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COVID-19 IMPACT AND SMALLHOLDER FARMING HOUSEHOLDS: INSIGHTS FROM RURAL NEPAL

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ABSTRACT

Most dairy producers in Nepal are small-holder farmers; the COVID-19 pandemic disrupted the dairy production value chain. This study was embedded in a longitudinal impact evaluation of educational interventions on household diet in rural livestock-holding families. The intervention and other project activities were cancelled due to COVID-19, but data collection continued and repurposed to investigate the relationship between sociodemographic variables and the impact of COVID-19 on small-holder dairy farmers over the lockdowns. Eight questions about COVID-19 impact were added to the mid- and endline household surveys, and a COVID-19 impact score calculated. Regression models examined whether – and to what degree - households reported an impact of COVID-19 on their dairy farming practices. Households with higher animal score (number/type of animals) had significantly increased odds of reporting COVID-19 impact on their dairy farming practices. Survey round was also significant: COVID-19 impact scores at midline were higher than at endline. These results suggest how livestock can act as a buffer in times of crises (e.g., providing animal source foods for the family as well as a source of income) but can

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also contribute to increased burdens on smallholder farming households as they cope with disruptions across the livestock value chain.

Keywords: smallholder farming, COVID-19, rural Nepal, dairy production, value-chain

1. INTRODUCTION

The 2020 outbreak of SARS-CoV-2 (COVID-19) and ensuing coronavirus pandemic highlighted the vulnerability of global food systems and populations in low- and middle-income countries (LMIC). Nepal, a landlocked country in South Asia, experienced major socioeconomic disruptions over the course of the pandemic. The pandemic hit nearly all sectors of the Nepalese economy, including tourism, trade, production, and health, and reduced the flow of remittance into the country [1]. To further stop the spread of COVID-19, the disease caused by the novel coronavirus, the Government of Nepal issued a nationwide lockdown from March 24 to July 21, 2020, which prohibited domestic and international travel, closed the borders, and halted businesses and non-essential services. Research investigating the macroeconomic effects of COVID-19 and the associated lockdown measures have indicated an adverse effect on economic growth in many sectors and a decrease in gross domestic product (GDP) growth [2,3]. The pandemic and associated lockdown also negatively affected the physical and mental health of Nepalese people and disrupted the educational sector as schools and universities faced closures [3].

Nepal's economy relies heavily on agriculture, with about 66% of the population engaging in smallholder farming to support their livelihoods [4]. Nepal is also a net importer of food and relies on other countries for goods, including importation of agricultural inputs required to produce crops and livestock [1,5]. The countrywide lockdown severely disrupted all segments of the supply chain, including agricultural production, transport and logistics, and goods distribution in Nepal. Facing market closures, many farmers were unable to sell their agricultural products, leading to product shortages in local markets and increases in food prices [6,7]. Furthermore, approximately 85% of the labor force in Nepal are informally employed, working in areas such as small-scale industries and tourism, highlighting the vulnerability and fragility of the economy and low-income households to external shocks [1]. Discussions about resiliency and survival of farming systems have also arisen, given Nepal's history with the 2015 earthquake and its ability to adapt to changing conditions [5].

Regarding ASF production, dairy production in Nepal is predominately in the smallholder production system [8]. Milk producers' cooperatives have an important role in directing the milk produced by smallholder farmers into the formal milk market, establishing strong networks among rural households across Nepal [9,10]. The dairy industry in Nepal is a critical sector for the flow of resources, income, and employment opportunities from urban areas to smallholder farmers in rural areas [11,12]. Furthermore, the cattle population, number of milking cattle, and overall milk

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production in Nepal increased 44% from 2008/09 to 2017/18, representing an increasingly important portion of Nepalese livelihoods and source of nutrition [9–11]. Key challenges in dairy production include health and low productivity of dairy cattle, lack of accessibility to markets, feed quality and milk quality [8,10]. Given the disruptive nature of COVID-19 and the importance of smallholder dairy production in Nepal, the purpose of this study is to investigate the relationship between various sociodemographic variables and the impact of COVID-19 on small-holder dairy farmers over the lockdown period in Nepal.

2. METHODS

2.1 Design and Sample

This study was approved by the Nepal Health Research Council (#391, 9 August 2019), Tufts University Human Investigation Review Board (#1903033, 13 May 2019), and was registered at ClinicalTrials.gov (NCT03886467). Informed consent was obtained from all participants in the study. This study analyzed data collected from a longitudinal, household survey conducted in the Terai region of Nepal, a lowland region in western Nepal populated by subsistence farming households. Study aims, research questions, and detailed methodology are published elsewhere [13] but will be briefly described. The original design of the project was to measure the impact of a mothers' group-based educational intervention on household diet through a longitudinal controlled impact evaluation trial implemented by Heifer-International Nepal (a non-governmental organization [NGO] dedicated to poverty alleviation).

