

Livelihood Resilience of Smallholder Dairy Farmers Against External Shocks: A Case Study in the Northern Dry Zone of Sri Lanka

S. Prasath^{1*} and K. Umashankar²

¹Faculty of Graduate Studies, University of Jaffna, Sri Lanka

²Department of Agricultural Economics, Faculty of Agriculture, University of Jaffna

ARTICLE INFO

Article history:

Received: 17 August 2021

Revised version received: 09 January 2022

Accepted: 25 March 2023

Available online: 01 April 2023

Keywords:

Dairy farm households
Jaffna District
Livelihood resilience
Structural Equation Model

Citation:

Prasath, S. (2023). Livelihood resilience of smallholder dairy farmers against external shocks: A case study in the northern dry zone of Sri Lanka. *Tropical Agricultural Research*, 34(2): 94-106.

DOI:

<http://doi.org/10.4038/tar.v34i2.8622>

Prasath, S. 

<https://orcid.org/0000-0002-6811-3365>

ABSTRACT

Improving dairy farmers' livelihood resilience helps them sustain farming and reap higher economic returns. This study was conducted in the Jaffna District, part of the dry zone of Sri Lanka. Households' livelihood resilience to environmental challenges and shocks was determined through the Structural Equation Model (SEM). The SEM path diagram was developed based on the Resilience Model developed by FAO, which uses resilience as a latent variable and is a function of six components that are not directly measured from the data set. The SEM analysis revealed that the latent variable 'livelihood resilience' correlates positively and significantly with the five components. Further, the study found that the independent variables, such as dietary diversity index ($P > |z| = 0.081$), the quality score of health services ($P > |z| = 0.052$), frequency of assistance ($P > |z| = 0.000$), quality evaluation of assistance ($P > |z| = 0.000$), land owned ($P > |z| = 0.086$), educational level ($P > |z| = 0.017$), and the number of household members who lost their jobs ($P > |z| = 0.010$), significantly influenced the livelihood resilience of the dairy farmers. The findings of this study will help develop a policy framework that could support gaining sustainability in milk production through fostering the livelihood resilience of the dairy farmers in the Northern Dry Zone of Sri Lanka.



* Corresponding author- ns.prasath85@gmail.com

INTRODUCTION

Around the globe, smallholders play a crucial role in a country's economy that depends profoundly on agriculture. The dairy sector is one of the most important sub-sectors as it plays a fundamental role in the regular income as well as food security of smallholder dairy farmers (Markelova, 2009; Wolfenson, 2013; Hong, 2015; ALCP, 2017; AL Sidawi *et al.*, 2021). Dairy is one of the vital sub-sectors in Sri Lanka, contributing to around 0.6% of the GDP (CBSL, 2020). The dairy sector plays a crucial role in meeting the growing demand for milk and milk products and the rural economy (Chand *et al.*, 2015). Moreover, sources of protein in Sri Lanka are primarily milk, fish, eggs, meat, and pulses. Among these, milk has been a critical source of high-quality protein, minerals, and vitamins for the masses. Considering individual food security entails the production of adequate quantities of high-quality protein and dietary energy (Coles, 2016). Hence it is obvious that the production of cow's milk, which is one of the important sources of protein, should be brought into focus. However, the local dairy industry can meet only 40% of the current requirement (Damunupola, 2022).

India has remained the world's largest milk producer since 2001, contributing around 23 % of global production. The majority of the milk producers in India are either landless, small, or marginal farmers (Govt. of India, 2022); the climate remains tropical, and natural resource endowments are more or less similar to those of Sri Lanka. So, this similar nature gives an encouraging message to Sri Lanka to try to attain self-sufficiency in dairy milk production.

Since there is a 60% deficit in the supply of dairy products, the country is compelled to import. Presently, Sri Lanka spends around Rs. 50 billion on importing milk and milk products annually (CBSL, 2019). In the import of dairy products, the more significant part is occupied by spray-dried milk powder. The CORONA outbreak has depleted the treasury, which needs foreign exchange for unloading freight. coupled

with inadequate local production and supply, have left the export industry in failure. This situation should motivate the country to seek and achieve a stable, sustainable dairy sector that is largely independent. Through the effort attributed to the Sri Lankan government, milk production doubled from 2010 to 2017. However, the local dairy industry can meet less than half of the population's growing demand.

Smallholder subsistence farm households dominate the dairy sector in Sri Lanka. They deliver more than 75% of the milk produced locally (Vidanarachchi *et al.*, 2019). Even here, it is observed that generally, dairy farmers are not full-time; instead, their dairy effort is only part-time. The fundamental reason for this fact is that farmer income is inadequate. Further, the farmer cannot bear the risk because earnings from the dairy sector can barely meet household expenditures. It leaves no sizeable reserve for further dairy investment. These may be the reasons for farmers' reluctance to favour full-time effort. On top of it, the lack of farmer resilience to cope with unforeseen circumstances is another cause. Milk production can be improved by encouraging the smallholder dairy farmer to enhance output by increasing farmer resilience to changing circumstances. The Sri Lankan government can make an effort to foster dairy farmers' ability to attain livelihood resilience through sustainable milk production. As a result, and increase in farmer income help to alleviate poverty and reduce social inequality. This procedure of lifting the social well-being of the society significantly falls in line with the Sri Lankan Government's commitment to the UN to achieve Sustainable Development Goals.

