Food security is a major concern of the world in the context of increasing population, changing climate and declining scarce natural resources. Reducing food loss is equally important as increasing food production and productivity to feed the world, where 9.7 billion inhabitants were expected by 2050. Food loss can occur at several points along the food chain, however, harvest loss at the farm level is often overlooked which is directly impacting on sustainability. The paper attempts to estimate harvest loss at the farm level. A household survey was executed in 300 households from ten sample districts across Nepal. The percentage of harvest loss at the farm level was calculated for each crop grown as per - the season, plot and priority. Likewise, the multiple regression was executed to determine the level of influence of the socio-economic factors on the post-harvest loss at the farm level for the major crops. The mean harvest loss at the farm level found around 5 percent for the reported crops. The multiple regression model demonstrated that at the farm level, socio-economic factors might have a smaller influence on harvest loss as compared to physical and biological contributing factors. Nevertheless, reducing the post-harvest loss will increase food availability and thus the food security.

Keywords: Food loss, Postharvest loss, Food Security, Sustainability, Nepal
ing Hunger) and SDG 12 (Ensuring sustainable consumption and production patterns) (FAO, 2019).

The food system is under pressure of rapid population growth, decline productivity, increasing scarcity of natural resources and increasing diversification of agriculture products to the production of biofuel (McKenzie, Singh-Peterson, & Underhill, 2017). The world is anticipating 9.7 billion inhabitants by 2050 (UN, 2015). Moreover, developing countries have greater challenges in reducing food loss before reaching consumers (Wohner, Pauer, Heinrich, & Tacker, 2019). Post-harvest losses are the main causes of food insecurity in developing countries (Manandhar, Milindi, & Shah, 2018). A consensus can be observed that the reduction of food loss greatly contributes to enhancing food security, strengthening the sustainability of the food system and lowering economic costs (Vilarino, Franco, & Quarrington, 2017).

Spoilage of food may occur due to technical, managerial and/or financial constraints (Manandhar, Milindi, & Shah, 2018) in production, processing, distributing and storing functions. Food loss can be very specific for each product and supply chain but also get influenced by several other factors (Verma, Plaisier, van Wagenberg, & Achterbosch, 2019). It is affected by several factors – physical factors (temperature, moisture and oxygen), biological factors (insect, rodent and mold) and socioeconomic factors (farmers’ family size, land-holding size, grain storage duration, off-farm income, road accessibility, market price of grain and grain safety during storage) (Manandhar, Milindi, & Shah, 2018). Further, it can be expanded to socioeconomic, biological and/or microbiological, chemical or biochemical, mechanical and environmental factors (Global Strategy, 2015).

Estimation of food loss has many uncertainties (Vilarino, Franco, & Quarrington, 2017). However, it is estimated that around 30 percent of global food loss occurs at the production stage, 20 percent at the post-harvest stage and 35 percent at the consumption stage (Vilarino, Franco, & Quarrington, 2017). From the caloric perspective, loss in cereal has the top position (53%) followed by roots, tuber (14%), fruits and vegetables (13%), however, fruits and vegetables are at the top (44%) considering the rate of food loss (Vilarino, Franco, & Quarrington, 2017).

The SDG Indicator 12.3.1 (Global food losses) has two components – (a) Food Loss Index and (b) Food Waste Index, and is a Tier II, which means it still demands more work and adoption by member countries (FAO, 2019b). Food loss is the loss along the field to the plate of consumers and food waste is the loss from the consumers’ plate.

Reducing food loss is of special importance for developing countries like Nepal due to several reasons. Around two-third population are engaging in agriculture which produces 27.2 percent of the Gross Domestic Product (GDP) (MoF, 2018) and prevalence of the multidimensional poverty is 28.6% in Nepal (NPC, 2018).

The paper attempts to document and to estimate food loss in Nepal. Researches on food loss are very limited in Nepal. Few works have been done on selected commodities at a specific locality. Majority of researches are focused on either specific disease-pest or types of the storage system (Bhandari, Achhami, Karki, Bhandari, & Bhandari, 2015; Manandhar & Mainali, 2000; Paneru, Duwadi, Khanal, & Bhandari, 1996; Paneru, Poudel, & Thapa, 2018).