In this investigation, 46 villages and settlements in three municipalities were matched based on various sociodemographic characteristics. Four non-adjacent groups of villages were identified, and two villages of each group were randomly assigned to "intervention" and "control". Intervention communities were targeted to receive intensive nutrition training during the study period. However, due to the COVID-19 lockdown and related restrictions, the nutrition training could not be implemented, and the main research question was adjusted to focus on diet quality over the course of the pandemic and the possible protective role of dairy animal ownership [13].

2.2 Data Collection

Household visits were conducted by a professional research organization with no relation to Heifer (timing described below). Households were eligible to participate if they had at least one child aged 6-66 months. Children with severe illnesses at the time of the survey and children with disabilities that impacted the consumption of a normal diet were excluded. With a supervisor present, trained field enumerators completed a questionnaire with the child's mother for each household visit. The questionnaire contained questions on demographic characteristics, child and household diet, household dairy farming, and, eventually, COVID-19 impact.

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Data collection was conducted at three time points. The baseline assessment was in December 2019 and included demographic questions. The first Nepal lockdown occurred between March and August 2020. The second survey was thus postponed until July 2021, where questions related to COVID-19 were included (described below). The Nepali government re-instituted lockdown restrictions from July to September 2021. At the time that the second lockdown was reinstated, 147 households had already been visited, so data for the remaining 125 households was collected by phone interview. The third survey was conducted in September 2021, after the second Nepal lockdown. Enrolled participants included 251 households with 309 mothers and fathers and 368 children between the ages of 6-66 months.

2.3 Variables

There were two primary outcome variables of interest: whether households reported an impact of COVID-19 on their dairy farming practices, and the degree of impact of COVID-19 on household dairy farming practices. The first outcome variable, whether households reported an impact of COVID-19 on dairy farming, was binary (coded as 0/1), where 0 indicated that households reported no impact, and 1 indicated that households reported that they were impacted. The second outcome variable, the degree of COVID-19 impact, was an aggregated impact score (0-16). Participants chose from four possible answers to each of these questions: problem occurred during lockdown, no problem occurred during lockdown, problem continued after lockdown, and problem resolved after lockdown. If a participant answered ‘yes’ for a problem that occurred during lockdown and that the problem continued after lockdown, this contributed two points to the question impact score. If a participant answered ‘yes’ for a problem that occurred during lockdown but that it resolved after lockdown, this contributed one point to the impact score. Thus, each question could yield a value of 0, 1, or 2. All eight questions were then aggregated to form an overall COVID-19 impact score, with possible values of 0 to 16, with the highest score indicating the most severe impact. Table 1 displays the questions that were used to construct this impact score. These questions were asked in reference to the most recent lockdown before each of the survey rounds (rounds 2 and 3).

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Table 1: COVID-19 impact questions

COVID-19 Impact Questions
Inability to acquire feeds and fodder for dairy animals
The price of maintaining animals has increased
Milk production has decreased
Veterinary services are not available
Artificial insemination services halted
External labor is not available
Unable to sell the produced milk
Milk price has decreased

The explanatory variables included in analysis were a household wealth score, annual income per household (Nepali rupees), amount of land owned (meters squared), household animal score, amount of yearly remittance, number of household members, time point, gender of the household head, highest level of any male in the household, highest level of female education in the household, mother's education, and father's education. The highest level of education of any male in the household, the highest level of education of any female in the household, highest level of father's education, and highest level of mother's education were dichotomized into high and low education, where high education indicated any secondary school or beyond, and low education included any or no primary school. Household animal score was calculated by recording how many immature and mature cows, buffalos, sheep, goats, pigs, chickens, and other poultry each household owned and converting to standardized score following the guidelines from FAO Global Livestock Units for Asia [13,14]. The household wealth score was a quantitative measure of assets in the household and was calculated using principal component analysis of household possessions and housing quality, following guidelines from DHS-Nepal [13,15]. Remittances were defined as the amount of money sent to households in one year from family members working abroad

2.4 Analysis

Data cleaning was performed in Microsoft Excel, and data analysis was performed in R statistical software [16]. Descriptive analyses were performed to explore sociodemographic characteristics of the study population. Kruskal-Wallis tests were performed to examine several variables over the three time points, including remittance, land ownership, household wealth score, and household animal score. A Kruskal-Wallis test was also performed to compare the median overall impact score for midline and endline time points. The distributions of remittance, land ownership, household wealth score, and household animal score did not appear normally distributed, so the Shapiro-Wilk test for normality was applied to each variable.

