Acta Sci. Pol.
Oeconomia 24 (3) 2025, 47–61
acta_oeconomia.sggw.pl ISSN 1644-0757 eISSN 2450-047X DOI: 10.22630/ASPE.2025.24.3.12

ORIGINAL PAPER

Received: 30.09.2024
Accepted: 30.05.2025

DOUBLE-HURDLE IN ADOPTION OF DAIRY CATTLE CONTRACT FARMING AMONG SMALL-SCALE FARMERS IN MBEYA, TANZANIA

Felister Y. Tibamanya✉, Harold Utouh, Aidan Sunday

Mzumbe University, Tanzania

ABSTRACT

Aim: Understanding the market dynamics of dairy cattle farming in Tanzania is vital for fostering a competitive and sustainable dairy industry. Contract farming is a prominent market structure in this realm, offering small-scale farmers improved breeds, veterinary services, feed, and extension support. However, the engagement of small--scale farmers in dairy cattle contract farming is currently limited. Encouraging its uptake requires a thorough understanding of the driving forces and impediments. Previous studies investigating the factors influencing the adoption of dairy cattle contract farming have overlooked the correlation between the liquidity constraints of vaccination and the barriers to its adoption. This study addresses this gap. **Methods:** The study analyzed data gathered using a structured questionnaire from 300 randomly selected small-scale dairy cattle farmers in the Mbeya Region and employed a double-probit model to correct sample selection biases. **Results:** The research uncovered that the adoption of dairy cattle contract farming by small-scale farmers is influenced by household size, risk aversion, access to extension services, radio ownership, quantity of dairy cattle owned, type of dairy cattle breed, liquidity constraints of vaccination, utilization of artificial insemination, and the application of veterinary treatment. **Conclusions:** The study emphasizes the efforts toward implementing initiatives that streamline farmers' access to superior dairy cattle breeds, vaccination, veterinary treatment, and artificial insemination services.

Key words: drivers, dairy cattle, contract farming, leaping hurdles, Tanzania

JEL codes: Q12, O33, D01, D10

INTRODUCTION

The adoption of contract farming in the dairy sector has garnered significant attention as a potentially transformative approach for enhancing agricultural production, income, and food security in many developing economies [Reardon et al. 2001, Hirpesa et al. 2021, Ng'ombe et al. 2022]. Dairy cattle contract farming arrangements involve formal agreements between farmers and agribusiness firms, often with provisions for technical support, input supply, and guaranteed markets [Key et al. 2000, Olounlade et al. 2020]. These agreements aim to optimize resource use and increase overall productivity, making them particularly appealing to small-scale farmers. In sustainable agricultural development, understanding the drivers of adopting dairy cattle contract farming is paramount [Spielman and Hartwich 2008].

Dairy cattle contract farming in Tanzania provides small-scale farmers access to advanced technologies

Felister Y. Tibamanya https://orcid.org/0000-0002-2258-9448, Harold Utouh https://orcid.org/0000-0002-1883-2433, Aidan Sunday https://orcid.org/0009-0002-0767-4545

✉ fytibamanya@mzumbe.ac.tz

(like veterinary services and dairy farming machines), resources (such as improved breeds, concentrates, drugs, and feed), and knowledge (via extension services, training and technical supports), which significantly elevate their productivity and profitability [RADO 2023]. Moreover, it secures a stable market for their milk, reducing uncertainties and price fluctuations [Olounlade et al. 2020]. Dairy contract farming plays a pivotal role in elevating milk production's quality and safety standards, ensuring alignment with market requisites, and boosting consumer confidence [Olounlade et al. 2020]. It also fosters connections between small-scale farmers and formal markets, enhancing market access and profitability [RADO 2023].

Contract conditions between dairy farmers and processors in Tanzania include milk quality requirements, delivery schedules, and pricing terms to ensure a reliable supply [RADO 2023]. Some contracts provide technical support and training to help farmers meet quality standards [RADO 2023]. Farmers must usually deliver a minimum quantity of milk, determined by herd size or historical production levels [RADO 2023]. Quality assessment focuses on fat content, bacterial counts, and freshness, with collection centers or processors conducting tests at delivery. Milk not meeting standards may be rejected or purchased at a reduced price [RADO 2023]. Penalties for contract non-fulfillment, including payment reductions or contract suspension, are outlined in the contract terms [RADO 2023].

Milk prices in Tanzania are influenced by market demand, production costs, and quality, with premiums awarded for high-quality milk [MLF et al. 2019, RADO 2023]. Additionally, seasonal demand variations and government policies contribute to price stabilization for both farmers and processors [MLF et al. 2019].

Despite the relevance of dairy cattle contract farming, challenges persist within Tanzania's system. These encompass the scarcity and high costs of inputs, inadequate extension services, difficulties in contract enforcement, and unequal power dynamics between farmers and contracting entities [RADO 2023]. These obstacles can potentially hinder fair benefit distribution and limit the transformative impact on the lives of small-scale dairy farmers. To address these challenges, various policies and plans in Tanzania advocate for and encourage engagement in contract farming among small-scale farmers. These include the National Agricultural Policy of 2013, the Agricultural Marketing Policy of 2008, and the Tanzania (National) Five-Year Development Plan (2016–2021) [MFP 2016, AGRA 2019]. Nonetheless, participation in contract farming remains limited among small-scale dairy cattle farmers in Tanzania [Ochieng et al. 2017].

Numerous research endeavors [Islam et al. 2019, Nhan 2019, Bidzakin et al. 2020, Olounlade et al. 2020, Hirpesa et al. 2021, Pham et al. 2020, Nhan 2019, Islam 2021, Kiwanuka-Lubinda et al. 2021, Ng'ombe et al. 2022] have investigated the factors influencing engagement in livestock contract farming across Sub-Saharan Africa, including Tanzania. Nevertheless, these studies have thus far omitted exploring the correlation between the utilization of artificial insemination, liquidity constraints stemming from vaccination, and participation in dairy cattle contract farming, which is a knowledge gap that this research seeks to address.

This paper comprehensively analyzes the overlooked driver, considering various socio-economic, technological, and institutional factors influencing farmers' decisions to participate in dairy cattle contract farming. This study contributes to the body of literature as it analyzes the relationship between the liquidity constraints of vaccination and the utilization of artificial insemination and participation in dairy cattle contract farming, which previous studies have overlooked. Also, this study examined the two hurdles dairy cattle farmers face while adopting contract farming.

