Nepal's Sacred Cattle: Profitability Analysis and Policy Implications

Kehinde Elizabeth Ojo[1], John J. VanSickle[2], and Bhawna Thapa[3]

[1]Department of Agricultural and Applied Economics, University of Georgia, USA; [2]Department of Food and Resource Economics, University of Florida, USA; [3] Department of Agricultural Economics, Oklahoma State University, USA

ABSTRACT

This paper analyzes Nepal's current livestock policy, which is rooted in culture and religion, and the extent to which its design has not kept pace with the continuing transformation of the country's agricultural landscape. It estimates the impact of the no-slaughtering of cattle policy on dairy producers using Latin hypercube simulations to quantify a baseline and alternative scenario for cattle milk production. The baseline models the current production system, while the alternative scenario models milk production where producers are allowed to slaughter or export cattle. Results indicate that farmers' profit per liter of milk increases by 19 to 31 percent in the alternative scenario.

Keywords: Nepal's sacred cattle, no-slaughtering of cattle policy, profitability analysis

JEL codes: O10, O13, Q10, Q18

INTRODUCTION

The controversy around cattle slaughter in countries where the larger percentage of the population practices Hinduism is enormous (Chigateri 2011; Sarkar and Sarkar 2016). In Nepal, where 80 percent of the people are Hindu (Central Bureau of Statistics 2013), cultural traditions forbid the slaughter of cattle and eating of beef (Azzi, Weizmann, and Harris 1974; Korom 2000; Shivaram 2009). This tradition stems from the religious belief that cows are the reincarnation of one of their gods, and therefore bad karma follows anyone who kills or harms the animals (Heston 1971). Consequently, the Nepali government has implemented the no-slaughtering of cattle policy, which has made it difficult for farmers to sell or export unproductive cattle. Financial penalties and imprisonment are strictly enforced on those who kill, euthanize, or export cattle (Schuler 1979;

Check the complete lineup of the Asian Journal of Agriculture and Development (AJAD) Vol. 19 No.1 June 2022

Contact Kehinde Elizabeth Ojo E-mail: kehindeojo@uga.edu https://doi.org/10.37801/ajad2022.19.1.4

Acharya, Acharya, and Wilson 2019). The policy forces farmers to keep unproductive cattle in their herds.

It has been argued that anti-slaughter policies result in an increased number of abandoned unproductive cattle, which impacts breeding efficiency (Vaidyanathan and Nair 1980; Marandure et al. 2018) and feed supply (Dandekar 1964; Simoons et al. 1979), thus directly affecting overall milk production costs and efficiency (Anagol, Etang, and Karlan 2017; Attanasio and Augsburg 2018). However, most of these findings were from studies of Indian dairy producers exhibiting state-dependent returns that vary through time. While it can be argued that the cow slaughter ban can impact dairy farmers, no research has assessed the impact of such ban on Nepal's dairy producers (NDDB 2015). Understanding the economic impact of the cattle slaughter ban on productivity and profitability among Nepali dairy farmers is of great importance to policymakers who have traditionally pandered to the religious sentiments of the majority population when formulating policy intervention rather than basing interventions on data-driven evidence.

There are more dairy cattle (seven million) than buffalo (five million) in Nepal (NMoAD 2016), yet 71 percent of the country's milk production comes from buffalo and only 29 percent comes from cattle. The major cause of low cattle productivity is that many cows in the herd are past their peak productivity period but cannot be culled because government laws prohibit their slaughter (Joshi et al. 2003; Acharya, Acharya, and Wilson 2019). Cattle milk producers cannot generate income from cattle sales due to restrictions on slaughtering cattle, whereas buffalo can be sold for slaughter, thus generating additional income from animal sales. Moreover, low-productivity cattle in the herds compete with productive ones for feeds and other resources. These practices and policies add to the cost of producing milk in Nepal, making it less competitive in the South Asia region.

Meanwhile, rapid urbanization with its accompanying changes in diets and preferences, as well as improved affordability due to higher remittance incomes have resulted in an increased demand for dairy products (NDDB 2012). These factors have contributed to widening the gap between milk supply and demand. For instance, annual milk consumption between 2004 and 2014 increased by 8 percent (measured by per capita consumption), while the average annual growth rate of milk production was only 3.3 percent (NMoAD 2015). As a result, Nepal markets are filled with imported milk and milk products, with which local producers must compete. Nepal's National Dairy Development Board (NDDB 2014) reports that the country imports about 45,734 t of fluid milk annually, which is equivalent to 125,000 L of milk per day (NDDB 2014). This suggests that there may be opportunities for significant growth in milk production in Nepal.

This paper examines the data on milk production cost for cattle while analyzing policy and economic returns. Specifically, it assesses the impact of the cattle slaughter ban on dairy producers' profit in Nepal. We used Latin Hypercube simulation to quantify a baseline and an alternative scenario for milk production. The baseline explains the current production scenario while the alternative explains a milk production scenario where animals can be slaughtered or exported. Simulation has been widely used in studies analyzing risky investments and new technology adoption, as well as in policy analysis (Richardson and Mapp 1976; Richardson, Bizimana, and Herbst 2017).

We used secondary data from various sources in our analysis. Milk production data and cow prices were obtained from a study on milk production cost conducted by NDDB in 2015 covering five districts in Nepal, namely, Dhankuta, Sindhupalchowk, Rupandehi, Surkhet, and Kailali. Milk prices were obtained from the United Nations Food and Agriculture Organization (UN FAO). Our analysis shows that dairy producers' profit per liter of cow milk increases in the alternative scenario. More specifically, the profit increases by 19.3 percent for Kailali (the lowest increase among the five districts included in our study) and 30.6 percent for Surkhet (the highest increase).

This paper contributes to the limited literature on cattle slaughter policies in Nepal. Previous studies on cattle slaughter mostly focus on India and cover a wide range of topics, including historical documentation, cow slaughter ban, and welfare of cattle (Chigateri 2011; Vaidyanathan 2015; Sarkar and Sarkar 2016). To the knowledge of the authors, this is the first study that estimates the effect of the cattle slaughter ban on dairy producers in Nepal.

The remainder of the paper is organized as follows: the background section provides information on Nepal and its livestock sector, followed by the data and methodology sections, results and discussion, and conclusion, which also presents some policy implications on diary producers in Nepal.