There are 46 agroecological regions in Sri Lanka, namely, Hill country, Mid Country, Coconut Triangle, Low Country Wet Zone and Low Country Dry Zone. The dry zone of Sri Lanka faces many challenges to effective milk production compared with other agroecological zones. The majority of the dairy farms in the dry zone are managed by an extensive system (Athambawa, 2021).

The leading causes of dry zone dairy farms' poor performance are attributed to the animal's poor genetic makeup, limited availability of fresh water, and quality of pastureland available for grazing, and the lack of livelihood resilience of the dairy farmers (Vidanarachchi *et al.*, 2019). Though herd size is generally large in the dry zone, the milk yield per cow is low. Since the fat content is high in milk in the Dry Zone, it commands greater industrial importance. Therefore, increasing dairy production, coupled with enhancing the socio-economic conditions and livelihood resilience, is expected to improve the performance of existing dairies. This will, in turn, help to improve the economic situation of dairy farmers in general.

The COVID-19 pandemic shocked and impacted most farm households, particularly in developing economies (Jaacks *et al.*, 2021a; Gray, 2020; Rozaki, 2020). Against this backdrop, this study examines the impacts, risks, and challenges faced by dairy farmers and their livelihood resilience to the COVID-19 pandemic shock in the Northern dry zone of Sri Lanka. National-level assessments often overlook the individual variability in resilience concerning income and food access, access to essential services, social safety nets, assets, adaptive capacity and stability of a particular dairy farmer.

Study objectives

Dairy farmers operating in the Northern region are also not an exception to the rule. They have difficulty getting access to pastureland, freshwater during the dry spells, and a reasonable farm gate price for their produce. Since most of them operate in rural settings, they commonly miss access to essential services and are deprived of social safety networks and veterinary services. Moreover, less access to the dairy supply chain and formal credit arrangements makes the scenario more challenging. Together, these features make the peninsula's dairy farmers face unprecedented challenges to their livelihood. Hence, this research seeks to explore avenues to engage the dairy

farmer's hostile elements in the Northern Dry Zone of Sri Lanka and address them successfully, increasing resilience amidst the COVID-19 outbreak. The research careered out at the district level to foster dairy farmer livelihood resilience, and the conclusions derived from the research could be made use of in the future policy framework outlining at the district and national levels.

The aims of our study were to (1) identify the livelihood status of smallholder dairy farm households in the Northern Peninsular region of Sri Lanka; (2) examine the relationship between the 'Livelihood Resilience of the Dairy Farmers' and six latent variables, namely Income and food access, Access to essential services, social safety nets, Assets, Adaptive Capacity and Stability of a particular dairy farmer in the Jaffna peninsula; and (3) investigate the socio-economic factors that influence the livelihood resilience of dairy farmers in the Jaffna peninsula.

Conceptual framework

Farm households are exposed to foreseeable and erratic shocks. Such events may affect the livelihood of farmers and pose a challenge to their capacity to provide food in adequate quantities and with the required quality. The ability of farm households to recover, reorganize, and evolve following external shocks and stresses is analysed within the framework of resilience theory. Often, quantifying resilience demands a multifaceted elaborative approach. Different researchers have adopted a number of modelling approaches. Resilience has been defined from a social-environmental viewpoint as the capacity of socio-economic systems to endure shocks through absorption, adaptation and transformation (Walker *et al.*, 2004; Folke, 2006). In the meantime, resilience is being applied in various contexts to comprehend whether and how social and economic systems could become more robust to shocks (Folke, 2006; Barrett & Constans, 2014; Martin & Sunley, 2014; Doran & Fingleton, 2016).