Materials and Methods

Food loss has been generally categorized into two types – qualitative and quantitative. The qualitative food loss refers to the degradation of food qualities – taste, appearance and nutritional value (Global Strategy, 2015). On the other hand, quantitative food loss refers to a decline in food volume or quantity. It can be studied by different methods. They are – (a) general baseline survey, (b) probability sample survey, (c) experimental designs – field trails, and (d) multivariate linear regression fitting (Global Strategy, 2015).

This study focuses on quantitative food loss and food loss is considered as all kind of losses at farm level after harvesting – that is neither consumed nor sold from the farm. Purposive sampling of districts was done to make the sample as representative as possible considering resource constraint. Nepal is geographically diverse and thus has greater agro-biodiversity and farming systems (GC & Ghimire, 2018; GC & Yeo, 2019). Nepal produces several kinds of cereals, fruits, and vegetables. However, rice, wheat, and maize are the most consumed staple cereal in the world (Manandhar, Milindi, & Shah, 2018) and also in Nepal. Therefore, instead of crop-specific survey, a general survey has been carried out from randomly selected 300 households from 10 sampling districts in 2015.

The farming practices were recorded using a structured questionnaire. Food loss was taken as quantity loss in the past year based on respondent’s reporting instead of physical measurement. The percentage of food loss was calculated from the quantity of post-harvest loss and quantity harvested. The equation (1) was used to calculate percentage food loss for an individual farming household.

Percentage Food Loss (FLP) = \[ \frac{\sum_{}^{n} QL \times 100}{QH} \] .......................... (1)

Where,QL = Quantity food lost, QH = Quantity harvested, and the subscript “a” = crop.

The percentage of Food Loss (FLP) was calculated for each season (winter and summer), each plot (single largest plot and additional plots) and each priority of crop (primary crop and secondary crop).

The mean harvest loss was estimated a confidence interval by using STATA command “mean”.

Regression analysis was executed for the major crops to determine the socio-economic factors affecting food loss. The generalized equation for regression analysis is given in equation (2).

PC_FoodLoss = \[ \alpha + \beta X_i + \epsilon \] .......................... (2)

Where, PC_FoodLoss = Percentage of Food Loss on a crop reported from individual farming household

\[ \alpha = \text{intercept of the equation} \]
\[ \beta = \text{a matrix of coefficient for each independent variables} \]
\[ X_i = \text{matrix of independent variables} \]
Selection of independent variable is crucial for any regression model. Food loss is affected by several factors – physical factor (temperature, moisture and oxygen), biological factor (insect, rodent and mold) and socioeconomic factor (farmers’ family size, land holding size, grain storage duration, off-farm income, road accessibility, market price of grain and grain safety during storage) (Manandhar, Milind, & Shah, 2018). However, for the study, we have considered only socio-economic characteristics of farming households. Paneru, et al (2018) also used several socio-economic variables including farming area, education, occupation and household size to estimate food loss. The description of variables used for the regression analysis has been presented in Table 1.

The data analysis was carried out using STATA software. To select the appropriate variables, the stepwise command was employed and the final model was obtained.

Results and Discussion

The food loss on the major crops the farm level was calculated for each season (winter and summer), each plot (single largest plot and additional plots) and each priority of crop (primary crop and secondary crop).

Postharvest loss of major crops

Rice, maize, wheat, potato, mustard, cabbage and lentils were found the major crop growing by the farmers in the surveyed districts of Nepal. For convenience, the annualized mean percentage of the harvest loss for those crops were calculated. The highest post-harvest food loss at the farm level was found for mustard and lentil. However, the lowest was reported for potato. The mean harvest loss at the farm level for rice, wheat, maize, potato, mustard, cabbage and lentil was found 3.24±0.44, 4.88±1.11, 4.00±1.18, 3.01±0.87, 5.18±1.52, 4.76±1.55 and 5.18±1.19 percent respectively. The detail with observation has been presented in Table 2.

Moreover, the average weighted mean of harvest loss at the farm level for cereal was found 3.94 percent. Under the cereal group, rice, wheat and maize – both summer and winter were categorized. The graphical presentation of annual mean postharvest loss at the farm level was presented in Figure 1.