PRODUCTION OF MILK IN TANZANIA

Milk production in Tanzania rose from 2017 to 2020 (Fig. 1), supported mainly by indigenous breeds and predominantly driven by smallholder farmers [Kitole and Sesabo 2022]. In Tanzania, around 2 million smallholder farms are involved in milk production, predominantly family-operated, with herds typically ranging from a single cow to 10 cows [MLF 2017]. Smallholders contribute

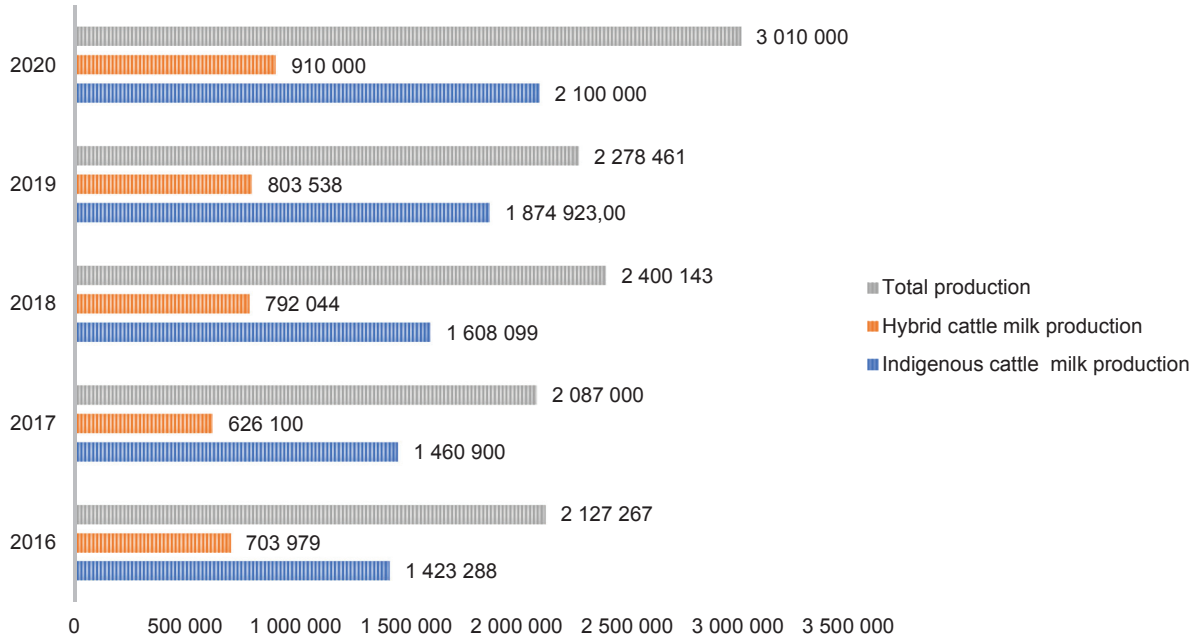

Fig. 1. Milk production (in thousands of liters) in Tanzania from 2016 to 2020

Source: NBS [2021].

over 90% of the national milk supply, while larger commercial farms, mainly in regions such as Arusha and Kilimanjaro, contribute a smaller share [Lunogelo and Makene 2020].

Most smallholder farms keep indigenous breeds like the Tanzania shorthorn zebu, yielding 1–2 L of milk daily [MLF et al. 2019, Kitole and Sesabo 2022]. Crossbreeding has introduced higher-yielding breeds, producing 10–15 L daily in favorable areas [MLF et al. 2019, Kitole and Sesabo 2022]. Commercial farms, though limited, manage high-yield breeds like the Holstein-Friesian, with outputs of 15–30 L daily [MLF et al. 2019]. Feeding strategies vary widely as smallholders depend on natural pastures and crop residues, while commercial farms use structured feeds like silage and concentrates to boost yields [MLF et al. 2019]. Development programs are helping smallholders adopt fodder cultivation to improve productivity [Shija et al. 2022]. As smallholder producers dominate the sector, much of the milk produced is consumed locally, with only a limited portion reaching formal markets [RADO 2023]. Major production areas include the northern, eastern, and southern highlands, with a few larger commercial dairies near urban centers [RADO 2023].

Milk production for native cows remains low, averaging 0.5–2.0 L daily, compared to pure dairy breeds, which can produce 20–30 L daily [MLF 2022]. However, milk production drops to a minimum during dry seasons, hindering the value chain [MLF 2022]. The country's annual milk production is approximately 3 billion L, though productivity varies significantly depending on factors like breed type, feeding practices, and farm management [Shija et al. 2022]. The national cattle herd comprises indigenous breeds, which currently exhibit low productivity [MLF 2022]. Nevertheless, these breeds have considerable potential for improvement if advancements are made in their feeding, health care, and breeding practices [MLF 2022]. Challenges like feed availability, limited veterinary care, and market access affect the overall productivity [MLF 2022]. To improve milk production and productivity, initiatives including the Livestock Sector Transformation Plan (LSTP) and the African

Dairy Genetic Gains (ADGG) Program focus on enhancing high-quality breeding, feed practices, animal health, extension services, value addition of livestock products, including milk, and infrastructure development [MLF 2022, Shija et al. 2022]. In Tanzania, only about 2.7% of the milk produced is sold to processors through contractual agreements or informal arrangements (Fig. 2).

Milk production from native cows in Tanzania remains low due to breed limitations and seasonal challenges. However, productivity can be improved through better feeding, healthcare, and breeding practices, supported by initiatives such as the LSTP and the ADGG.

LITERATURE REVIEW

Two-step partially observed theoretical model

This study extracted pertinent insights regarding the determinants of engagement in contract farming by employing the two-step partially observed model established by Dimara and Skuras [2003] to elucidate individual decision-making processes. The model postulates that whether to embrace an innovation is contingent upon prior awareness or knowledge of that innovation, i.e., achieving an optimal information level. Within this framework, participation in contract farming is conceived as a two-step decision-making process. Initially, the decision-maker decides whether to acquire awareness regarding the presence and advantages of contract farming. Subsequently, the decision-maker chooses to engage in or adopt contract farming practices. These two steps are presumed to be influenced by a range of factors encompassing household socio-demographic and economic variables and institutional elements.

The decision-maker's goal is to maximize utility based on the information accessible to them. Under this premise, the relationship can be articulated as follows:

$$I^* \equiv I(x) \tag{1}$$

where:
I^* – latent information level,
I – observed information level,
x – vector of individual characteristics.