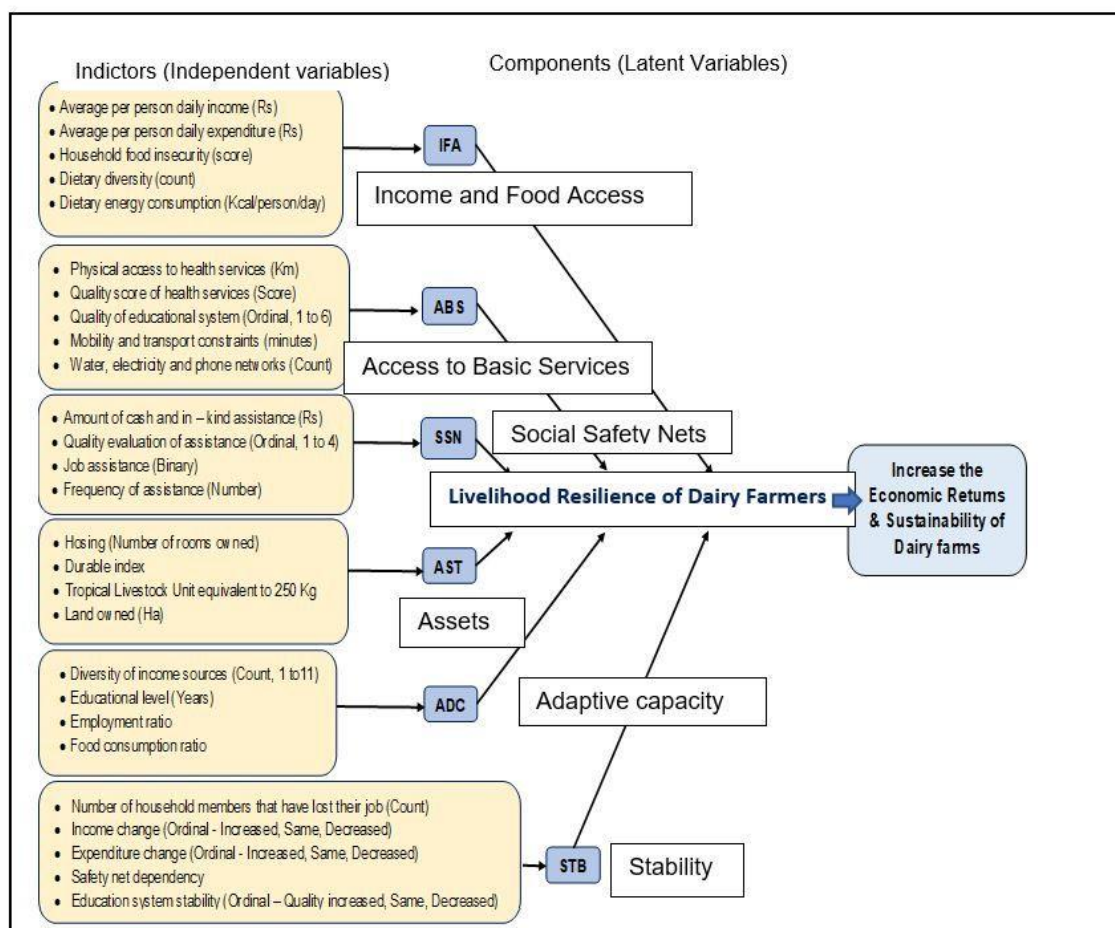


Figure 1: Conceptual Framework

MATERIALS AND METHODS

Study area and data collection

The site selected for the research was Jaffna District, located at the Island Nation's Northern tip. Jaffna district falls under the dry zone where the mean annual rainfall is less than 1750 mm, and animals are predominantly indigenous and generally managed under an extensive system. Jaffna district was having around 21,700 dairy farm households operating under 15 veterinary ranges. Out of this, 19,182 dairy farmers maintained a herd size equal to or less than five. The second majority, 1,909 farm households, kept a herd size between 6 – 10. The rest, around 600 dairy farmers, held a herd size above 10 (DAPH-NP, 2020). This study focused on the second majority. The researchers found that the farm households that maintained a herd size below 6 were not stable and were mostly partially engaged in dairy farming. The

dairy farmers who held more than ten animals were primarily full-time and commercially oriented. The in-between population was the most dynamic, and the farmers were comparatively more receptive and enthusiastic about transforming their dairy into potentially viable commercial dairy units. The proportionate samples were drawn randomly from 11 veterinary ranges where most dairy farmers maintained a herd size between 6 -10.

A structured questionnaire was prepared based on the guidelines in 'Resilience and Resilience Capacities Measurement Options-Full Approach' published by TANGO International, USA in 2018. Before the data collection, focus group meetings were organized, and the questionnaire was pretested. The multistage cluster sampling technique was used with proportional affixation to select 219 samples out of 1,909 dairy households. A household survey was conducted from February to September 2020 (time period T₁) by administering the

questionnaire to the respondents. The secondary data were collected [RW1] from the Department of Animal Production and Health-Northern Province (DAPH-NP) and the annual report of the Central Bank of Sri Lanka and Divisional Secretariat – Jaffna. After removing the outliers, the effective sample size was 203. This analysis collected data during two periods corresponding to the same farm households. The first data set was obtained from the Giz database, which conducted a baseline survey among dairy farmers from January 2016 to July (time period T_0).

Data analysis

This research determined household resilience to environmental challenges and shocks using the Structural Equation Model (SEM). The structural equation model path diagram was developed based on the Resilience Model developed by FAO. At a particular time (T_0), the dairy household has certain options for survival. This includes the dairy farmer's access to assets, income-generating activities, public services, and social safety nets. At time T_0 , each component was estimated separately to generate a composite index of household resilience. The difference between time periods T_0 and T_1 reflects how these indicators influence household livelihood resilience. In algebraic terms, the resilience index for households can be expressed as below:

$$RES_i = w_{IFA} IFA_i + w_{ABS} ABS_i + w_{SSN} SSN_i + w_{AST} AST_i + w_{ADC} ADC_i + w_{STB} STB_i + E_i$$

The model treats 'resilience' (RES) as a latent variable and is a function of six components such as income food access (IFA), access to basic services (ABS), assets (AST), social safety nets (SSN), adaptive capacity (ADC) and stability (STB) of a particular dairy farmer that were again not directly measurable from the data set expressed in the above equation. Here, w_k is the weight for the k th block in defining resilience; and E_i is the error term. Here the six components in the model were considered the latent variables and were measured through a set of observable variables (indicators) as depicted in

diagram 1. The six components of the resilience framework were estimated through a set of explanatory variables collected through the field survey. The resilience model uses a systemic approach and assumes that change is constant. Unlike other frameworks that control change and surmise that systems are relatively stable, it lays the groundwork for policies that help socio-economic systems cope with, adapt to and shape change.

