly because they can access alternative marketing channels more easily. In contrast, access to credit has a positive and significant effect, indicating that financial resources enable farmers to participate in contractual production systems that often require investment and compliance with production standards. Furthermore, the results reveal that contract farmers experience significantly lower levels of food insecurity than non-contract farmers, indicating that contractual arrangements may improve household resilience to food insecurity by providing more stable market access and more predictable income from milk sales. These findings contribute to the growing literature on contract farming by extending the discussion beyond economic performance indicators such as income and productivity to include household food insecurity outcomes. The results highlight the importance of institutional market arrangements in strengthening the welfare of smallholder dairy farmers by providing more stable marketing channels and reducing income uncertainty. From a practical perspective, the study suggests that policies aimed at improving farmers' access to credit and strengthening institutional partnerships within the dairy value chain may enhance farmers' participation in contract farming and, in turn, improve household food security. However, this study also acknowledges several limitations that open opportunities for future research. Further studies may apply more advanced impact evaluation methods to address potential self-selection bias in contract farming participation and explore additional welfare indicators such as nutritional outcomes, income stability, and household resilience to economic shocks. Overall, this study underscores the role of contract farming as a potential institutional mechanism for improving the resilience of smallholder dairy farming households in addressing food insecurity.

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