The decision-maker is aware of the innovation if the level of acquired information is greater than a certain threshold level (I^T):

$$I^* > I^T \tag{2}$$

or

$$Y^{A*} \equiv I^* - I^T > 0 . \tag{3}$$

It can be expressed as a linear model:

$$Y^{A*} \equiv \beta z + \varepsilon^A \tag{4}$$

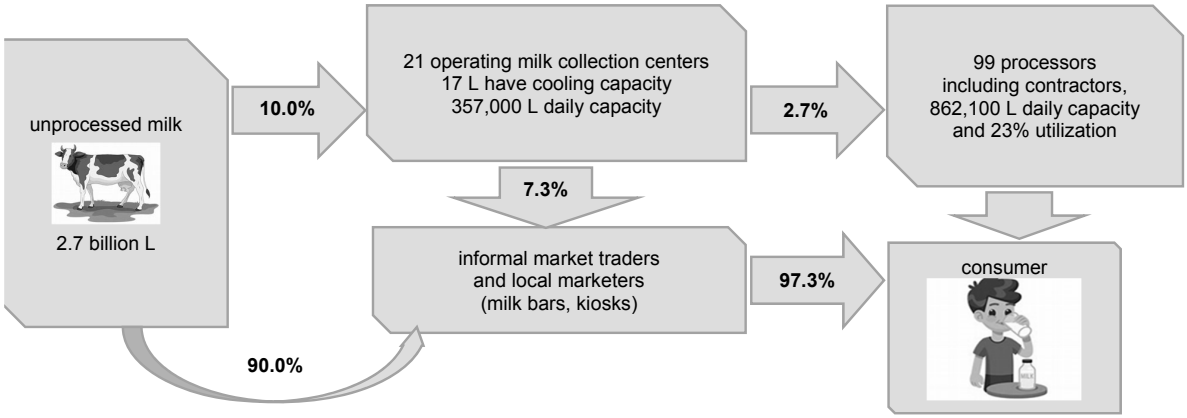

Fig. 2. Market channels of milk produced in Tanzania

Source: MLF et al. [2019].

where:
Y^{A*} – latent variable for awareness,
β – vector of parameter,
z – vector of explanatory variables,
ε^{A} – error term related to the level of awareness (A),

Thus, the outcome (i.e., whether the dairy contract farming is adopted or not) is denoted by Y. Hence, the relationship can be expressed as:

$$Y = Y^{A} = \begin{cases} 1 \text{ if adopted}, & \theta X > 0 \\ 0 \text{ if not adopted}, & \theta X \leq 0 \end{cases} \quad (5)$$

Thus, the outcome (i.e., whether the dairy contract farming is adopted or not) is denoted by Y.

Empirical literature on the drivers of adopting contract farming

The studies unveiled several household characteristics that influence participation in contract farming. Engagement in these contracts was positively and significantly associated with age [Hirpesa et al. 2021], gender, where male-headed households showed a positive correlation [Kiwanuka-Lubinda et al. 2021], and female-headed households demonstrated a similar trend [Soullier and Moustie 2018], as well as household size [Rondhi et al. 2020, Ng'ombe et al. 2022]. The marital status of the household head [Ng'ombe et al. 2022], education, farm size, and risk preference [Rondhi et al. 2020], experience [Kiwanuka-Lubinda et al. 2021] and wealth [Kiwanuka-Lubinda et al. 2021], selling to milk collection centers [Kiwanuka-Lubinda et al. 2021], ownership of improved breed animals [Soullier and Moustie 2018], livestock holding, and ownership of a milking parlor [Kiwanuka-Lubinda et al. 2021] all demonstrated a positive influence on farmers' inclination to participate in contract farming. Access to these inputs through the contract enhanced productivity and profitability. Price stability and premiums also played a pivotal role. Contracts offering stable and favorable prices, including price premiums or guaranteed minimum prices, motivated farmers to adopt contract farming. Perceptions of price uncertainty [Hirpesa et al. 2021], delayed payment [Ng'ombe et al. 2022], milk price [Soullier and Moustie 2018], price fluctuations, and the average price experience before contract farming participation [Islam et al. 2019] were significant incentives for smallholder farmers.

Institutional factors, including access to marketing information [Kiwanuka-Lubinda et al. 2021], proximity to the central market and cooperative membership [Bezabeh et al. 2020], access to dairy marketing information [Soullier and Moustie 2018], distance from a miller offering production contracts [Soullier and Moustie 2018], and the frequency of extension contacts and access to training [Hirpesa et al. 2021] positively influenced the adoption of contract farming. These services augmented farmers' knowledge and capacity to meet quality standards, employ improved practices, and comply with contractual requirements. However, some studies indicated that participation in contract farming was negatively and significantly linked with distance from the collection center and perceived credit uncertainty [Soullier and Moustie 2018].

Socioeconomic factors were also notable determinants. Landholding [Soullier and Moustie 2018, Kiwanuka-Lubinda et al. 2021], and income from other sources, the presence of milk collection centers, and milk price [Soullier and Moustie 2018] were identified as significant factors influencing contract farming adoption. Farmers with higher levels of education, larger households, and secure land tenure were more inclined to engage in contract farming. The empirical literature reviewed underscores the intricate array of determinants shaping the decision of smallholder farmers to partake in contract farming in developing countries. The findings highlight the importance of household factors, resources/inputs, price stability, institutional factors, and socioeconomic elements in influencing farmers' participation in contract farming agreements.

DATA AND METHODS

The study utilized cross-sectional data gathered in the Mbeya Region, a well-known and esteemed area in the Southern Highlands of Tanzania. It is celebrated for its exceptional dairy cattle breeds and long-established dairy farming practices. The study adopted a cross-sectional survey design and employed a three-stage sampling strategy. Initially, purposive sampling was used to select the specific districts for the study.

The Rungwe district was chosen deliberately due to its notable prominence in dairy farming relative to other districts. Secondly, based on the presence of contract farming, the study selectively identified five villages for inclusion. Finally, a stratified random sampling technique with non-proportional sampling, as per the method delineated by Kilima [2021], was employed to select dairy farmers with and without contract farming. The process yielded a sample size of 300 dairy cattle farmers, consisting of 179 dairy cattle contract farmers and 121 non-dairy cattle farmers. Data for the study, conducted in 2023, was gathered from the sample using a structured questionnaire.

The two-stage or double-probit model, as suggested by Dimara and Skuras [2003], is applied to analyze the determinants of adoption of contract farming among dairy farmers. Dimara and Skuras [2003] describe the two-stage or double-probit model as consisting of the awareness and adoption equations. The probit model for the awareness equation is specified as:

$$Y_i^{A*} = \beta_i X_i + \varepsilon_i^A \tag{6}$$

$$Y_i^A = \begin{cases} 1 \text{ if } Y_i^{A*} > 0,\ \beta_i X_i > \varepsilon_i^A \\ 0 \text{ if } Y_i^{A*} \le 0,\ \beta_i X_i \le \varepsilon_i^A \end{cases} \tag{7}$$

where:
Y_i^{A*} – latent continuous variable indicating the tendency of the household (i) of being aware of the availability of contract farming,
β_i – vector of unknown parameters,
X_i – vector of variables that may explain whether a household (i) is aware of the availability of contract farming,
ε_i^A – error term related to the level of awareness (A) that considers the effects of unobserved variables on the tendency of the household (i) to be aware of the availability of contract farming,
Y_i^A – observed binary variable indicating whether the household (i) is aware of the availability of contract farming or not (Y_i^A = 1 if a dairy cattle farmer is aware of the availability of contract farming; Y_i^A = 0 otherwise).