BACKGROUND INFORMATION ON NEPAL

Nepal is a landlocked developing country located in South Asia, bordered by India and China. As of December 2017, its population was approximately 30 million. It has a land area of 147,181 km^2, 75 percent of which is covered with mountains and hills (MOFA 2017). Nepal has three regions: the Terai, the Hill, and the Himalayan (mountain) regions (NMoAD 2016). Each region has different geographical attributes. The Terai region, which covers about 17 percent of the total land area, is characterized by a low stretch of land, which makes it the most suitable area for agricultural production (NMoAD 2016).

Livestock Sector

Nepal's agriculture sector employs about two-thirds of its population; however, the sector generates only about one-third (32%) of the country's gross domestic product (GDP) (Ministry of Finance 2015), down from 50 percent in 1995 (NMoAD 2015). Livestock is an important aspect of the agriculture sector, contributing to the supply of money flowing from urban to rural areas (Panta 2008; Dinesh and Paudel 2013). In particular, the dairy subsector contributes 33 percent of the agricultural GDP and 63 percent of the livestock GDP (NMoAD 2014). It is the largest and fastest growing subsector, contributing to the increase in household income in the rural areas (Adhikari, Gautam, and Chapagain 2015), as many farmers are transitioning from subsistence to semi-commercial dairy farming (Pingali 2001; NDDB 2012). Cattle and buffalo are the major livestock used for milk production in Nepal. Almost three-fourths of the Nepalese households keep cattle and about half of them keep buffalo (Panta 2008), and as indicated earlier, there were about seven million cattle and five million buffalo in Nepal in 2015 (NMoAD 2016). Since Nepal's livestock system consists of smallholder farmers raising small numbers of livestock in small land holdings, it is imperative that dairy farms achieve profitability to remain economically viable.

Despite the increasing importance and scope of the dairy subsector in Nepal, productivity is very low, with only about 60 L of milk produced per capita per year. On the other hand, the World Health Organization recommends an annual per capita consumption of 91 L of milk for a healthy population (NMoAD 2014; Kumar et al. 2017). Milk not only generates income but also serves as a vital source of high-quality protein for rural households, thereby contributing to Nepal's nutritional security and rural poverty alleviation (Pradhanang et al. 2015).

The number of cattle and buffalo increased by 20 percent and 43 percent, respectively, between 2002 and 2013; cow milk production correspondingly increased by 40 percent and buffalo milk production by 47 percent (NMoAD 2014). But even with these increases, milk production has remained inadequate to meet the increasing domestic milk demand resulting from increased household income and population growth (Kumar et al. 2017).

DATA

Milk production cost data were obtained from the National Dairy Development Board (NDDB) of Nepal. The NDDB annually conducts a study on the cost of milk production across the country's different districts. The data used in this study were completed by NDDB in 2015. The production cost prepared by NDDB includes variable cost, fixed cost, total value of milk produced, and the cost of producing one liter of milk. The fixed cost of milk production includes animal purchase, shed construction, interest, insurance, and depreciation. The variable cost includes the cost of breeding, feeding, care and management, disease prevention and control, and marketing. We used the 2015 cost calculation by the NDDB for the baseline model; the costs were assumed to be constant for the time horizon of the analysis due to the unavailability of agricultural inflation data.

The NDDB collected milk production cost data for cattle by selecting a sampling frame that covered five development regions (districts) in Nepal, milk production potential and geographical coverage in 2015 (NDDB 2015). The districts included in the NDDB 2015 study were Dhankuta (66 lactating cows), Sindhupalchowk (25 lactating cows), Rupandehi (66 lactating cows), Surkhet (65 lactating cows), and Kailali (40 lactating cows).

The price of cows used in this study was obtained also from the NDDB 2015 study. The historical data on milk production, from years 2011 to 2015, for each of the districts were obtained from FAOSTAT (FAO 2017). The range of years for the historical data was limited to the years for which data were available.

METHODOLOGY

Simulation Model

Latin Hypercube simulation models were used to analyze baseline and alternative scenarios for a milk production system in Nepal. The simulation employed the Microsoft Excel add-in Simetar (Richardson, Shuman, and Feldman 2008), a tool used to analyze data, simulate risk, estimate parameters, simulate random variables, manipulate data, estimate the probability distribution for key output variables (KOVs), and probability forecasting. This tool has been used in farm simulation modeling (FARMSim) for countries such as Ethiopia, Tanzania, and Ghana to analyze policy and farming technologies (Richardson, Bizimana, and Herbst 2017). Latin Hypercube was used in this study because it is more efficient than Monte Carlo simulation; it systematically samples all regions of probability density functions, thus requiring fewer iterations to simulate the risk of each random variable (Richardson, Bizimana, and Herbst 2017).

This simulation model, which was applied to a 10-year planning horizon for livestock farms in Nepal, is recursive, and involved 500 iterations. The 500 values for each KOV allow the empirical probability distributions to be identified to compare the baseline and alternative scenarios. The comparison of the probability distributions for the baseline and alternative scenarios can guide decision makers in analyzing the probable implications of introducing alternative farming systems (Richardson, Bizimana, and Herbst 2017). The following explains each part of the simulation model.

Scenario analysis

We used scenario analysis to calculate results for both the current milk production system (baseline) in Nepal and the alternative scenario. The current system does not allow farmers to slaughter or export unproductive cattle in the herd. The alternative scenario estimates milk production in Nepal where farmers are allowed to slaughter or export unproductive cattle in the herd. Both scenarios were simulated with stochastic milk price (assumed to be the same for both scenarios) and stochastic milk production. The summary of the baseline and alternative scenarios are as follows:

- Baseline scenario: No-slaughtering policy for cattle (current practice)
- Alternative scenario: Animals can be slaughtered or exported.

Simulating alternative farming systems that have not been implemented is a difficult task. In this case, the productivity of the alternative farming system was based on assumptions derived from the literature. To determine milk production and farmers' profit under this scenario, a model was developed to calculate the farmers' herd size[1] for each lactation stage for each of the five districts included in the NDDB (2015) study. It was assumed that the typical herd in all the districts starts with the number of cows identified in the NDDB (2015) study. The entire Dhankuta district had 67 lactating cows, Sindhupalchowk 25, Rupandehi 66, Surket 65, and Kailali 40. The number of animals for each lactation stage was calculated iteratively until a steady state was reached with replacements (cows in their first lactation) added into the herd and a death rate used in a study conducted by Pinedo, De Vries, and Webb (2010). Another assumption was that animals were removed from the herd after eight lactations (considered spent) and replaced with animals on their first lactation (Cowsmopolitan 2016). The death rates are 3.9, 5.6, 8.5, and 11.7 percent for parity groups one, two, three, and four or more, respectively. We first calculated the herd distribution with only the death rate applied by assuming the districts would maintain constant herd size by replacing the animals culled due to death. This was done to depict the current milk production practices among the dairy farmers since they are not allowed to cull live animals. Live culling is the act of removing cows from the herd to maintain constant or increase herd size with first-year lactating heifer or another cow (Hadley, Wolf, and Harsh 2006).