Generally, structural equation model analysis gives more reliable estimates with larger samples. Since the data collection has to be carried out in two different periods with the same households, it was observed in several instances that the herd composition and the family's decision to maintain the dairy changed drastically. These have posed a challenge in precisely measuring the resilience of dairy farm households to an external shock. Often, structural equation model analysis suffers from multicollinearity (Grewal *et al.*, 2004; Tarka, 2017). Though the researchers were aware of this by scrutinizing the correlation matrix, on the other hand, to avoid specification errors, the respective variables were not excluded from the model while admitting the mistakes caused by the multicollinearity in the inference process.

RESULTS & DISCUSSION

Even though there are 15 veterinary ranges in the Jaffna district, only households that operate dairy farms under the control of 11 veterinary divisions were taken into account. Four ranges were excluded as they had comparatively fewer dairy farm households. Among the respondents, 30% were females, and the rest were males with a mean experience in dairy farming of 15 years. Almost 74% of the samples were occupied with dairy efforts full-time. The average daily milk production of a household was around 24 liters, with a standard deviation of 11.83 liters.

The goodness of fit of the model

Standardized Root Mean Square Residual (SRMR) measures the observed and implied

correlations' average difference. Hu & Bentler (1999) suggested a value close to 0.08 or below. Here the goodness of fit statistics (Size of residuals) SRMR value of 0.014 indicated that the model fits well.

The resilience model analysis

The SEM analysis revealed that the latent variable resilience of the dairy households showed a significant positive association with the five dimensions. The safety net (0.02241), assets (0.04379), adaptive capacity (0.03157) and stability (0.07764) were found significant at 5%, 10%, 10%, 5%, and 5% significance (α) levels, respectively. This revealed that any effort to improve these five dimensions would undoubtedly enhance the resilience of the dairy farmers in the Jaffna district. The SEM STATA-13.1 output expressed the relationship between the latent variables – resilience and components which are

summarized in Table 01. To achieve convergence, the model most likely dropped the first component, Income and Food Access.

Income and food access (IFA) – dietary diversity

Among the population of developing countries, the average diet does not consist of essential micronutrients, proteins, fats, and fibre. This condition leads to the population being undernourished and leads to poverty in these regions, leaving people destitute. Dietary diversity was measured numerically by counting diet aggregation or unit food material, as the case may be, for a stipulated time frame. Nevertheless, a variety of food aggregates, methods of analysis and time frames were employed. The comparison and generalization of findings were limited by this procedure. In

Table 1: SEM Output – Livelihood resilience – Components

Component	Coefficient	Standard Error	P> z
Income and Food Access (IFA)	1 (Constrained)		
Access to Basic Services (ABS)	0.075453**	0.000487	0.030
Social Safety Nets (SSN)	0.022413*	0.010692	0.053
Assets (AST)	0.043789*	0.004201	0.073
Adaptive capacity (ADC)	0.031566**	0.001752	0.041
Stability (STB)	0.077644**	0.003753	0.020

*- significant at 10% level, **- significant at 5% level, *** - significant at 1% level

Table 2: SEM Output - Components – Variables

Components	Significant Variables	Coefficient	Standard Error	P> z
IFA	Dietary diversity	0.423551*	0.000058	0.081
ABS	Quality of the health services	0.049984*	0.030685	0.052
SSN	Frequency of assistance	0.326829***	0.406467	0.000
SSN	Quality evaluation of assistance	0.839258***	0.134217	0.000
AST	Land owned	0.231908*	0.140978	0.086
ADC	Education level	0.410156**	0.505562	0.017
STB	No. of hh members lost their job	0.217870***	0.171508	0.010

*- significant at 10% level, **- significant at 5% level, *** - significant at 1% level

this research, the dietary diversity was measured through the dietary diversity and food frequency score, with 17 types of food groups over a recall period of 30 days. The validation of dietary diversity against the sufficiency of nutrition is evidence for the well-recorded positive relationship revealed in developed countries. The structural equation model analysis showed a significant ($P>|z|=0.081$) positive association between dietary diversity and income and food access (IFA). This is consistent with the findings of many previous studies reviewed by Ansah *et al.*, 2019. It was seen from the study of many nation-states that family diet diversity was closely associated with household income and food access and, consequently, with resilience. On the other hand, increased income and food access positively influenced dietary diversity and balanced food consumption. Thus, higher family health and improved well-being of the farm lead to the prosperity of each individual involved in the dairy farm. Hence, it can be concluded that income and food access played a catalyst role in enhancing farm households' prosperity by improving their resilience to external shocks.

Access to basic services (ABS) – quality of health services

The capability of a farm household to depend on and live in an organized and stable community profile is reflected in the quality of the available health services. Access to quality health services is not a choice for farm households. SEM analysis revealed that access to basic services (0.075453) significantly enhanced dairy farmer resilience at a 5% significant level. This implies the cruciality of access to basic services (ABS) for the progress and livelihood resilience of smallholder dairy farmers operating in the Jaffna Peninsula. Further, the research revealed that access to quality health services was significant ($P>|z|=0.052$) and positively correlated with access to basic services. Nevertheless, access to quality health services was assessed by the farmers themselves, which is largely subjective. The reason for this is that the farmer's estimate was an individual

opinion. There were no standards given to them to rank their opinions. The variety of assessments from farmers of totally different backgrounds could, as a rule, be very different. However, when farmer opinions, as in the Jaffna District, were evaluated since their socio-economic background and resource environment was more or less the same, it could be said that the assessment would have minimum bias.