Percentage of food loss for winter season (S1) crops

Wheat, potato, mustard and maize were found the major winter season crop in Nepal. Table 3 provides the detail of the food loss at the farm level for winter crops from the single largest plot as the first priority crop. The average percentage harvest loss on wheat, potato, mustard and maize were found 5.40, 2.00, 3.38 and 2.99 respectively. However, the median harvest loss was found 0.60, 0.00, 0.00, and 0.98 percent for wheat, potato, mustard and maize respectively. Among these crops, wheat was found the most commonly grown crop, which was produced by 105 households as a primary crop in the single largest plot.

Potato, lentil, cabbage and mustard were found the popular crop, which was grown in the winter season in the single largest plot as the second choice after the crops described in Table 3. The highest loss was reported for cabbage and the lowest was reported for potato. Average percentage harvest loss at the farm level for potato, lentil, cabbage and mustard was found 4.23, 5.78, 7.03 and 5.71 respectively. However, the median value was found 0.00 percent for all crops under this category. Table 4 presents the detail under this condition.

Wheat, potato, mustard and lentil were the top choice of farmers in the winter season for additional plots. Table 5 presents the detail on harvest loss on the crops from the additional plots as the primary crop. The highest post-harvest loss was reported for mustard and the lowest post-harvest loss was reported for potato. The average percentage of harvest loss on wheat, potato, mustard and lentil was found 3.46, 2.84, 9.13 and 3.90 respectively. However, the median values were observed at 0.00 percent except for Mustard (1.52 percent).

Lentil, potato and mustard were found popular second choices for the winter crop in additional plots. The highest percentage of post-harvest loss was reported for lentil and the lowest post-harvest loss was reported for potato. The average percentage of harvest loss on lentil, potato and mustard was found 5.73, 1.86 and 5.66 respectively. However, the median value was found 0.00 percent for lentil and potato and 1.14 percent for mustard. The detail has been presented in Table 6.

Percentage of food loss for summer season (S2) crops

Rice (or paddy), maize and cabbage were found the most dominating crops in the summer season in the single largest plot. Around 60 percent farmers were found planting rice in the summer season as the first choice crop in their single largest plot. The highest percentage of post-harvest loss was reported for maize and the lowest percentage of post-harvest loss was reported for cabbage. The average percentage of the harvest loss in rice, maize and cabbage was found 3.26, 2.88 and 0.94 respectively. However, the median value was observed 0.00 except for rice (1.04 percent). The detail has been presented in Table 7.

Except for rice and maize, other crops were not found significantly growing during the summer season in the additional plots as a primary choice. The post-harvest loss for rice and maize were reported almost similar. The average percentage loss of the harvest at farm level was found 2.38 and 1.59 for rice and maize respectively. The median value was found 0.00 percent for both rice and maize under this condition. The detail has been presented in Table 8.

Estimation of harvest loss by Multiple Regression Analysis

To determine the determinants of the post-harvest loss of the crops, a multiple regression analysis was executed. The multiple regression analysis will enable to quantify the effect of several variables on the post-harvest loss.

Table 9 presents the result of the multiple regression model for post-harvest loss for rice, wheat, maize, potato, lentils and cabbage. The highest value of R-square was observed 0.81 for lentil and the lowest value was found 0.094 for maize. Furthermore, the majority of dependent variables have produced mix results for different crops. Nevertheless, use of past
weather information, having access to the internet, a percentage of total income coming from the farm, number of extension workers’ visit, gender and household size produced positive results in all models. It means they are a positive contributor to the postharvest loss in all crops.

Moreover, the use of weather information announced, the number of male working in the farm, having access to the extension service, total area and having exclusively rainfed farming has yielded negative coefficients. It implies that they are positive contributors to reduce postharvest loss in those crops.