The participation equation (outcome equation) estimated using the probit model can be written as:

$$Y_i^* = \gamma_i Z_i + \varepsilon_i \tag{8}$$

$$Y_i = \begin{cases} 1 \text{ if } Y_i^* > 0 \ \ Y_i^{A*} > 0 \\ 0 \text{ if } Y_i^{A*} \le 0 \ \ Y_i^{A*} \le 0 \end{cases} \tag{9}$$

where:
Y_i^* – (latent) expected utility gain from adopting the contract farming ,
γ_i – vector of unknown parameters,
Z_i – vector of explanatory variables that may explain the expected utility gain from adopting the contract farming,
ε_i – error term that considers the effects of unobserved factors on the expected utility gain from adopting the contract farming,
Y_i – observed binary variable indicating whether the household adopts the contract farming or not (Y_i = 1 if a dairy cattle farmer participates in the contract farming; Y_i = 0 otherwise).

Dimara and Skuras [2003] suggest that error terms follow a bivariate standard normal distribution:

$$\begin{pmatrix} \in_i^A \\ \in_i \end{pmatrix} \sim N_2(\rho) \tag{10}$$

where:

$$\begin{pmatrix} \varepsilon_i^A \\ \varepsilon_i \end{pmatrix} \sim N_2 \tag{11}$$

where:
N_2 – indicates the bivariate standard normal distribution,
$\rho \in [-1, 1]$ – coefficient of correlation between variances ε_i^A and ε_i (and are without loss of generality normalized to 1).

The double-probit model offers two notable advantages [Dimara and Skuras 2003]: (1) This model treats the variable "awareness" as an observed variable, enhancing the precision of estimates through the inclusion of additional information; and (2) The influence of unobserved factors on awareness is uncorrelated with the influence of unobserved factors on adoption – this study does not impose such a highly restrictive assumption.

RESULTS AND DISCUSSION

Descriptive results

Table 1 provides a comprehensive overview of the descriptive findings, encompassing the entire sample and those obtained by separating participants from non-participants in dairy cattle contract farming. The results in Table 1 indicate significant disparities between these two groups across various variables. The analysis reveals a significant difference in awareness of dairy cattle contract farming between participants and non-participants, significant at the one--percent level. This suggests that participants are more informed about dairy cattle contract farming than non--participants. There is a substantial difference in education levels between participants and non-participants, significant at the ten-percent level. Participants tend to be more educated than non-participants. Participants

Table 1. Descriptive results of contract and non-contract dairy cattle farmers

Variable	All	Dairy cattle contract farmers	Dairy cattle non-contract farmers	*p*-Value
Awareness of dairy cattle contract farming	0.683	0.989	0.231	0.000
Sex of the household head (male)	0.790	0.816	0.752	0.19
Age [year]	0.468	0.470	0.465	0.798
Education (no education)	0.0700	0.045	0.107	0.053
Household size (number)	4.107	4.045	4.198	0.474
Experience in dairy farming [year]	13.450	14.402	0.120	0.061
Risk aversion [risk taker]	0.570	0.520	0.645	0.031
Total landholding [acre]	1.803	1.894	2.140	0.009
Quantity of cattle (number)	2.387	2.553	2.140	0.093
Quantity of dairy cattle (number)	1.817	1.939	1.636	0.014
Liquidity constraints of vaccination [yes]	0.220	0.235	0.198	0.453
Distance from veterinary clinic to grazing land [km]	1.653	1.274	2.215	0.0000002
Distance from Mbeya to the village [km]	870.912	102.438	64.388	0.302
Type of breed (improved)	0.160	0.240	0.041	0.000001
Use of veterinary treatment/improved cure (yes)	0.897	0.933	0.843	0.019
Use of artificial insemination (yes)	0.127	0.145	0.099	0.226
Use of vaccinations (yes)	0.780	0.816	0.727	0.078
Received extension service (yes)	0.370	0.380	0.355	0.667
Radio ownership (yes)	0.870	0.922	0.793	0.0023
Cost of feed [TZS]	556 930.4	586 377.8	513 367.8	0.322
Cost of concentrate [TZS]	385 891.9	386 848.5	384 476.9	0.972
Cost of veterinary care [TZS]	134 325	14 204.75	122 900.8	0.226
Cost of rope [TZS]	27 182.0	22 360.9	34 314.05	0.434
Cost of production tools [TZS]	23 842.84	22 678.78	25 564.88	0.483
Cost of phone calls [TZS]	51 988.00	53 473.74	49 790.08	0.562
Cost of transport [TZS]	40 498.17	39 730.17	41 634.3	0.735
Observation	300	179	121	×

Source: authors' research.

in dairy cattle contract farming have, on average, significantly more years of experience in dairy cattle farming than non-participants, which is significant at the ten-percent level. Risk aversion substantially differs between the two groups, significant at the one-percent level, indicating that participants are, in proportion, less inclined to take risks than non-participants. Total landholding significantly differs between the two groups at the one-percent level. On average, participants have smaller total landholdings than non-participants.

Participants have, on average, significantly larger quantities of both cattle and dairy cattle compared to non-participants, significant at the ten-percent and five-percent levels, respectively. There is a substantial difference in the distance from veterinary services to grazing land between participants and non-participants, significant at the one-percent level. On average, participants have a shorter distance from veterinary services to grazing land. Participants significantly used improved dairy cattle breeds and vaccinations compared to non-participants, which were significant at the one-percent and ten-percent levels, respectively. A substantial difference in radio ownership exists between the two groups, significant at the one-percent level. Participants own a higher proportion of radios compared to non-participants.

Table 1 shows significant differences between participants and non-participants in dairy cattle contract farming, including awareness, education, experience, risk aversion, livestock ownership, and access to veterinary services. These disparities highlight the influence of contract farming participation on socioeconomic and farming characteristics.

Drivers of awareness of contract farming among small-scale dairy cattle farmers

Table 2 shows that awareness of dairy cattle contract farming is significantly associated with household size, risk aversion, extension service, quantity of dairy cattle owned, dairy cattle breed type, distance from the veterinary clinic to the grazing land, use of artificial insemination, and liquidity constraints of vaccination. Household size is found to be negative and significantly associated with awareness of dairy cattle contract farming at 10%. The finding indicates that household size reduces the probability of awareness of dairy cattle contract farming by 3 percentage points (pp), ceteris paribus. This finding concurs with the underpinning theoretical expectations.