In this case, access to quality health services would imply comprehensive services for both humans and animals in the dairy sector. In the research questionnaire, the respondents were required to describe access to quality health services in general. They were not asked to supply information about private or state services separately. Regarding family health is concerned, 80% of the farming community seeks state health services; however, farmers obtain 96% of them from state services when veterinary services are required. The prime reason for this could be that the government sector renders free and reasonably competent service. The inference is that farmer resilience could be enhanced considerably through the provision of quality state services in both medical and veterinary health.

The research reveals that the farmer community often flouted precautionary measures. Thus, it is imperative that state service measures for COVID-19 prevention be made mandatory. Indifference towards guidelines will bring about sickness, which will drain funds and disturb farm production. This will ultimately significantly hamper resilience. As far as personal protection was concerned, two-thirds of dairy farmers wore a mask without fail, and only one-third complied with handwashing and social distancing. Similarly, few farmers used appropriate sanitation practices in dairy farming, such as wearing gloves when milking, disinfecting teats, and cleaning vessels and other equipment. The use of fresh water and mastitis screening were often ignored. Thus, it is seen that access and availability of quality health services, along with health education through extension services to farm households, will

enhance farmer livelihood resilience against external shocks.

Social safety nets (SSN) – quality and frequency of assistance

SEM path analysis revealed a significant (10%) positive correlation between SSN (0.022413) and resilience. The results further disclosed that frequency of assistance (0.326829) and quality of assistance (0.839258) were found to be positive predictors of SSN at a 1% significant level. These results are consistent with Alinovi *et al.*, 2010; Ciani and Romao, 2014.

Social safety net programs generally protect farm families from the impact of economic shocks, natural calamities, and other external crises. They can be defined as formal and informal, non-contributory resource transfers to people who are in need. In Sri Lanka, the social safety net is reasonably well organized and supported by the government. Valid infrastructure settings and public service provisions, for instance, free education, health services, subsidized credit schemes, inputs and marketing services, security, etc., strengthened the social safety net network and supported the farm household's capacity to manage the crises and respond to shocks like the COVID-19 pandemic in Sri Lanka. Moreover, the regular direct cash transfer programs and relief supports extended during emergency times by the government, for example, flood relief, drought relief, COVID-19 relief, etc. considerably supported farm households to improve resilience via strengthening the social safety net.

Asset (AST) – Land Owned

Assets are the key elements of a livelihood. Assets include but are not limited to farmland, buildings, machinery and equipment, grain, feed, market livestock, breeding livestock and cash. Farm households raise their income by making use of these assets. This research revealed a significant (10%) positive correlation (0.043789) between households' livelihood

resilience and assets. Furthermore, land ownership was a significant ($P > |z| = 0.086$) positive predictor of the asset. The mean holding size of the dairy farmers was 1.2 ha. In Sri Lanka, the dairy sector is mainly dominated by smallholders, and their share of the national production is estimated to be over 75% (Vidanarachchi *et al.*, 2019).

It is worth noting that this estimate treated 'landless' people as outliers and excluded them from the sample. It was found that around 3% of dairy farmers in the Jaffna district were landless and lived and farmed on rented or leased properties. Landless farmers are comparatively more vulnerable to access credit and other institutional support for their livelihood and daily effort. Moreover, those who want to establish forage or pasture for their animals will also be deprived. Considering these facts and the exorbitant nature of land value in the Jaffna district, if the government or local authority could establish common facilities for grazing, it would help to resolve this challenge considerably. Also, this could give a long-term solution to the landless and marginal holders who lack access to land and collateral. Farmers' increased accessibility to the land for their dairy effort could foster their livelihood resilience considerably, which will, in turn, support them in converting their scale of operation to commercial units (Vidanarachchi *et al.*, 2019).

Figure 2 depicts the relationship between landholding, average milk yield, and gender of dairy farmers. The average daily yield in the Jaffna district was estimated to be around 2.5 litres of milk per cow, whereas this is 15 litres in South India. This is far below the Indian dry zone average. It was observed that irrespective of gender, there was a general tendency to increase milk yield in proportion to landholding size.

The yield performance of male dairy farmers was found to be consistently higher than their female counterparts. The difference in yield was pronounced when the landholding size remained smaller. The