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A logistic regression model was performed for the outcome of whether households reported that their dairy farming was impacted by COVID-19. A Poisson regression model was also performed for the outcome of the overall impact score. A diagnostic test described in [17] gave evidence that the impact score followed a Poisson distribution. Overdispersion was tested, and there was no evidence of overdispersion. A test for multicollinearity was performed for both models. No significant evidence of multicollinearity between the covariates was discovered for either model. Both forward and backward selection were used, and the model with the best BIC was selected.

3. RESULTS

Table 2 shows the descriptive statistics for various demographic variables the counts of impact score (divided into high and low impact score by median) by each demographic variable.

Table 2: Descriptive statistics for various demographic variables by impact score at midline survey (round 2)[a]

	High (Above Median) COVID-19 Impact Score (N, %)	Low (Below Median) COVID-19 Impact Score (N, %)	Total (N)
Male head of household	58 (74.4%)	20 (25.6%)	78
High education of any male in the household[b]	58 (70.7%)	24 (29.3%)	82
Female head of household	9 (64.3%)	5 (35.7%)	14
High education of any woman in household[b]	59 (71.1%)	24 (28.9%)	83
High education of mother[b]	46 (66.7%)	23 (33.3%)	69
Above median animal score	44 (73.3%)	16 (26.7%)	60
Household wealth score 1st quartile (lowest)	14 (77.8%)	4 (22.2%)	18
Household wealth score 2nd quartile	14 (73.7%)	5 (26.3%)	19
Household wealth score 3rd quartile	20 (74.1%)	7 (25.9%)	27

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Household wealth score 4th quartile (highest)	19 (67.9%)	9 (32.1%)	28

[a]Table includes only data with non-missing values.
[b]High education defined as any secondary school or beyond.

Table 3: Descriptive statistics for various demographic variables by impact score at endline survey (round 3)[a]

	High (Above Median) COVID-19 Impact Score (N, %)	Low (Below Median) COVID-19 Impact Score (N, %)	Total (N)
Male head of household	56 (58.9%)	39 (41.1%)	95
High education of any male in the household[b]	55 (52.4%)	50 (47.6%)	105
Female head of household	10 (38.5%)	16 (61.5%)	26
High education of any woman in household[b]	58 (53.7%)	50 (46.3%)	108
High education of mother[b]	44 (51.2%)	42 (48.8%)	86
Above median animal score	40 (53.3%)	35 (46.7%)	75
Household wealth score 1st quartile (lowest)	12 (44.4%)	15 (55.6%)	27
Household wealth score 2nd quartile	15 (55.6%)	12 (44.4%)	27
Household wealth score 3rd quartile	20 (58.8%)	14 (41.2%)	34
Household wealth score 4th quartile (highest)	19 (57.6%)	14 (42.4%)	33

[a]Table includes only data with non-missing values.
[b]High education defined as any secondary school or beyond.

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The results of the Kruskal-Wallis tests demonstrates that there were no differences in remittance, land ownership, household wealth score, and household animal score over the three survey rounds.

Tables 4 and 5 display the percent of households that reported impact from COVID-19 for various issues related to dairy farming at survey rounds two and three (after first and second lockdowns, respectively). At survey round two, inability to sell produced milk, inability to acquire feed and fodder for dairy animals, and increased price of maintaining dairy animals were the top three dairy farming-related issues reported by households during the lockdown. Inability to acquire feed and fodder for dairy animals, price of maintaining dairy animals, and decreased milk production were the only three issues that persisted after the lockdown ended.

At survey round three, inability to sell produced milk, inability to acquire feed and fodder for dairy animals, and decreased milk production were the top three dairy farming-related issues reported by households during the lockdown. Inability to acquire feed and fodder for dairy animals, price of maintaining dairy animals, and decreased milk production were the three issues that persisted after the lockdown ended. At both survey rounds, nearly all households reported inability to sell produced milk during lockdown but that this issue was resolved completely for all households after the lockdown ended. Additionally, at both survey rounds, increased price of maintaining dairy animals was the most reported problem after the lockdown ended.