Risk aversion is found to be negative and significantly related to awareness of dairy cattle contract farming at 5%. The finding shows that risk-taking dairy cattle farmers are 12 pp less likely to be aware of dairy cattle contract farming than risk-averse dairy cattle farmers, holding the other factors constant. This finding aligns with the underpinning theoretical expectations. However, the extension service is found to be positive and significantly associated with awareness of dairy cattle contract farming at 10%. The finding indicates that dairy cattle farmers with access to extension services have a 9 pp higher probability of being aware of dairy cattle contract farming than those with no access to extension services, ceteris paribus. This finding concurs with the underpinning theoretical expectations.

Also, the quantity of dairy cattle owned and the dairy cattle breed type were found to be positively and significantly related to awareness of contract farming at 5% and 1%, respectively. These indicate that the probability of being aware of dairy cattle contract farming increases by 7 pp for farmers with a larger quantity of dairy cattle and by 19 pp for farmers using improved dairy cattle breeds, respectively, than otherwise, ceteris paribus. This finding concurs with the underpinning theoretical expectations. On the other hand, the finding shows that dairy cattle farmers who use artificial insemination are 12 pp more likely to be aware of dairy cattle contract farming than those with no use of artificial insemination at the ten-percent level. In contrast, distance from the veterinary clinic to the grazing land is found to significantly reduce the probability of being aware of dairy cattle contract farming by 9.5%, holding the other factors constant.

Further, the results show that liquidity constraints from vaccination significantly (at 5%) increase the likelihood of being aware of dairy cattle contract farming by 13 pp at ceteris paribus. The discovery implies that limited financial access to vaccination services heightens awareness about contract farming among dairy cattle farmers. Financial constraints

can prompt farmers to explore diverse approaches to enhance dairy cattle management and income generation, ultimately leading to increased awareness of contract farming as a viable solution. Additionally, the finding suggests that farmers facing these constraints possess greater awareness of contract farming as a method to mitigate risks related to dairy cattle health and financial stability. Contract farming may provide a channel to access resources, such as vaccination services, through collaborations with contract farming sponsors or buyers. This acts as a significant obstacle to dairy contract farming, compelling farmers to seek contract farming knowledge for future decision--making.

Therefore, awareness of dairy cattle contract farming is significantly influenced by household size, risk aversion, extension services, livestock quantity and breed type, artificial insemination, distance

Table 2. Estimated DPM results on drivers of awareness of dairy cattle contract farming

Variable	Estimate	*SE*	*ME*
Intercept	−0.704	0.847	–
Age [year]	0.006	0.007	0.180
Sex (male)	0.209	0.209	0.063
Education (no education)	−0.283	0.327	−0.089
Household size (number)	−0.086*	0.049	−0.025
Experience [year]	0.0095	0.011	0.003
Risk attitude (risk taker)	−0.411**	0.1966	−0.115
Radio ownership (yes)	0.272	0.253	0.084
Extension service (yes)	0.340*	0.186	0.094
Quantity of dairy cattle owned (number)	0.250**	0.109	0.072
Dairy cattle breed type (improved)	0.862***	0.310	0.188
Quantity of cattle owned (number)	−0.008	0.088	−0.002
Land holding [acre]	−0.031	0.052	−0.009
Cost of dairy production tools [TSZ]	0.000003	0.0000029	0.0000009
Cost of fodder [TSZ]	−0.0000006	0.000001	−0.00000002
Cost of concentrates [TSZ]	0.0000003	0.0000002	0.0000007
Cost of rope [TSZ]	−0.000003	0.000003	−0.000001
Cost of veterinary services [TSZ]	0.0000005	0.0000006	0.0000002
Cost of phone calls [TZS]	0.0000005	0.000002	0.0000001
Cost of transport [TZS]	−0.000001	0.000002	−0.0000004
Distance from veterinary clinic to grazing land [km]	−0.333***	0.0746	−0.095
Distance from Mbeya town to the village [km]	0.011	0.0106	0.003
Use of veterinary services (yes)	−0.314	0.313	−0.081
Use of artificial insemination (yes)	0.477*	0.278	0.116
Liquidity constraint of vaccination service (yes)	0.494**	0.227	0.125
Access/Use of the vaccination service (yes)	0.335	0.211	0.103

*indicates statistical significance at the 0.10 level, **indicates statistical significance at the 0.05 level, ***indicates statistical significance at the 0.01 level.

Source: authors' research.

to veterinary services, and liquidity constraints. These factors highlight key determinants affecting farmers' awareness and decision-making in contract farming.

Drivers of participation in dairy cattle contract farming among small-scale contract farming

Table 3 shows that determinants of participation in dairy cattle contract farming are significantly associated with education, household size, risk aversion, extension service, radio ownership, quantity of dairy cattle owned, dairy cattle breed type, use of artificial insemination, and use of veterinary treatment. Education is found to be negative and significantly related to participation in contract farming at 5%, whereas not being educated reduces the probability of participating in dairy cattle contract farming by 27 pp, ceteris paribus. Farmers with education are better equipped to assess the potential benefits and risks associated with contract farming and make informed decisions about participation. This finding concurs with the theoretical expectations and with previous studies [Kiwanuka and Machethe 2016, Islam et al. 2019, Olouniade et al. 2020, Rondhi et al. 2020].

Household size is also found to be negative and significantly associated with participation in dairy cattle contract farming at 5%. The finding indicates

Table 3. Estimated DPM results on drivers of participation in dairy cattle contract farming

Variable	Estimate	*SE*	*ME*
Intercept	−1.592***	0.540	–
Age [year]	0.001	0.007	0.0004
Sex (male)	0.262	0.204	0.102
Education [year]	−0.699**	0.320	−0.273
Household size (number)	−0.105**	0.047	−0.040
Experience [year]	0.011	0.010	0.0004
Risk attitude (risk taker)	−0.349*	0.184	−0.131
Radio ownership (yes)	0.802***	0.251	0.312
Extension service (yes)	0.468***	0.178	0.173
Quantity of dairy cattle owned (number)	0.212**	0.099	0.081
Dairy cattle breed type (improved)	1.137***	0.298	0.347
Quantity of cattle owned (number)	−0.013	0.085	−0.0005
Land holding [acre]	−0.028	0.0482	−0.001
Cost of dairy production tools [TSZ]	−0.0000009	0.000002	−0.0000003
Cost of fodder [TSZ]	−0.00000001	0.0000001	−0.000000005
Cost of concentrates [TSZ]	−0.00000007	0.0000002	−0.00000003
Cost of rope [TSZ]	−0.000002	0.000002	−0.0000008
Cost of veterinary services [TSZ]	0.0000003	0.0000006	0.0000001
Cost of phone calls [TZS]	0.000001	0.0000015	0.0000004
Cost of transport [TZS]	−0.0000008	0.000002	−0.0000003
Use of veterinary services (yes)	0.554*	0.284	0.217
Use of artificial insemination (yes)	0.464*	0.254	0.164
Liquidity constraint of the vaccination service (yes)	0.196	0.205	0.073
Use of the vaccination service (yes)	0.258	0.203	0.10003

*indicates statistical significance at the 0.10 level, **indicates statistical significance at the 0.05 level, ***indicates statistical significance at the 0.01 level.