The herd size distribution was also calculated using both death rate and live culling, assuming live culling rates of 16.9, 23.3, 30.1, and 40.8 percent for parity groups one, two, three, and four or more, respectively. The live culling rates were derived from a study conducted by Pinedo, De Vries, and Webb (2010), following the assumption of the district maintaining constant herd size. We further calculated the herd distribution with only live culling to generate the number of animals that could be sold if cow slaughter and export were allowed and to determine the revenue that could be generated from culled animals that are sold.

To determine the herd distribution at a steady state, we used an iterative method analogous to numerical analysis in Matrix Laboratory programming (MATLAB 2017) since the calculations for animals in their second lactation depend on the number of animals in their first lactation and so on. Animals in their first lactation are designated to be at year one. Starting with N number of cows in a district, we determined the number of cows that will move from one stage of lactation to the next using the set of equations given below. The first lactation animals are equal to N, while the number of animals in the second to eighth lactations were calculated using:

$$L_{(i,j)} = L_{(i-1,j-1)} * (1 - D_i) \qquad (1)$$

where $L_{(i,j)}$ is the number of cows at lactation i stage for year j, with i being the lactation stage, j the year, and j and $i = 2, 3\ldots8$; $L_{(i-1,j-1)}$ is the number of cows in the previous lactation stage (i-1) for the previous year from the reference year (j-1); and D_i is the death rate for lactation stage i.

Animals in their eighth lactation were assumed to be spent (i.e., have low productivity) (Cowsmopolitan 2016). Therefore, all such animals are culled and replaced with cows in the first lactation stage. The number of animals in the first lactation at year 9 onward was calculated using:

$$L_{(i,j)} = \sum_{i=1}^{7} L_{(i-1,j-1)} * (1 - D_i) + L_{(8,j-1)} \qquad (2)$$

where $L_{(8,j-1)}$ is the number of animals in the eighth lactation of the previous year (j-1), while animals in their second to eighth lactations follow the initial equation.

[1] Farmers' herd size here is assumed to be the entire district's lactating animals. The NDDB (2015) study uses the entire district's lactating cows and not herd size of a farmer. All calculations on the alternative scenario were based on entire district's lactating cows.

To derive the number of animals in each lactation stage at steady state, we continued iterating the above two equations for 8 more years, assuming nine years consistently at steady state. We then tested for each year to see if the steady-state criterion is met using the following equation:

$$Y_k: \frac{\Delta L_{i,j}}{\Delta y_j} \leq 0.05 \tag{3}$$

where y_j is the year being examined and Y_k is the steady state year.

The steady-state year is achieved when the proportional difference between the number of animals in the lactation stage for year j and the previous year is less than or equal to 0.05. If the condition in equation 3 is satisfied for nine years, then the steady-state year criterion is achieved, and iteration of equation 2 is stopped. If the criterion in equation 3 is not met, the next year is taken as the new reference year and a new set of iterations is started.

For calculations with death rate and live culling, D_i is changed to DL_i, which is equal to the sum of death rate and live culling rate. For calculations with only live culling, D_i is changed to L_i for the live culling rate for each parity group. The resulting herd distribution at steady state was used to calculate the total milk produced and the number of animals that are culled under this scenario. Milk production was calculated for each parity group based on a study conducted in Zoetic Inc. (Cowsmopolitan 2016) for the longevity-driven profit curve in year 2015. Results from the study show that animals in parity group 1 produced less milk than animals in parity group 2, while animals in parity group 4 had the highest milk production. We turned this result into an index used to calculate milk production in Nepal for each district per herd size. The indices for parity groups 1 to 8 were 0.84, 0.99, 1.04, 1.08, 1.07, 1.04, 1.02, and 0.93, respectively, calculated as:

$$I_j = \frac{M_j}{\overline{M}} \tag{4}$$

where I_j is the index for each parity group j=1, 2, 3,…,8; M_j is the milk produced in each parity group for j= 1, 2, 3,…,8; and M is the mean of the milk produced in all parity groups.

We then multiplied the index by the average milk production per day in each district to get the dairy farmers' milk productivity by parity group per day.

The assumptions used in the alternative scenario are summarized as follows:

- The percentage of animals in the first lactation with only live culling at steady state is the percentage of animals that can be culled and sold.
- Replacement cows in the first lactation stage are from animals produced by the dairy farmers.
- Feed cost remains the same since the districts are assumed to maintain the same herd size.

Stochastic Model

The stochastic model simulates a large number of randomly selected values for the risky variables to estimate the probable outcomes for the KOVs (Richardson, Shuman, and Feldman 2008). The components of milk production in Nepal considered stochastic are milk price and productivity. The stochastic model has been used by a wide range of researchers in the agricultural field to analyze new technology adoption in developing countries (Richardson, Bizimana, and Herbst 2017).

Prices of cow milk per liter for each of the five districts were stochastically simulated over 10 years using multivariate empirical (MVE) distributions. MVE is used when data are limited. Historical data on cow milk prices were collected from FAOSTAT (FAO 2017) for years 2011 to 2015 and forecast over a 10-year period, assuming the data were empirically distributed to avoid forcing them to a particular distribution. The MVE distribution requires the estimation of the deterministic, stochastic, and multivariate components (Richardson, Shuman, and Feldman 2008). The deterministic component is the projected value based on the mean milk price and the trend resulting from ordinary least square regression. The stochastic component is the measure of dispersion about the deterministic component. The measure of the dispersion for the empirical distribution is the vector-sorted deviations from the deterministic component. The multivariate component is determined from the correlation matrix of the unsorted residuals from the trend. The correlated uniform standard deviates (CUSD) were calculated using the correlation matrix for prices.