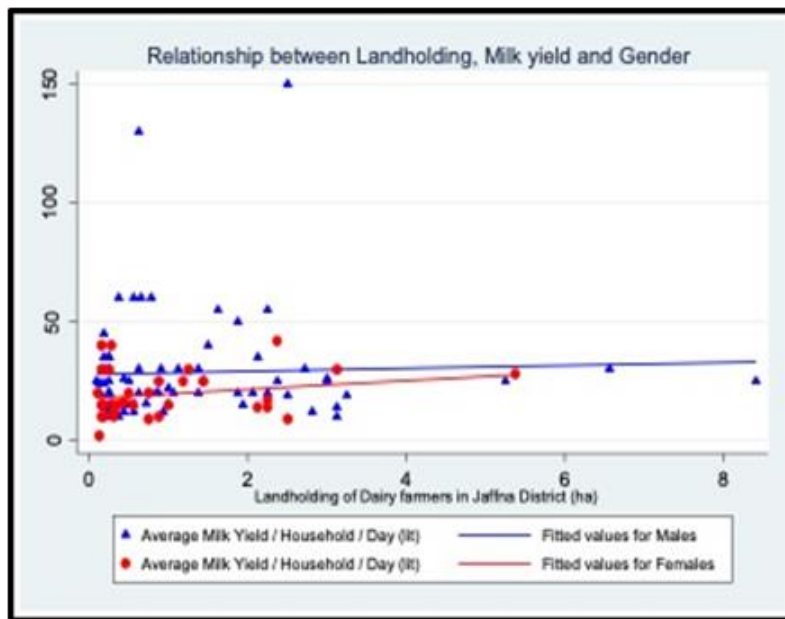


Figure 2: Relationship between Landholding, Milk yield and Gender

deviation becomes narrower when the landholding size increases. From this, it can be inferred that the gender influence on milk yield can be minimized with increased access to land. This would help transform the subsistence dairy farmers into successful entrepreneurs regardless of their gender.

Adaptive capacity (ADC) – educational level

Adaptive capacity indicates the ability of a farm household to cope and adapt after a shock, enabling it to continue performing its essential functions. Adaptive capacity provides the household with the ability to engage the shock. The characteristic of adaptability is the buffer effect for the household's essential routines (Alinovi *et al.*, 2010). Out of four indicators, the educational level of the household (0.410156) became a significant ($P > |z| = 0.017$) positive predictor of adaptive capacity. Maddison (2007) and Lanciano *et al.*, (2020) also arrived at similar conclusions.

It was implied that education was crucial for helping dairy farm households in the Jaffna district maintain their ability to support themselves. The mean number of years of formal education among the

sample farmers was 10, with a minimum of 3 and a maximum of 13 years. The education level of dairy farm households was generally low, mainly at the primary and secondary levels. Few had more than secondary education, and they were considered outliers in the data set and removed. Hence, the majority of the farm households' education level was low, which may limit the influence of the capacity for learning on their livelihood strategy (Zhou *et al.*, 2021). The only viable option to improve the knowledge and skills of dairy farmers could be informal education provisions given through regular extension and training programs. Thus, government and non-governmental organizations connected to the dairy sector in the Jaffna district can have regular interactive teaching and training sessions included in their mandate, which would help enhance milk production by promoting livelihood resilience.

Figure 3 shows the interaction between the average milk yield of the dairy and the educational level and gender of the household head. It was noted that the level of education was positively correlated with the average milk yield for the male farmers, but the opposite happened to their female counterparts. The reduction in the average