Source: authors' research.

that household size reduces the probability of participating in dairy cattle contract farming by 4 pp, ceteris paribus. The finding indicates that a larger household size decreases the likelihood of participation in dairy cattle contract farming. The large number of household members reduces participation in dairy cattle contract farming because the head of the household has a huge burden of taking care of them and invests less effort in dairy cattle farming. The discovery underscores the potential hurdles faced by farmers in larger households, as they might possess fewer resources to invest in learning about and participating in contract farming. This aligns with the expected theories underlying this issue. Moreover, it diverges from earlier research by Nhan et al. [2019], Rondhi et al. [2020], and Ng'ombe et al. [2022], likely due to their focus on broiler contract farming determinants [Rondhi et al. 2020] and rice contract farming [Nhan et al. 2019]. Additionally, Ng'ombe et al. [2022] explored dairy contract farming using Bayesian zero-one inflated beta regression, while this study employed a double-probit model.

Similarly, risk aversion is found to be negative and significantly related to participation in dairy cattle contract farming at 10%. The finding shows that risk-taking dairy cattle farmers have less likelihood of participating in dairy cattle contract farming by 12 pp than risk-averse dairy cattle farmers, holding the other factors constant. The finding indicates that farmers who are more risk-averse are less likely to be aware of contract farming opportunities and are hesitant to engage in such arrangements. Risk-taking farmers may be less inclined to seek information or actively engage in learning about contract farming due to their aversion to potential risks and uncertainties. This finding supports the earlier studies [Hou et al. 2020, Pham et al. 2020] and is contrary to theoretical expectations.

Radio ownership is found to be positive and significantly associated with participation in dairy cattle contract farming at 1%. The finding indicates that dairy cattle farmers with a radio have a higher probability of participating in dairy cattle contract farming by 31 pp than those with no radio, ceteris paribus. On the other hand, the extension service is found to be positive and significantly associated with participation in dairy cattle contract farming at 1%. The finding implies that radio access plays a significant role in facilitating awareness and engagement in contract farming among dairy cattle farmers. The radio is a significant means of accessing information and knowledge regarding participation in dairy cattle contract farming among small-scale farmers.

The finding indicates that dairy cattle farmers with access to extension services have a higher probability of participating in dairy cattle contract farming by 17 pp than those with no access to extension services, ceteris paribus. The finding suggests that extension services play a crucial role in promoting knowledge dissemination, awareness, and engagement in contract farming among dairy cattle farmers. By having access to extension services, farmers can receive up-to--date information about the benefits, requirements, and opportunities associated with dairy cattle contract farming. This finding supports theoretical expectations and previous studies [Mishra et al. 2018, Islam et al. 2019, Pham et al. 2020, Hirpesa et al. 2021].

The quantity of dairy cattle owned and the dairy cattle breed type were positively and significantly related to the adoption of contract farming at 5% and 1%, respectively. These indicate that the probability of participating in dairy cattle contract farming increases by 8 pp for farmers with a larger quantity of dairy cattle and by 35 pp for farmers using improved dairy cattle breeds, respectively, than otherwise, ceteris paribus. The finding suggests that certain factors related to herd size and breed selection significantly influence farmers' engagement in contract farming arrangements. Farmers with a larger quantity of dairy cattle may benefit from economies of scale in contract farming. A larger herd size allows for greater production volumes, which can attract contract farming sponsors or buyers seeking a stable and consistent supply of dairy products. The finding about the number of dairy cattle validates earlier research by Bezabeh et al. [2020] and Kiwanuka-Lubinda et al. [2021]. Similarly, the observation concerning the specific dairy cattle breed aligns with a prior study conducted by Kiwanuka and Machette [2016].

Again, the finding shows that dairy cattle farmers who use artificial insemination are 16 pp more

likely to be aware of dairy cattle contract farming at the ten-percent level than those who do not use artificial insemination. Artificial insemination is a technology-driven practice that offers several advantages for dairy cattle breeding. Artificial insemination is relevant for dairy cattle herds in contract farming as it helps to improve the quality of dairy cattle breeds and, thus, the production of milk, while also helping to enhance the breeding efficiency and genetics in dairy cattle herds in contract farming. The finding confirms this study's expectations as per the theory used.

Likewise, the use of veterinary treatment services is found to be significant at 1%, increasing the probability of participation in dairy cattle contract farming by 22 pp while holding the other factors constant. The finding indicates the importance of animal health management and the role it plays in farmers' decision-making regarding contract farming engagement. Veterinary treatment plays a crucial role in maintaining the health and well-being of dairy cattle. Farmers who prioritize veterinary care are likely to have healthier and more productive herds. This finding is in line with the theoretical expectation.

Thus, participation in dairy cattle contract farming is influenced by education, household size, risk aversion, access to information, and livestock management practices, highlighting key factors affecting farmers' decisions.

CONCLUSIONS AND POLICY IMPLICATIONS

Participation in dairy cattle contract farming follows a two-step process involving distinct decision-making stages. Firstly, it hinges on an individual's awareness of dairy cattle contract farming, and secondly, it encompasses the actual engagement in dairy cattle contract farming. These two decision stages are influenced by various factors, which can operate independently or in combination. The decision to participate in contract farming is primarily influenced by factors such as household size, risk aversion, access to extension services, radio ownership, the quantity of dairy cattle owned, the type of dairy cattle breed, utilization of artificial insemination, and the application of veterinary treatment.

Given the positive influence of radio ownership and extension services on dairy contract farming participation, it is imperative to emphasize the promotion of these information sources. Policymakers should prioritize initiatives to enhance access to information and knowledge dissemination through radio programs. By advocating for the use of radios and broadcasting pertinent agricultural information, policymakers can effectively raise awareness among farmers regarding dairy contract farming opportunities, their advantages, and the support services accessible to them. This proactive approach can greatly facilitate the engagement of farmers, particularly those in remote areas, by ensuring they remain well-informed about market dynamics, technological advancements, and available extension services.

The study recommends the effective and streamlined delivery of artificial insemination and the utilization of veterinary treatment to enhance the quality and well-being of dairy cattle breeds, ultimately supporting sustainable milk production within contract farming. The policy implications of this finding could involve incentivizing and promoting the adoption of artificial insemination among dairy cattle farmers. Encouraging the use of artificial insemination might also indirectly bolster awareness and engagement in dairy cattle contract farming initiatives. Policymakers could consider subsidizing artificial insemination programs or offering educational resources to facilitate its adoption among farmers, potentially contributing to increased awareness and participation in dairy cattle contract farming. This strategy may enhance overall productivity and sustainability within the dairy farming sector.