The stochastic production model follows the same format as the milk price stochastic model. The MVE distribution model for each is written as:

$$Price\ per\ liter\ of\ milk = X_p * (1 + EMP(S_i, F_{(s_i)}, CUSD)) \quad (5)$$

$$Production = X_{pp} * (1 + EMP(S_i, F_{(s_i)}, CUSD) \quad (6)$$

where (X_p) represents the mean value of the historical milk prices and X_{pp} represents the mean value of the historical milk production; S_i is the fractional deviation from the means; $F_{(si)}$ is the probability of occurrence for the deviates; CUSD is the correlated uniform standard deviates; and EMP is the multivariate empirical distribution that is defined by *si* and $F_{(si)}$ using the uniform standard deviate indicated by the CUSD.

Income Statement and Net Present Value

The milk production used to calculate revenue in the alternative scenario was adjusted to reflect the quantity of milk to be produced if the farmers are allowed to carry out live culling. The prices were adjusted to reflect the local price of milk in each district. The adjustments were made using price wedges. The price wedges were then subtracted from the forecast stochastic national price of milk to reflect the forecast local price. Price wedge and local price were calculated using:

$$PW = NP - PM \quad (7)$$

$$LP = SFP - PW \quad (8)$$

where *PW* is price wedge, *NP* is the 2015 national price of milk, *PM* is 2015 NDDB price of milk for each district, *LP* is the local price of milk by district, and *SFP* is the stochastic milk price.

The baseline model revenue was calculated as:

$$R = MS + DS \quad (9)$$

and the alternative scenario revenue as:

$$R = MS + DS + CS \quad (10)$$

where *R* is revenue, *MS* is milk sales value, *DS* is dung sales value, and *CS* is culled cow sales value.

Net present value (NPV) is a capital budgeting measure used to determine whether a proposed investment or project will be worth more than its cost once it is in place (Ross, Westerfield, and Jordan 2014)—that is, it indicates the profitability of a new investment in agriculture or new technology or production practice. The NPVs of the profit for each district under the baseline and alternative scenarios were calculated for a period of 10 years. The NPV of the profit for each district equals the present value of profit for years 1 to 10 with a 10 percent discount rate. This discount rate was adopted from a study conducted by Richardson, Bizimana, and Herbst (2017) on new technology adoption.

The KOVs for this research include profits and NPVs. The KOVs of profit for the baseline and alternative scenarios differ because the alternative scenario's profit includes sales of culled cows, which is absent in the baseline scenario. The KOVs were simulated for 500 iterations and the resulting 500 values were put into a cumulative distribution function. Stoplight charts for both baseline and alternative scenarios were developed to analyze the outcomes.

RESULTS AND DISCUSSION

Herd Distribution

The resulting number of animals in their first lactation calculated with only live culling rates was assumed as the number of animals that can be sold and replaced. The total number of animals in their first lactation calculated with both death and live culling rates does not translate to bigger sales because animals culled due to death are a complete loss for the dairy farmers (Table 1). The percentage of culled animals due to death and live culling ranges between 33.3 and 33.4 percent of the herd size for all the five districts, which is consistent with the culling rate reported by Hadley, Wolf, and Harsh (2006). The results also showed that a higher percentage of cattle were in their first lactation and the percentage declines as the stage of lactation increases from 2 to 8. Moreover, about 95 percent of the animals were culled before they reached the eighth lactation.

Income Statement

The income statement measures the profitability of milk production in the five districts for the baseline and alternative scenarios. The same total cost of producing milk was used for both scenarios because we assumed the farmers maintained the same herd sizes in the five districts. The total cost of milk production for the 10-year horizon is the same as that of NDDB (2015) for each of the five districts. As Figure 1 shows, the cumulative distribution function (CDF) of the simulated profits indicates that profits generated under the alternative scenario are higher than those of the baseline for all five districts. The alternative

Table 1. Number of animals in each parity group at steady state with live culling only and death rate and live culling rate

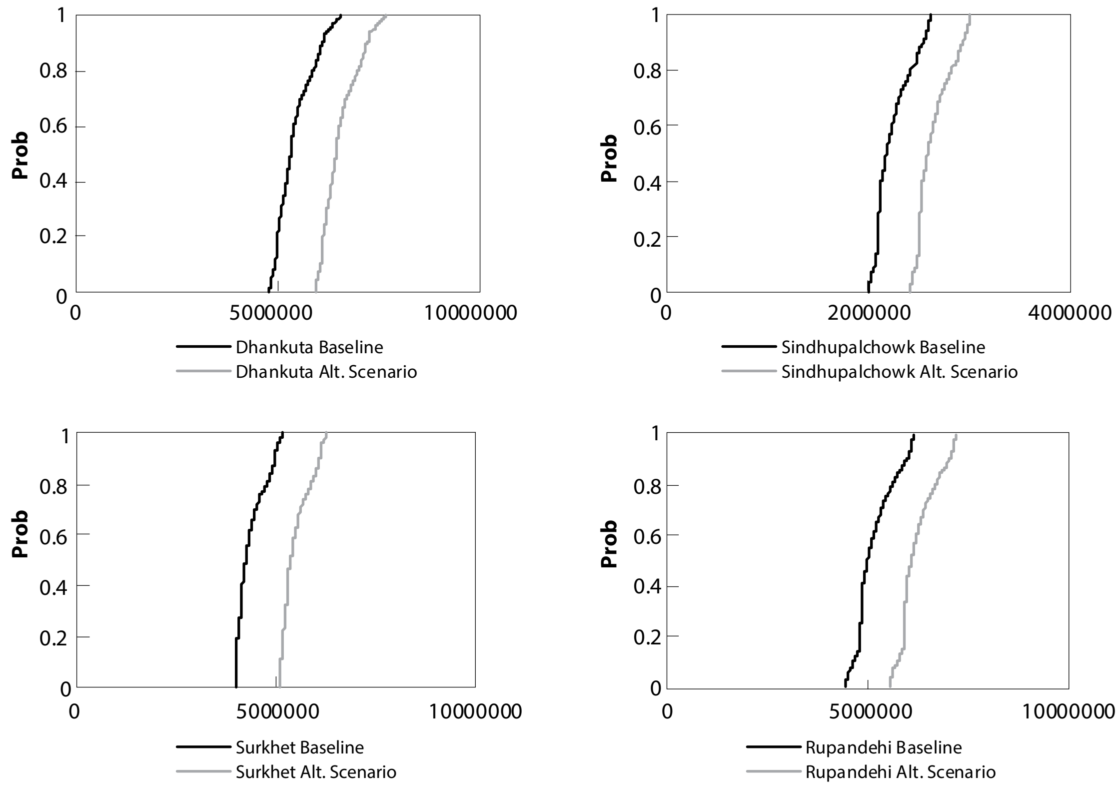
Dhankuta	Sindhupalchowk	Rupandehi	Surkhet	Kailali	Parity Group
With live culling only					
19.22	7.17	18.93	18.67	11.47	1
16.05	5.90	15.81	15.51	9.58	2
12.26	4.44	12.08	11.88	7.32	3
8.56	3.49	8.43	8.35	5.11	4
5.07	1.84	5.00	4.92	3.03	5
3.02	1.09	2.98	2.91	2.91	6
1.78	0.65	1.75	1.75	1.73	7
1.04	0.41	1.03	1.03	1.03	8
67.00	**25.00**	**66.00**	**65.00**	**40.00**	**Total**
With death rate and live culling rate					
19.22	7.17	18.93	18.67	11.47	1
17.73	6.59	17.46	17.20	10.54	2
12.59	4.66	12.40	12.21	7.46	3
7.71	2.95	7.59	7.48	4.72	4
3.64	1.36	3.59	3.53	2.18	5
1.78	0.64	1.73	1.73	1.02	6
0.82	0.31	0.80	0.80	0.49	7
0.39	0.16	0.38	0.38	0.25	8
67.00	**25.00**	**66.00**	**65.00**	**40.00**	**Total**