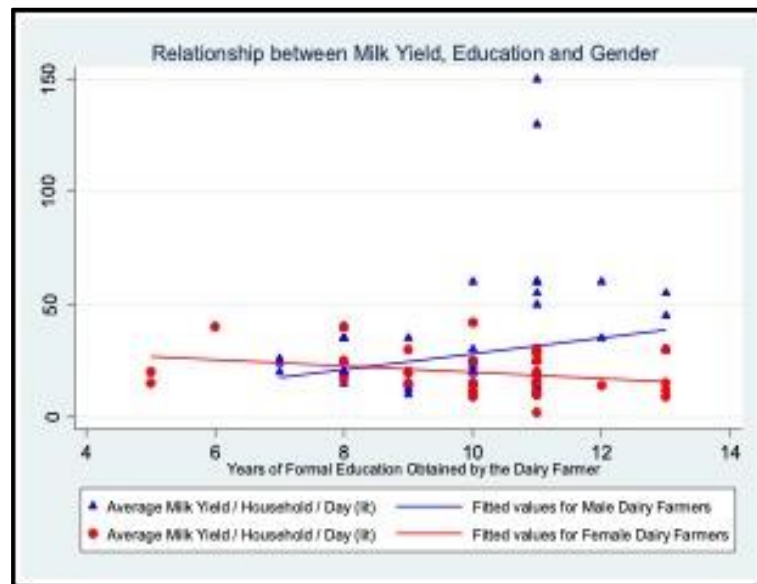


Figure 3: Relationship between Milk Yield, Education and Gender

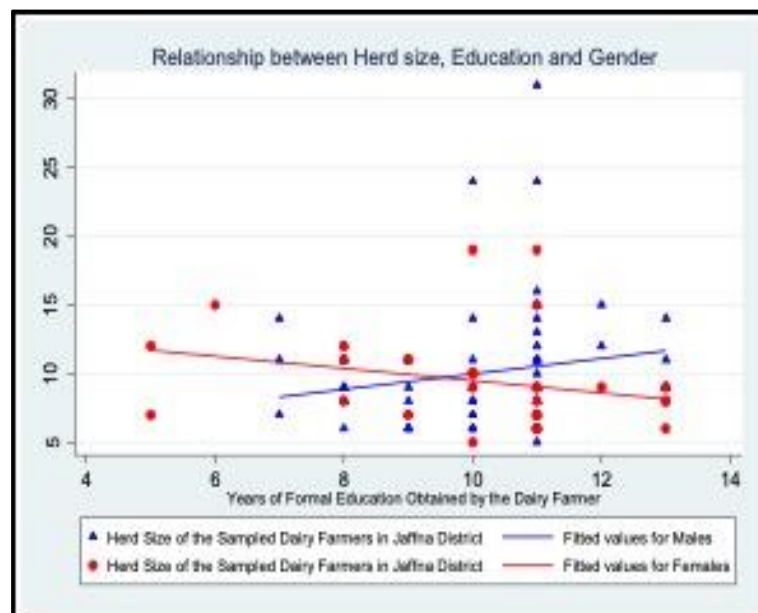


Figure 4: Relationship between Herd size, Education and Gender

milk yield is due to the decline in the herd size for female-headed dairy farmers (see figure 4). When the education level of the farm households goes up to the secondary level, they are probably getting the opportunity to earn income from off-farm engagements. Male farmers are seen to be managing the opportunity well, but along with their commitment towards family, female farmers might have found it challenging to maintain larger herds. Nonetheless, it was shown that female-headed dairy farmers keep a larger herd

and have higher average yields than their male counterparts despite having lower levels of education.

Stability (STB) – number of household members who lost their job

Stability is a widely used concept in farm and household resilience studies. In this study, it was considered a cross-sectoral dimension of Resilience. The variables used for measuring stability were the number of

household members who lost their jobs, income change, change in household expenditure, safety net dependency, and stability of the education system. Among all these explanatory variables, only the first one was found to be a significant ($P > |z| = 0.010$) positive predictor (0.217870) of stability. On the other hand, stability showed a positive correlation with the latent variable resilience at a 5% significant level, consistent with the findings of Mojtahedi et al., 2021. It was estimated that around one-fifth of the sampled population lost at least one job during the last six months. In the worst-case scenario, 1% of the farm's household members lost their jobs during the previous six months.

Overall, 74% of the sampled population took dairy as their full-time effort. It is noteworthy that no one lost their dairy whatsoever during the last six months. Globally, many have lost their jobs as a result of the COVID-19 pandemic. Sri Lanka is also not an exception to the rule. As far as the dairy farm families in the Jaffna district were concerned, the loss of employment by a household member has strengthened their livelihood resilience by fostering their involvement in on-farm activities. While widespread, once the job is lost, people were desperate and compelled to reorient themselves to the entrepreneurial effort already within their reach.

CONCLUSIONS

This study has made an effort to model the livelihood resilience among the smallholder dairy farmers in the Dry Zone of Jaffna. The SEM analysis revealed that the latent variable 'resilience' of the dairy households has a significant synergic association with the five components, namely access to basic services, social safety nets, assets, adaptive capacity, and stability. Furthermore, the results indicated that resilience would be significantly higher for households with land and higher dietary diversity. Improved health services, quality and frequency of assistance, and the educational level of the household head significantly enhance the

livelihood resilience of dairy farm households.

Significant variables are the tools for building resilience among dairy farmers. Among the significant components of livelihood resilience, the social safety net and adaptive capacity had comparatively greater coefficient values. This implies that the livelihood resilience of the dairy farmers could be meaningfully improved by enhancing the social safety net and the adaptive capacity of the dairy farmers in the Jaffna district. Furthermore, improving dietary diversity, providing quality health services, increasing access to land, and increasing the frequency of assistance will enhance the resilience of dairy farmers. Further, introducing adult education provisions and farmer awareness programs in line with their entrepreneurial initiatives is intended to bring a desirable change in the livelihood resilience of the dairy farming community in the Jaffna district. Authorities should take appropriate measures to strengthen the livelihood resilience of farm households to enhance their ability to recover from shocks and ensure sustainable development in dairy farming. The study results could be used to develop a policy framework to foster the resilience of dairy farmers in the Jaffna district of Sri Lanka. However, the scope of the study was insufficient to make generalizations in the dry zone.

ACKNOWLEDGEMENT

The authors express their appreciation to the Department of Animal Production and Health-Northern Province and dairy farmers for their valuable support for this study.

REFERENCE

- Abeygunawardena, H. A., Rathnayaka, D., & Jayathilaka, W. M. A. P. (2012). Characteristics of cattle farming systems in Sri Lanka. *Journal of the National Science Foundation of Sri Lanka*, 25(1).