Table 4: Number and percent of households that reported impact from COVID-19 for dairy farming-related issues at midline (survey round 2, N = 92)

Issue	No, not a problem during lockdown (N, %)	Yes, during lockdown (N, %)	Yes, during lockdown and problem continued after lockdown end (N, %)
Unable to sell the produced milk	5 (5.4)	87 (94.6)	0 (0)
Inability to acquire feed and fodder for dairy animals	27 (29.3)	64 (69.6)	1 (0.1)
Price of maintaining dairy animals has increased	31 (33.7)	52 (56.5)	9 (9.8)
Milk production decreased	49 (53.3)	42 (45.6)	1 (0.1)
Veterinary services not available	50 (54.3)	42 (45.7)	0 (0)

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Artificial insemination services halted	55 (59.8)	37 (40.2)	0 (0)
External labor not available	45 (48.9)	47 (51.1)	0 (0)
Milk price decreased	68 (73.9)	24 (26.1)	0 (0)

Table 5: Number and percent of households that reported impact from COVID-19 for dairy farming-related issues at endline (survey round 3, N= 121)

Issue	No, not a problem during lockdown (N, %)	Yes, during lockdown (N, %)	Yes, during lockdown and problem continued after lockdown end (N, %)
Unable to sell the produced milk	2 (1.7)	119 (98.3)	0 (0)
Inability to acquire feed and fodder for dairy animals	41 (33.9)	69 (57.0)	11 (9.1)
Price of maintaining dairy animals has increased	39 (32.2)	56 (46.3)	26 (21.5)
Milk production decreased	56 (46.3)	60 (49.6)	5 (4.1)
Veterinary services not available	102 (84.3)	19 (15.7)	0 (0)
Artificial insemination services halted	101 (83.5)	20 (16.5)	0 (0)
External labor not available	112 (92.6)	9 (7.4)	0 (0)
Milk price decreased	120 (99.2)	1 (0.8)	0 (0)

The results for the regression examining the relationship between various demographic variables and the extent of COVID-19 impact are shown in table 6. The results show that time point was significant, such that the average COVID-19 impact score at midline was higher on average than at endline. These results also demonstrate that households led by men tended to have, on average, higher impact scores than the households led by women.

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Table 6: Poisson regression results for the model regressing impact score by demographic variables

	Dependent Variable
	Impact Score
Time[a]	-0.215**
Male head of household[b]	0.242*
Lowest education level of any male in household[c]	0.241
Low education of father[d]	-0.111
Constant	1.294***
Observations	205

***p<0.01, **p<0.05, *p<0.10. Values in each cell are the regression coefficients. They are the expected difference in mean impact score between groups.

[a]Reference group: round 2.

[b]Reference group: woman head of household.

[c]Low education defined as any or no primary school. Reference group is high education (defined as any secondary school or beyond.).

[d]Low education defined as any or no primary school. Reference group is high education of father (defined as any secondary school or beyond).

The results for the logistic regression examining the relationship between various demographic variables and impact of COVID-19 on household dairy farming are shown in table 7. The results show that the coefficient for animal score was significant ($p < 0.01$), indicating that households with a higher animal score are associated with an increase in the odds of households reporting COVID-19 impact on their dairy farming practices. Yearly income per household member and amount of yearly remittance per household were also significant ($p < 0.01$); however, the coefficients are very close to zero, suggesting negligible effects.

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Table 7: Logistic regression results for the model regressing binary impact by demographics

	Dependent Variable
	Being impacted
Time[a]	0.08293
Low education level of highest educated woman[b]	-0.138
Yearly income per household member	0.000009**
Amount of yearly remittance per household	-0.000004***
Amount of land owned	-0.00007
Household animal score	0.969***
Constant	-1.673***

***p<0.01, **p<0.05, *p<0.10. Values in each cell are the regression coefficients.

[a]Reference group: round 2.

[b]Low education defined as any or no primary school. Reference group is high education (defined as any secondary school or beyond.).

4. DISCUSSION

This study aimed to explore the relationship between various sociodemographic variables and the impact of COVID-19 on small-holder farmers over the lockdown period in Nepal. The results from this analysis highlighted how dairy farming practices were more likely to be impacted by COVID-19 among households with a higher animal score. Results also showed that inability to sell the milk produced by households was the most reported issue during Nepal's COVID-19 lockdown among households in this sample but that no households reported this issue persisting after the lockdown ended, indicating that market closures over lockdown likely contributed, at least in part, to this issue. An increase in the price of maintaining animals was the most reported issue after the lockdown ended, and an inability to acquire feed and fodder for animals was the second most reported issue after the lockdown ended. Restrictions on movement between regions and measures to promote social distancing may have undermined the flow of goods and services to and within farming systems, the ability to access markets for inputs and supplies, to sell products, and to access extension services, contributing to the disruption of livestock farming among smallholder households [18–20]. Throughout the pandemic, livestock systems in LMIC have faced additional pressures that exacerbated the influence of other existing challenges, such as climate change, scarcity of resources, lack of pasture, and urbanization [18].