scenario's CDF of profits lie completely to the right of the baseline for all five districts, indicating that the alternative scenario is economically more profitable. Profits per liter of milk for the alternative scenario in 2019 was higher by 24.9, 21.0, 24.4, 30.6, and 19.3 percent for Dhankuta, Sindhupalchowk, Rupandehi, Surkhet, and Kailali, respectively, compared with those of the baseline (Table 2).

The increase in profit in the alternative scenario is due to the culled animal sales, which increases revenue. Table 3 shows the income statements for the baseline and alternative scenarios for 2019 in the five districts. It indicates that revenues in the alternative scenario for 2019 were higher by 6.7 to 9.9 percent compared with those in the baseline in all the districts.

Additionally, the means and standard

Figure 1. CDF of profit for the five districts for 2019



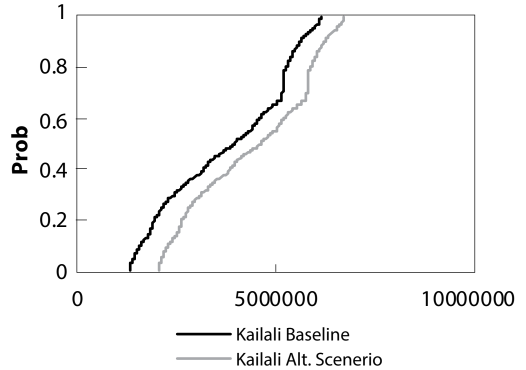


Table 2. Percentage change in profit per liter of milk and revenue for baseline and alternative scenario for 2019

District	Percentage Change in Revenue	Percentage Change in Profit/Liter
Dhankuta	8.26	24.90
Sindhupalchowk	6.75	20.96
Rupandehi	7.64	24.37
Surkhet	9.88	30.64
Kailali	6.74	19.28

Table 3. Income statement for baseline and alternative scenarios for 2019 (in Nepalese rupee)

Cost	Dhankuta	Sindhupalchowk	Rupandehi	Surkhet	Kailali
Fixed cost					
Investment Interest	812,185	303,060	799,857	788,190	485,304
Depreciation of Animal	510,527	190,575	501,679	494,910	304,428
Depreciation of Shed	83,147	30,988	82,434	80,958	49,996
Insurance	76,579	28,586	75,252	74,237	45,664
Total fixed cost	**1,482,437**	**553,209**	**1,459,222**	**1,438,294**	**885,392**
Variable cost					
Water, electricity	28,743	12,043	28,374	27,959	17,244
Feed					
Straw	437,577	162,375	432,102	428,155	259,480
Concentrate	3,359,581	1,273,575	3,364,548	3,312,855	2,031,840
Micronutrients	13,945	5,093	13,475	13,238	8,157
Green grass	670,140	577,065	437,453	232,688	698,063
Total feed costs	**4,481,243**	**2,018,108**	**4,247,578**	**3,986,935**	**2,997,539**
Breeding-AI/bull	39,999	15,050	39,402	38,805	24,160
Other materials	183,643	213,055	183,942	150,582	137,635
Labor charge	1,671,879	609,133	1,592,468	1,570,148	946,357
Vaccination	54,286	24,982	53,139	52,244	32,153
Veterinary service	108,355	40,980	107,017	108,629	60,797
Treatment	133,510	50,253	1,383,304	134,894	80,529
Milk delivery	160,051	137,812	104,514	55,599	166,736
Total variable cost	**6,861,708**	**3,121,415**	**7,739,738**	**6,125,795**	**4,463,149**
Total Cost	**8,344,145**	**3,674,624**	**9,198,960**	**7,564,089**	**5,348,541**
Revenue for baseline scenario					
Cow milk production	259,424	108,731	276,774	222,135	173,061
Milk price (per liter)	51	51	51	51	51
Cow milk value	13,172,794	5,498,190	14,109,145	11,326,027	8,796,201
Dung produced (kg)	247,047	247,047	115,888	300,354	241,995
Dung price (NPR/kg)	2	2	2	2	2
Dung value	370,571	370,571	173,831	450,531	362,993
Total revenue	**13,543,365**	**5,868,761**	**14,282,976**	**11,776,558**	**9,159,194**
Profit	**5,199,219**	**2,194,137**	**5,084,016**	**4,212,469**	**3,810,653**
Net profit/liter	**20**	**20**	**18**	**19**	**22**
Cost/liter of milk	**32**	**34**	**33**	**34**	**31**

Continued on next page

Table 3 continued

Cost	Dhankuta	Sindhupalchowk	Rupandehi	Surkhet	Kailali
Revenue for alternative scenario					
Cow milk production	252,939	106,012	269,855	216,582	168,735
Milk price (per liter)	51	51	51	51	51
Cow milk value	12,843,474	5,360,736	13,756,416	11,042,876	8,576,296
No. of animals culled	19	7	19	19	11
Price of cow	76,198	76,230	76,012	76,140	76,107
Value of culled animals	1,447,762	533,610	1,444,228	1,446,660	837,177
Dung produced (kg)	247,047	247,047	115,888	300,354	241,995
Dung price (NPR/kg)	2	2	2	2	2
Dung value	370,571	370,571	173,831	450,531	362,993
Total revenue	**14,661,807**	**6,264,916**	**15,374,476**	**12,940,067**	**9,776,466**
Profit	**6,317,661**	**2,590,293**	**6,175,515**	**5,375,978**	**4,427,925**
Net profit/liter	**25**	**24**	**23**	**25**	**26**
Cost/liter of milk	**33**	**35**	**34**	**35**	**32**

Note: values are rounded up to the nearest rupee.

deviations of simulated profits for the baseline and alternative scenarios were added to get the mean for the two scenarios in each district. One standard deviation from the average profit and one standard deviation added to the average profit for each district were put into a stoplight chart.