- AL Sidawi, R., Urushadze, T. and Ploeger, A. (2021). Factors and Components Affecting Dairy Smallholder Farmers and the Local Value Chain Kverno Kartli as an Example. *Sustainability*, 13(10), p.5749.
- Athambawa, M. J., Kubota, S., & Kono, H. (2021). Knowledge affecting foot-and-mouth disease vaccination behavior: traditional dairy farmers in the dry zone of Sri Lanka. *Tropical Animal Health and Production*, 53(1), 1-8.
- ALCP. (2017). Ensuring Sustainability in the Dairy Market Sector; Swiss Agency for Development and Cooperation (SDC): Bern, Swiss.
- Alinovi, L., D'errico, M., Mane, E. and Romano, D. (2010). Livelihood's strategies and household resilience to food insecurity: An empirical analysis to Kenya. *European report on development*, pp.1-52.
- Ansah, I.G.K., Gardebroek, C. and Ihle, R. (2019). Resilience and household food security: A review of concepts, methodological approaches and empirical evidence. *Food Security*, 11(6), pp.1187-1203.
- Barrett, C.B. and Constanas, M.A., (2014). Toward a theory of resilience for international development applications. *Proceedings of the National Academy of Sciences*, 111(40), pp.14625-14630
- CBSL - Central Bank of Sri Lanka. Annual Report - 2019 and 2020.
- Chand, P., Sirohi, S. and Sirohi, S.K. (2015). Development and application of an integrated sustainability index for small-holder dairy farms in Rajasthan, India. *Ecological Indicators*, 56, pp.23-30.
- Ciani, F. and Romano, D., 2014. *Testing for household resilience to food insecurity: Evidence from Nicaragua* (No. 1053-2016-85948).
- Coles, G. D., Wratten, S. D., & Porter, J. R. (2016). Food and nutritional security require adequate protein as well as energy, delivered from whole-year crop production. *PeerJ*, 4, e2100.
- Damunupola, D. A. P. R., Munasinghe, M. A. L. S. S., Rasika, D. M. D., & Weerathilake, W. A. D. V. (2022). Sri Lanka's Dairy Sector: Where to Move and What to Do—Prediction and a Trend Analysis.
- DAPH-NP. (2020). Annual report. Department of Animal Production and Health, Northern Province, Sri Lanka.
- Doran, J. and Fingleton, B., (2016). Employment resilience in Europe and the 2008 economic crisis: Insights from micro-level data. *Regional Studies*, 50(4), pp.644-656.
- FAO - The Food and Agriculture Organization (2010). Measuring Resilience: A Concept Note on the Resilience Tool. *Food Security Information for Decision Making Concept Note*, pp.1-4. <https://www.fao.org/resilience/resources/resources-detail/ru/c/317275/>
- Folke, C. (2006). Resilience: The emergence of a perspective for social-ecological systems analyses. *Global environmental change*, 16(3), pp.253-267.
- Gray, R. S. (2020). Agriculture, transportation, and the COVID-19 crisis. *Canadian Journal of Agricultural Economics/Revue canadienne d'agroeconomie*, 68(2), 239-243.
- Grewal, R., Cote, J.A. and Baumgartner, H. (2004). Multicollinearity and measurement error in structural equation models: Implications for theory testing. *Marketing science*, 23(4), pp.519-529.
- Hong, D. (2015). On World Food Day, Farmers should Come First; One Acre Fund Global: Kakamega, Kenya.

- Hu, L.T. and Bentler, P.M., 1999. Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural equation modeling: a multidisciplinary journal*, 6(1), pp.1-55.
- Jaacks, L. M., Veluguri, D., Serupally, R., Roy, A., Prabhakaran, P., & Ramanjaneyulu, G. V. (2021). Impact of the COVID-19 pandemic on agricultural production, livelihoods, and food security in India: baseline results of a phone survey. *Food security*, 13(5), 1323-1339.
- Lanciano, T., Graziano, G., Curci, A., Costadura, S. and Monaco, A., (2020). Risk perceptions and psychological effects during the Italian COVID-19 emergency. *Frontiers in psychology*, 11, p.2434.
- Maddison, D. (2007). The perception of and adaptation to climate change in Africa (Vol. 4308). World Bank Publications.
- Markelova, H., Meinzen-Dick, R., Hellin, J. and Dohrn, S. (2009). Collective action for smallholder market access. *Food policy*, 34(1), pp.1-7.
- Martin, R. and Sunley, P., 2015. On the notion of regional economic resilience: conceptualization and explanation. *Journal of Economic Geography*, 15(1), pp.1-42.
- Mojtahedi, D., Dagnall, N., Denovan, A., Clough, P., Hull, S., Canning, D., Lilley, C. and Papageorgiou, K.A. (2021). The Relationship Between Mental Toughness, Job Loss, and Mental Health Issues During the COVID-19 Pandemic. *Frontiers in psychiatry*, 11, p.1668.
- Nishantha Jayasooriya, (2020). Sunday Observer, Dairy industry: Milk production to be Streamlined.
- Press Information Bureau, Government of India. (2022). Milk production in India. <https://pib.gov.in/FeaturesDeatils.aspx?NotelId=151137&ModuleId%20=%202>
- Rozaki, Z. (2020). COVID-19, agriculture, and food security in Indonesia. *Reviews in Agricultural Science*, 8, 243-260.
- Smith, L.C. and Frankenberger, T.R. (2018). Does resilience capacity reduce the negative impact of shocks on household food security? Evidence from the 2014 floods in Northern Bangladesh. *World Development*, 102, pp.358-376.
- Tarka, P. (2017). The comparison of estimation methods on the parameter estimates and fit indices in SEM model under 7-point Likert scale. *Archives of Data Science*, 2(1).
- Vidanarachchi, J.K., Chathurika, H.M.M., Dias, H.M. and Gedara, K. (2019). Dairy Industry in Sri Lanka: Current Status and Way Forward for a Sustainable Industry.
- Walker, B., Holling, C.S., Carpenter, S.R. and Kinzig, A. (2004). Resilience, adaptability and transformability in social-ecological systems. *Ecology and society*, 9(2).
- Wolfenson, (2013). *Coping with the Food and Agriculture Challenges: Smallholder Farmers' Agenda*; Food and Agriculture Organisation of the United Nations (FAO): Rome, Italy.
- Zhou, W., Guo, S., Deng, X. and Xu, D., (2021). Livelihood resilience and strategies of rural residents of earthquake-threatened areas in Sichuan Province, China. *Natural hazards*, 106(1), pp.255-275.