This study reiterates the importance of improving the accessibility of veterinary services. Therefore, policymakers should place a high priority on initiatives aimed at augmenting access to high-quality veterinary services for dairy farmers. This goal can be achieved by establishing veterinary clinics, mobile veterinary units, and telemedicine platforms that offer prompt and cost-effective veterinary care. By ensuring that veterinary treatment is readily available, policymakers can foster the overall health and productivity of dairy cattle, thereby motivating more farmers to engage in contract farming.

The research has uncovered that possessing a significant number of improved dairy cattle breeds bolsters participation in contract farming. This study underscores the importance of actively promoting

the adoption of advanced dairy cattle technologies to boost engagement in dairy contract farming and, consequently, milk production. Policymakers should direct their efforts toward implementing initiatives that streamline access to superior dairy cattle breeds for farmers. Achieving this objective may involve the introduction of breeding programs, subsidies, or partnerships with organizations specializing in livestock enhancement. By expanding the availability of improved breeds, a larger number of farmers can partake in contract farming, potentially leading to heightened productivity, increased profitability, and the overall advancement of the dairy sector.

LIMITATIONS AND AREA FOR FUTURE RESEARCH DIRECTIONS

To bolster the external validity of this study, future research initiatives may contemplate utilizing longitudinal data to scrutinize the enduring relationship between participation in dairy cattle contract farming and diverse factors or impediments. Furthermore, it is imperative to undertake an analysis of the effects of engaging in dairy cattle contract farming by harnessing data from multiple countries. This broader approach can offer a more comprehensive understanding of the subject matter and its global applicability.

Acknowledgement

Mzumbe University Small Competitive Grant of 2022 under the Directorate of Research and Postgraduate Studies, Department of Research and Publications, Mzumbe University, Morogoro, Tanzania.

REFERENCES

Alliance for a Green Revolution in Africa [AGRA] (2019). Agricultural Policy Reforms in Tanzania: reform on registration and access for new seed propagation, fertilizer industry regulations on registration and supply, contract farming and agricultural marketing. Final Report. Retrieved from https://agra.org/wp-content/uploads/2020/10/Agricultural-Policy-Reforms-in-Tanzania.pdf [accessed: 08.09.2023].

Bezabeh, A., Beyene, F., Haji, J., Lemma, T. (2020). Impact of contract farming on income of smallholder malt barley farmers in Arsi and West Arsi zones of Oromia region, Ethiopia. Cogent Food & Agriculture, 6(1). https://doi.org10.1080/23311932.2020.1834662

Bidzakin, J., Fialor, S., Awunyo, V.D., Yahaya, I. (2020). Contract farming and rice production efficiency in Ghana. Journal of Agribusiness in Developing and Emerging Economies, 10(3), 33–45. https://doi.org/10.1108/JADEE-11-2018-0160

Dimara, E., Skuras, D. (2003). Adoption of agricultural innovations as a two-stage partial observability process. Agricultural Economics, 28(3), 187–196. https://doi.org/10.1111/j.1574-0862.2003.tb00137.x

Hirpesa, M., Legesse, B., Haji, J., Bekele, K. (2021). Determinants of participation in contract farming among smallholder dairy farmers: the case of North Shewa Zone of Oromia National Regional State, Ethiopia. Sustainable Agriculture Research, 10(1), 10–19. https://doi.org/10.5539/sar.v10n1p10

Hou, J., Wu, L., Hou, B. (2020). Risk Attitude, Contract Arrangements and Enforcement in Food Safety Governance: A China's Agri-Food Supply Chain Scenario. International Journal of Environmental Research and Public Health, 17(8), 2733. https://doi.org/10.3390/ijerph17082733

Islam, A.H.M., Roy, D., Kumar, A., Tripathi, G., Joshi, P.K. (2019). Dairy contract farming in Bangladesh: implications for welfare and food safety. IFPRI Discussion Paper 1833. International Food Policy Research Institute, Washington, DC. https://doi.org/10.2499/p15738coll2.133227

Key, N., Sadoulet, E., Janvry, A. de (2000). Transactions costs and agricultural household supply response. American Journal of Agricultural Economics, 82(2), 245–259. https://doi.org/10.1111/0002-9092.00022

Kilima, F.T.M. (2021). Integrating smallholder dairy farmers into formal milk markets in Tanzania: Key lessons and policy implications. Tanzania Journal of Agricultural Sciences, 20(1), 72–81.

Kish, L. (1965). Survey Sampling. John Wiley and Sons, New York.

Kitole, F.A., Sesabo, J.K. (2022). Smallholder livestock keepers' breeding choices and its implication on poverty reduction in developing countries: empirical evidence from Tanzania. Global Social Welfare, 9(4), 241–251. https://doi.org/10.1007/s40609-022-00252-9

Kiwanuka, R.N.L., Machethe, C. (2016). Determinants of smallholder farmers' participation in Zambian dairy sector's interlocked contractual arrangements. Journal of Sustainable Development, 9, 230–245. https://doi.org/10.5539/jsd.v9n2p230

Kiwanuka-Lubinda, N.R., Ng'ombe, N.J., Machethe, C. (2021). Impacts of interlocked contractual arrangements on dairy farmers' welfare in Zambia: a robust Bayesian instrumental variable analysis. Agrekon, 60(1). https://doi.org/10.1080/03031853.2021.1875854

Lunogelo, H., Makene, F. (2020). Dairy Processing in Tanzania: Prospects for SMEs inclusion. Retrieved from https://esrf.or.tz/wp-content/uploads/2021/05/Tanzania-Dairy-Brief.pdf [accessed: 13.10.2023].

Ministry of Finance and Planning of the United Republic of Tanzania [MFP] (2016). National five-year development plan 2016/2017–2020/2021: Nurturing Industrialization for Economic Transformation and Human Development. Ministry of Finance and Planning (MFP). Dar es Salaam. Retrieved from https://www.planning.go.tz/uploads/documents/sw-1715179474-NATIONAL%20FIVE%20YEAR%20DEVELOPMENT%20PLAN%202016_17-2021_22.pdf [accessed: 13.10.2023].

Ministry of Livestock and Fisheries of the United Republic of Tanzania [MLF] (2017). Tanzania Dairy Master Plan 2017/18–2021/22. Retrieved from https://www.mifugouvuvi.go.tz/uploads/projects/1553601793-TANZANIA%20LIVESTOCK%20MASTER%20PLAN.pdf?lang=en [accessed: 13.10.2023].

Ministry of Livestock and Fisheries of the United Republic of Tanzania [MLF] (2022). Livestock sector transformation plan 2022/2023–2026/2027. Retrieved from www.mifugouvuvi.go.tz [accessed: 13.10.2023].