The resulting stoplight chart for the Dhankuta district (Figure 2) with its 67 lactating cows shows that the probability that the profit in the baseline scenario will be less than 5,540,523.59 Nepalese rupee (NPR)[2] is 68 percent; the probability that it will be greater than NPR 5,540,523.59 but less than NPR 6,430,038.77 is 29 percent. The probability that it will exceed NPR 6,430,038.77 per year is 2 percent only for the baseline scenario, but 53 percent for the alternative scenario.

The Sindhupalchowk district's stoplight chart shows a 65 percent chance that profit will be below NPR 2,266,992.19 and a 35 percent chance that it will be between NPR 2,266,992.19 and NPR 2,616,288.98 for the baseline scenario. For the alternative scenario, the chart shows a 44 percent probability that profit will be greater than NPR 2,616,228.98.

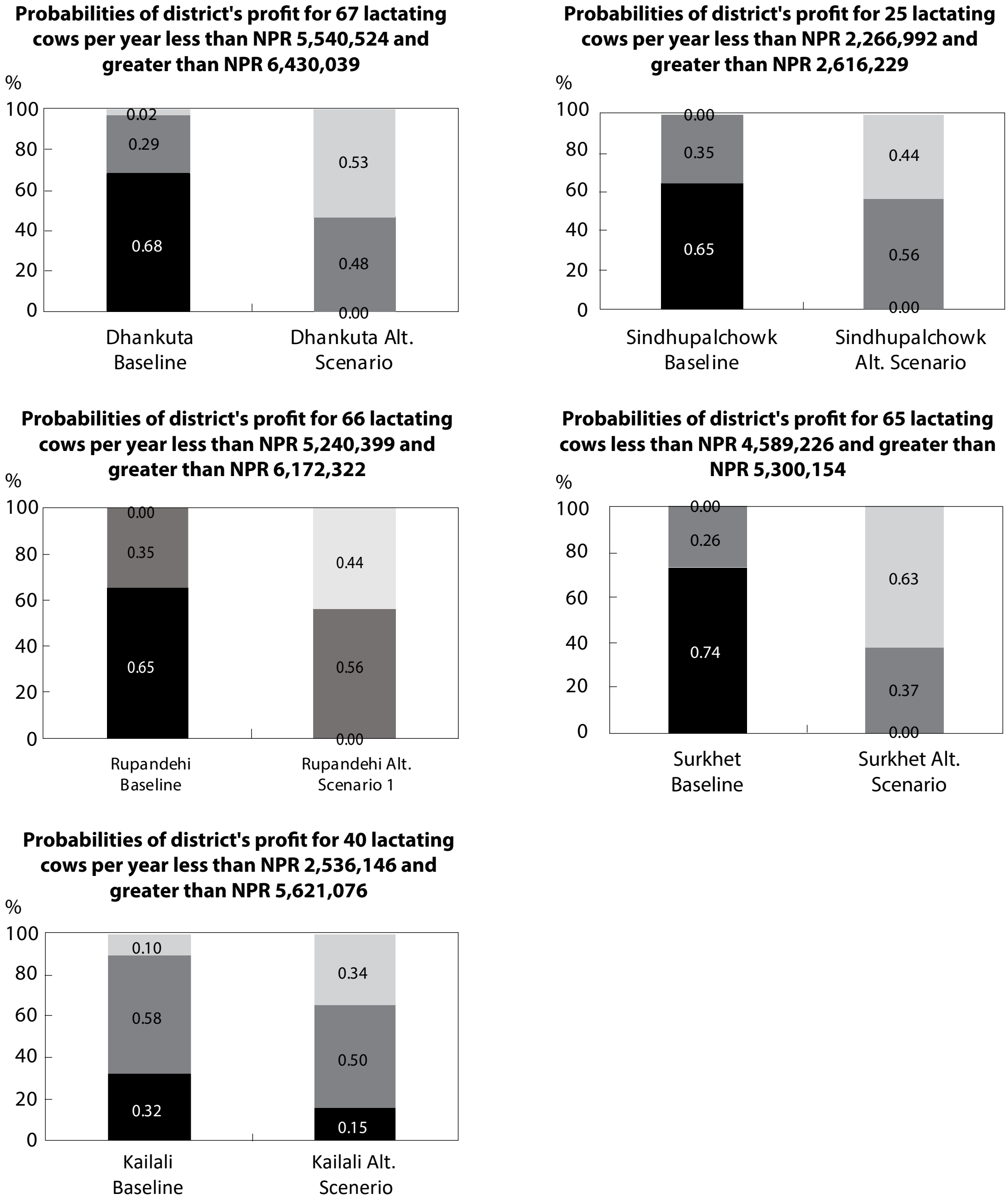
The remaining three districts have similar results as the first two districts. The stoplight charts for all five districts indicate a higher probability of profit in the alternative scenario.

Net Present Value (NPV)

NPV is used to determine the profitability of a proposed investment over a defined period. The CDFs of the NPVs for the five districts are similar with the CDF of simulated profit in Figure 1. The CDF falls to the right side of the base scenario for all 500 values of the simulated model in all five districts. This indicates that it is more profitable for dairy farmers to sell or export unproductive cows (alternative scenario). Allowing dairy farmers to do live culling and to sell their unproductive cows generates more income and leads to more profit.