These results point to how livestock can act as a buffer in times of crises (e.g., providing animal source foods for the family as well as a source of income) but can also contribute to increased burdens on smallholder farming households as they cope with disruptions across the livestock value chain. Despite government support for hard-hit sectors in Nepal, including dairy farming,

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assistance primarily reached wealthier farmers and larger businesses instead of smallholder farmers [21]. Furthermore, results from a previous publication on these data indicated that dairy animal ownership related to increased diet quality indicators (milk consumption, ASF consumption) for children and family members during the pandemic but increased household economic vulnerability [13].

The results demonstrated a higher average impact score at midline compared to endline. The first lockdown, initiated in March 2020, was more severe than the second lockdown, which began in June 2021. Recognizing that severe lockdown measures were a major disruption to the economic health of the population, the Nepalese government implemented a less severe second lockdown. Reduced feeding rations for animals, because of higher cost and/or inability to acquire feed, may have contributed to less milk produced. Additionally, some smallholder farms may have absorbed returning youths who traveled back to Nepal during COVID-19 lockdowns, contributing to more on-farm help. These results also point to the importance of recognizing and understanding the possible resilience of Nepalese farming systems, which was observed after the 2015 earthquake [22]. Some smallholder farms may have depended on local farming systems and local inputs, such as local indigenous seeds, compost, and family and community labor exchange [5], highlighting the importance of supporting the capacity of local indigenous knowledge and farming systems.

Unexpectedly, the results demonstrated that men-led households tended to be more impacted by COVID-19 than women-led households. Crises can affect gender issues in unexpected ways. The COVID-19 crisis may have contributed to major disruptions in households' normal activities, shifting responsibilities around to other family members and affecting dynamics of decision-making between men and women within the household [23]. There may have been a possible increased reliance by women on social networks after the lockdown, as women may rely on more informal sources of support compared to formal sources of support.

Remittances in this sample did not decrease over the three time points. Compared to many other countries, Nepal is highly dependent on remittances, which account for around 23% of its gross domestic product (GDP) [25]. Its remittances-to-GDP ratio is among the top ten highest globally. Some economic organizations (e.g., the World Bank) predicted a sharp decline in the flow of remittances into Nepal because of COVID-19, but remittances into Nepal actually remained resilient. [1] speculated that this resilience in remittances may be partly due to the closure of informal money transfer systems between Nepal and other countries, with more money being diverted through formal systems. Other possible reasons for this resilience include a lower-than-expected number of migrant workers returning to Nepal because of job loss, reduced outflow of migrant workers due to COVID-19 travel restrictions (hence allowing more job opportunities for established migrant workers), differences in timing or impact of lockdowns on Nepalese overseas (many of whom may have been in jobs considered essential workers, thus continuing to earn

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incomes), and remitting more than usual due to uncertainty around job security [26]. Whatever the reason for the preservation and persistence remittances throughout the periods of lockdown, it is important to note that these did not sufficiently buffer rural populations from the significant impact of COVID-19 on their livestock productions efforts.

Our study had several limitations and strengths. The impacts of COVID-19 was likely not uniform across households. Differences in vulnerability could exist that were not captured by this sample, such as differences by caste, region, education, and crop type [24]. The small sample size of women-led households was a further limitation of this study. Additional limitations include the necessary reliance on phone interviews during the lockdown, which may have affected the consistency and depth of responses. The study was conducted only in one region of Nepal (the Terai), which might limit generalizability to other regions or countries. We focused only on dairy farming; integrating other aspects of smallholder livelihoods would provide a more comprehensive view of COVID-19 impact. We also were unable to assess long-term resilience or post-pandemic recovery of smallholder farmers. As strengths, longitudinal household survey data was used to allow comparisons across different lockdown periods. The use of both logistic and Poisson regressions ensured rigorous statistical analysis of household level impacts. Finally, we were able to highlight how livestock can act both as a buffer and a burden during crises, providing useful implications for policymakers and development programs.

5. CONCLUSION

These findings point to the importance of livestock as a buffer in unexpected economic conditions and how smallholder farming households can shift in unexpected ways to cope in times of crises, but that livestock can also contribute to increased burdens on smallholder farming households. Given that these data were collected in 2019 and 2021, future research could consider in what ways smallholder dairy farming households have demonstrated resiliency following COVID-19-related lockdowns as well as current challenges in a post-pandemic global economy, as well as the long-term impacts and resilience strategies of smallholder farmers beyond the immediate COVID-19 crisis.

Notes

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