Ministry of Livestock and Fisheries of the United Republic of Tanzania [MLF], National Bureau of Statistics (Tanzania) [NBS], Tanzania Dairy Board [TDB] (2019). Sector Analysis: Price, Cost, Revenue, Profitability and Human capital chains in Tanzania's Dairy Sector. Report. Retrieved from https://www.mifugouvuvi.go.tz/uploads/publications/sw1592794301-Tanzania%20%20Diary%20Sector%20Analysis%20-%20Dalberg.pdf [accessed: 02.09.2023].

Mishra, K.A., Pramod, K.A., Joshi, K., D'Souza, A. (2018). Production Risks, Risk Preference and Contract Farming: Impact on Food Security in India. Applied Economics Perspectives and Policy, 40(3), 353–378. https://doi.org/10.1093/aepp/ppy017

National Bureau of Statistics (Tanzania) [NBS], Ministry of Finance and Planning of the United Republic of Tanzania [MFP] (2021). Tanzania in Figures 2020. Dodoma. Retrieved from https://www.nbs.go.tz/uploads/statistics/documents/sw-1705580209-2020_Tanzania_in_Figure_English.pdf [accessed: 11.10.2023].

Ng'ombe, J.N., Kabwela, B., Kiwanuka-Lubinda, R.N., Addai, K.N. (2022). A Bayesian zero-one inflated beta modeling of dairy farmers' decision to sell nothing or some output through contract farming. Q Open, 2, 1–23. https://doi.org/10.1093/qopen/qoac015

Nhan, T.Q. (2019). Effect of private-led contract farming on rice growers' yield, cost, selling price and return: evidence from Vietnam's central Mekong Delta. International Food and Agribusiness Management Review, 22(5), 731–746. https://doi.org/10.22434/IFAMR2018.0093

Ochieng, D.O., Veettil, P.C., Qaim, M. (2017). Farmers' preferences for supermarket contracts in Kenya. Food Policy, 68, 100–111. https://doi.org/10.1016/j.foodpol.2017.01.008

Olounlade, A.Q., Li, G-C., Kokoye, S.E.H., Dossouhoui, F.V., Akpa, K.A.A., Anshiso, D., Biaou, G. (2020). Impact of participation in contract farming on smallholder farmers' income and food security in rural Benin: PSM and LATE parameter combined. Sustainability, 12(3), 901. https://doi.org/10.3390/su12030901

Pham, T.T., Dang, H.L., Pham, T.N.A., Dang, H.D. (2021). Adoption of contract farming for managing agricultural risks: a case study in rice production in the Mekong Delta, Vietnam. Journal of Agribusiness in Developing and Emerging Economies, 3(3), 33–45. https://doi.org/10.1108/jadee-05-2021-0107

Reardon, T., Berdegué, J., Escobar, G. (2001). Rural nonfarm employment and incomes in Latin America: Overview and policy implications. World Development, 29(3), 395–409. https://doi.org/10.1016/S0305-750X(00)00112-1

Rondhi, M., Aji, J.M.M., Khasan, A.F., Putri, A.T.R., Yanuarti, R. (2020). Risk Aversion, risk preference and farmers' decision to participate in broiler contract farming: A Case Study in Jember, Indonesia. Caraka Tani: Journal of Sustainable Agriculture, 35(1), 98. https://doi.org/10.20961/carakatani.v35i1.37964

Rungwe Agricultural District Office [RADO] (2023). Market structure of the dairy sector and dairy cattle

contract farming in Mbeya, Tanzania. Retrieved from https://rungwedc.go.tz/sw/agricultural-production [accessed: 11.10.2023].

Shija, D.S., Mwai, O.A., Migwi, P.K., Komwihangilo, D.M., Bebe, B.O. (2022). Identifying positive deviant farms using Pareto-Optimality ranking technique to assess productivity and livelihood benefits in smallholder dairy farming under contrasting stressful environments in Tanzania. World, 3(3), 639–656. https://doi.org/10.3390/world3030035

Soullier, G., Moustie, P. (2018). Impacts of contract farming in domestic grain chains on farmer income and food insecurity: contrasted evidence from Senegal. Food Policy, 79, 179–198. https://doi.org/10.1016/j.foodpol.2018.07.004

Spielman, D.J., Hartwich, F. (2008). Policies to promote cereal intensification in Ethiopia: The search for appropriate public and private roles. Food Policy, 33(6), 545–557. https://doi.org/10.1016/j.foodpol.2009.12.002

BARIERY WDRAŻANIA CHOWU KONTRAKTOWEGO BYDŁA MLECZNEGO PRZEZ DROBNYCH ROLNIKÓW W REGIONIE MBEYA W TANZANII

STRESZCZENIE

Cel: Zrozumienie dynamiki rynku hodowli bydła mlecznego w Tanzanii jest kluczowe dla wspierania konkurencyjnego i zrównoważonego sektora mleczarskiego. Kontraktacja rolnicza jest istotną strukturą rynkową w tym obszarze, gdyż oferuje drobnym rolnikom ulepszone rasy bydła, usługi weterynaryjne, paszę oraz wsparcie doradcze. Jednak zaangażowanie drobnym rolników w hodowlę bydła mlecznego w ramach kontraktów jest obecnie ograniczone. Zachęcanie do jej upowszechnienia wymaga dogłębnego zrozumienia czynników motywujących i barier. Dotychczasowe badania nad czynnikami wpływającymi na przyjmowanie hodowli kontraktowej bydła mlecznego pomijały związek między ograniczeniami płynności finansowej w zakresie szczepień a barierami w jej wdrażaniu. Niniejsze badanie wypełnia tę lukę. **Metody:** Analizie poddano dane zebrane za pomocą ustrukturyzowanego kwestionariusza od 300 losowo wybranych drobnych hodowców bydła mlecznego w regionie Mbeya. W celu korekty błędów doboru próby zastosowano model podwójnego probitu. **Wyniki:** Badanie wykazało, że przyjmowanie hodowli kontraktowej bydła mlecznego przez drobnych rolników zależy od wielkości gospodarstwa domowego, awersji do ryzyka, dostępu do usług doradczych, posiadania radia, liczby posiadanego bydła mlecznego, rodzaju rasy bydła mlecznego, ograniczeń płynności finansowej związanych ze szczepieniami, stosowania sztucznej inseminacji oraz korzystania z leczenia weterynaryjnego. **Wnioski:** Badanie podkreśla znaczenie działań zmierzających do ułatwienia rolnikom dostępu do lepszych ras bydła mlecznego, jak również do szczepień, leczenia weterynaryjnego i usług sztucznej inseminacji.

Słowa kluczowe: czynnik, bydło mleczne, rolnictwo kontraktowe, przezwyciężanie barier, Tanzania