2 USD 1 = NPR 102, as of August 2017 exchange rate (Nepal Rastral Bank 2017)

Figure 2. Stoplight chart for profit for each of the five districts



Discussion

Results show that the alternative scenario is more profitable than the baseline. Government assistance may be required to pursue additional alternative scenarios. One option to improve profitability in the no-slaughtering policy is to provide subsidies to the dairy farmers for the maintenance of unproductive cattle in their herd. Another option is for the government to build cattle rehabilitation centers to house the unproductive cattle collected from the farmers, similar to the government initiative in India. India has several such shelters across the country, which take care of sick and injured cattle and spent milk cows until their death (Fox 1999). Moreover, the Nepalese government could provide a hybrid heifer as a replacement for every unproductive animal collected from the farmers, similar to the Girinka program in Rwanda, which provides a cow to each poor household (Kayigema 2013).

CONCLUSIONS AND IMPLICATIONS

Although this study was conducted specifically for Nepal, its findings are relevant for other countries with similar national bans on animal slaughter based on religious beliefs. This study demonstrates that Nepal can increase profits per liter of milk between 19 percent to 31 percent depending on the geographic region (districts) under study. We analyzed the cost and profitability of milk production under two scenarios in five districts in Nepal: the baseline scenario with its current milk production practices under a no slaughtering of cow policy and the alternative scenario where dairy farmers are allowed to export or slaughter unproductive cattle. The total cost of milk production in each district was the same for the baseline and the alternative scenario. Profit per liter of milk produced increased in all five districts of Nepal under the alternative scenario.

The CDF and stoplight charts of profit for each district suggest that the alternative scenario is more profitable than the baseline scenario. Allowing dairy farmers to carry out live culling and sell or export unproductive cattle is seen as more advantageous to them because doing so will increase profit generated from milk production. They can use the additional profit from culled animal sales to offset the cost of producing milk.

Contrary to the expectation that milk production would increase if the no-slaughtering policy is rescinded, this study shows that milk production decreased. This decrease could be the result of replacing culled heifers with locally bred ones. Consequently, per liter production cost of milk increased in the alternative scenario. The study's result of decreased milk production raises additional questions. A possible policy implication is that instead of replacing the culled animals with heifers that the farmers produced, they could purchase hybrid cattle as replacements to increase herd productivity. NDDB (2015) indicates that most farmers in all the districts have indigenous and crossbred cattle. The study's data-driven results can provide a guide for the Nepalese government to anticipate the effect of a no-slaughtering policy on the country's dairy production. While the study indicates an increase in income for producers when live culling is allowed, additional policy measures appear necessary to avoid a net decline in total milk production.

The study could be improved by generating replacement data for the baseline and alternative scenarios with representative farm data, as primary data collection could better demonstrate the effects of a no-slaughtering policy. Additional research can also be done to analyze the impact of replacing culled animals with hybrid heifers in the alternative scenario. Additional studies can include other alternative scenarios of government interventions to help build more productive herds. This study could be expanded also to evaluate the impact of possible subsidies that may be provided to farmers under the no-slaughtering policy scenario.

On the other hand, even if it would be cost-effective to pursue the more profitable alternative to the cow slaughter ban in Nepal, it would be difficult to obtain political support for such a change due to the mostly Hindu population. Dairy farming in Nepal is a labor-intensive economic activity, located mainly in rural regions. A reduction in cattle production will likely lead to a decline in agricultural employment and income in regions where poverty is more rampant and severe. Additionally, since cow protection is a highly politicized core of the Hindu religion in Nepal and India, implementation of any policies that remove the existing ban on cow slaughter will likely be highly challenging and controversial. More acceptable alternatives might include government support and funding to subsidize dairy farmers and to establish cow shelters across the country to improve the health and welfare of cows that have passed their productive period.

ACKNOWLEDGMENT

The study was funded by the United States Agency for International Development (USAID) and its Feed the Future Innovation Lab for Livestock Systems managed by the University of Florida and the International Livestock Research Institute. The contents are the sole responsibility of the authors and do not necessarily reflect the views of USAID or the US government.

REFERENCES

Acharya, K.P., N. Acharya, and R.T. Wilson. 2019. "Animal Welfare in Nepal." *Journal of Applied Animal Welfare Science* 22(4): 342–356. DOI: 10.1080/10888705.2018.1519437

Adhikari, R.K., K.R. Gautam, and S.P. Chapagain. 2015. *Value Chain Analysis of Nepalese Dairy Sector*. Lalitpur, Nepal: Heifer International Nepal.

Anagol, S., A. Etang, and D. Karlan. 2017. "Continued Existence of Cows Disproves Central Tenets of Capitalism?" *Economic Development and Cultural Change* 65(4): 583–618.

Attanasio, O., and B. Augsburg. 2018. "Holy Cows or Cash Cows? The Economic Return to Livestock in Rural India." *Economic Development and Cultural Change* 66(2): 307–30.

Azzi, C., H. Weizmann, and M. Harris. 1974. "More on India's Sacred Cattle." *Current Anthropology,* 15: 317–21. doi: 10.1086/201478

Central Bureau of Statistics. 2013. *Statistical Yearbook of Nepal*. Ramshahpath, Thapathali Kathmandu, Nepal: National Planning Commission Secretariat..

Chigateri, S. 2011. "Negotiating the 'Sacred' Cow: Cow Slaughter and the Regulation of Difference in India." In Mookherjee, M., eds, *Democracy, Religious Pluralism and the Liberal Dilemma of Accommodation. Studies in Global Justice* Vol. 7. Springer, Dordrecht. https://doi.org/10.1007/978-90-481-9017-1_8

Cowsmospolitan. 2016. "Six Factors Separate Top Dairy Herds." Accessed on 8 January 2018. http://www.cowsmo.com/?news=six-factors-separate-top-dairy-herds

Dandekar, V.M. 1964. "Problem of Numbers in Cattle Development." *Economic Weekly 16*: 351–53.

Dinesh, P.P., and L.N. Paudel. 2013. "Present Status, Problem, and Strategies for the Dairy Sector Development in Nepal." Proceedings of the 9th National Workshop on Livestock and Fisheries Research in Nepal. Khumaltar, Latipur, Nepal: Nepal Agriculture Research Council, National Animal Science Research Institute.

FAO (Food Agricultural Organization of the United Nations). 2017. FAOSTAT Statistical database. Nepal: FAO. Accessed on 16 October 2017. http://www.fao.org/faostat/en/#data

Fox, M.W. 1999. "India's Sacred Cow: Her Plight and Future." *Animal Issues* 3(2): 1–35.

Hadley, G.L., C.A. Wolf, and S.B. Harsh. 2006. "Dairy Cattle Culling Patterns, Explanations, and Implications." *Journal of Dairy Science* 89(6): 2286–96. DOI: 10.3168/jds.S0022-0302(06)72300-1

Heston, A. 1971. "An Approach to the Sacred Cow of India." *Current Anthropology* 12: 191–209. doi: 10.1086/201191

Joshi, D.D., M. Maharjan, M.V. Johansen, A.L. Willingham, and M. Sharma. 2003. "Improving Meat Inspection and Control in Resource-Poor Communities: The Nepal Example." *Acta Tropica* 87(1): 119–27.

Kayigema, V. 2013. "An Assessment of the Girinka (One Cow Per Poor Family) Program and Poverty Alleviation in Rwanda: A Case Study of Bugesera District." PhD dissertation, University of KwaZulu-Natal, Durban.

Korom, F.J. 2000. "Holy Cow! The Apotheosis of Zebu, or Why the Cow Is Sacred in Hinduism." *Asian Folklore Studies* 59(2): 181–203. doi: 10.2307/1178915

Kumar, A., G. Thapa, D. Roy, and P.K. Joshi. 2017. "Adoption of Food Safety Measures on Milk Production in Nepal: Impact on Smallholders' Farm-Gate Prices and Profitability." *Food Policy* 70: 13–26.

Marandure, T., G. Makombe, K. Dzama, W. Hoffmann, and C. Mapiye. 2018. "Towards a System-Specific Framework for the Sustainability Evaluation of Low-Input Ruminant Meat Production Systems in Developing Countries." *Ecological Indicators* 85: 1081–91.

MATLAB and Statistics Toolbox Release. 2017. Natick, Massachusetts, USA: The MathWorks, Inc.

Ministry of Finance. 2015. "Economic Survey, Fiscal Year 2014/2015." Government of Nepal.

MOFA (Ministry of Foreign Affairs). 2017. *About Nepal*. Singha, Durbar, Kathmandu, Nepal: MOFA.

NDDB (National Dairy Development Board). 2012. *Milk Marketing Strategy Study*. Hariharbhawan, Lalitpur, Nepal: NDDB.

———. 2014. *Final Report on Study on Cost of Milk Production*. Haiharbhwan, Lalitpur, Nepal: National Dairy Development Board.

———. 2015. *Final Report on Study on Cost of Milk Production*. Haiharbhwan, Lalitpur, Nepal: National Dairy Development Board.

———. 2017. *Final Report on Study on Cost of Milk Production*. Haiharbhwan, Lalitpur, Nepal: National Dairy Development Board.

Nepal Rastral Bank. 2017. Foreign Exchange Rates. Assessed on 8 January 2018. https://www.nrb.org.np/fxmexchangerate.php?YY=2017&MM=08&DD=28&B1=Go

NMoAD (Nepal Ministry of Agricultural Development). 2014. Statistical Information on Nepalese Agriculture. Singh Durbar, Kathmandu, Nepal: NMoAD.

———. 2015. Statistical Information on Nepalese Agriculture. Singh Durbar, Kathmandu, Nepal: Ministry of Agricultural Development,.

———. 2016. Statistical Information on Nepalese Agriculture. Singh Durbar, Kathmandu, Nepal: Ministry of Agriculture Development.

Panta, B.K. 2008. *Current Scenarios of the Cost of Milk Production in South Asian Countries, Issues, and Way Forward to Reduce the Milk Production Cost for Nepal*. Nepal: National Dairy Development Board.

Pinedo, P.J., A. De Vries, and D.W. Webb. 2010. "Dynamics of Culling Risk with Disposal Codes Reported by Dairy Herd Improvement Dairy Herds." *Journal of Dairy Science* 93(5): 2250–2261. DOI: 10.3168/jds.2009-2572

Pingali, P.L. 2001. "Environmental Consequences of Agricultural Commercialization in Asia." *Environment and Development Economics* 6(4): 483–502.

Pradhanang, U., S. Pradhanang, A. Sthapit, N. Krakauer, A. Jha, and T. Lakhankar. 2015. "National Livestock Policy of Nepal: Needs and Opportunities." *Agriculture* 5(1): 103– 31.

Richardson, J.W., J.C.C. Bizimana, and B.K. Herbst. 2017. *Agricultural Technology Assessment for Smallholder Farms in Developing Countries: An Analysis Using Farm Simulation Model (FARMSIM)*. Texas A&M University Integrated Decision Support System Team, USAID Feed the Future Innovation Laboratory for Small-Scale Irrigation.

Richardson, J.W., K. Shuman, and P. Feldman. 2008. *Simulation and Econometrics to Analyze Risk*. Simetar Inc. Accessed on 23 October 2017. http://www.simetar.com/

Richardson, J., and H. Mapp. 1976. "Use of Probabilistic Cash Flows in Analyzing Investments under Conditions of Risk and Uncertainty." *Journal of Agricultural and Applied Economics* 8(2): 19–24.

Ross, S.A., R. Westerfield, B.D. Jordan, and E.N. Biktimirov. 2008. *Essentials of Corporate Finance*. McGraw-Hill/Irwin: USA.

Sarkar, R., and A. Sarkar. 2016. "Sacred Slaughter: An Analysis of Historical, Communal, and Constitutional Aspects of Beef Bans in India." *Politics, Religion & Ideology* 17(4): 329–51. https://doi.org/10.1080/21567689.2016.1259108

Schuler, S. 1979. "Yaks, Cows and Status in the Himalayas." *Contributions to Nepalese Studies* 6(2): 65–72.

Shivaram, C. 2009. "My Encounter with a Divine Bovine." *Hinduism Today*. 1 April 2009. https://www.hinduismtoday.com/magazine/april-may-june-2009/2009-04-my-encounter-with-a-divine-bovine/

Simoons, F.J., S.M. Batra, A.K. Chakravarti, P. Diener, G.E. Ferro-Luzzi, M. Harris, A. Heston, R. Hoffpauir, D.O. Lodrick, S.L. Malik, and W.E. Mey. 1979. "Questions in the Sacred-Cow Controversy [and comments and reply]." *Current Anthropology* 20(3): 467–93.

Vaidyanathan, A. 2015. "Cow Slaughter Ban and the Welfare of Cattle." *Economic and Political Weekly* 50(48): 44–49.

Vaidyanathan, A. and K.N. Nair. 1980. "On the Sacred-Crow Controversy." *Current Anthropology* 21: 380–84. https://doi.org/10.1086/202470