Table 1. Description of variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Observation</th>
<th>Mean</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>WethAnnounce</td>
<td>Use of weather information (Yes =1; No=0)</td>
<td>253</td>
<td>0.40</td>
<td>0.49</td>
</tr>
<tr>
<td>WethUsePast</td>
<td>Use of past weather experience (Yes=1; No=0)</td>
<td>284</td>
<td>0.33</td>
<td>0.47</td>
</tr>
<tr>
<td>FarmExp</td>
<td>Years of farming experience</td>
<td>300</td>
<td>24.83</td>
<td>14.18</td>
</tr>
<tr>
<td>FarmDec</td>
<td>Farming decision taken by HoH (Yes=1; No=0)</td>
<td>300</td>
<td>0.83</td>
<td>0.38</td>
</tr>
<tr>
<td>Rainfed</td>
<td>Having exclusively rainfed farming (Yes=1; No=0)</td>
<td>297</td>
<td>0.39</td>
<td>0.49</td>
</tr>
<tr>
<td>C_totalsarea</td>
<td>Total cropping area in hectar</td>
<td>293</td>
<td>0.91</td>
<td>0.86</td>
</tr>
<tr>
<td>Primaryoccupation</td>
<td>Agriculture as a primary occupation (Yes = 1; No=0)</td>
<td>300</td>
<td>0.79</td>
<td>0.41</td>
</tr>
<tr>
<td>Secondaryoccupation</td>
<td>Agriculture as a secondary occupation (Yes = 1; No=0)</td>
<td>300</td>
<td>0.68</td>
<td>0.47</td>
</tr>
<tr>
<td>Internet</td>
<td>Having internet access (Yes=1; No=0)</td>
<td>300</td>
<td>0.21</td>
<td>0.41</td>
</tr>
<tr>
<td>Electricity</td>
<td>Having electricity access (Yes=1; No=0)</td>
<td>300</td>
<td>0.92</td>
<td>0.28</td>
</tr>
<tr>
<td>Farmaleduales</td>
<td>Number of adult males working in the farm</td>
<td>300</td>
<td>2.09</td>
<td>1.40</td>
</tr>
<tr>
<td>Farmadultfemales</td>
<td>Number of adult females working in the farm</td>
<td>300</td>
<td>1.50</td>
<td>1.07</td>
</tr>
<tr>
<td>Educoh</td>
<td>Years of schooling of HoH</td>
<td>300</td>
<td>6.27</td>
<td>4.62</td>
</tr>
<tr>
<td>Genderho</td>
<td>Gender of HoH (Male =1; Female =0)</td>
<td>300</td>
<td>0.85</td>
<td>0.35</td>
</tr>
<tr>
<td>Ageho</td>
<td>Age of HoH in year</td>
<td>283</td>
<td>50.90</td>
<td>12.44</td>
</tr>
<tr>
<td>Hsize</td>
<td>Household size</td>
<td>300</td>
<td>6.50</td>
<td>3.64</td>
</tr>
<tr>
<td>farmareanuaplots</td>
<td>Number of land parcel</td>
<td>300</td>
<td>1.70</td>
<td>0.65</td>
</tr>
<tr>
<td>farm_nearestdist</td>
<td>Distance to the nearest market</td>
<td>298</td>
<td>2.57</td>
<td>3.76</td>
</tr>
<tr>
<td>farm_settime</td>
<td>Time to the nearest market</td>
<td>299</td>
<td>0.49</td>
<td>0.69</td>
</tr>
<tr>
<td>Outputcoop</td>
<td>Having membership of output selling cooperative</td>
<td>300</td>
<td>0.58</td>
<td>0.49</td>
</tr>
<tr>
<td>Inputcoop</td>
<td>Having membership of input selling cooperative</td>
<td>300</td>
<td>0.61</td>
<td>0.49</td>
</tr>
<tr>
<td>Getext</td>
<td>Having access to the extension service (Yes=1; No=0)</td>
<td>300</td>
<td>0.72</td>
<td>0.45</td>
</tr>
<tr>
<td>Extvisits</td>
<td>Number of extension visit per year</td>
<td>300</td>
<td>3.56</td>
<td>3.80</td>
</tr>
<tr>
<td>totalincome</td>
<td>Total income in NRs 10,000</td>
<td>296</td>
<td>34.32</td>
<td>46.00</td>
</tr>
<tr>
<td>pctonfarincome</td>
<td>% of total income coming from farming</td>
<td>299</td>
<td>66.50</td>
<td>37.27</td>
</tr>
<tr>
<td>borrowedincome</td>
<td>Having eredit access (Yes=1; No=0)</td>
<td>300</td>
<td>0.40</td>
<td>0.49</td>
</tr>
<tr>
<td>PC_Rice</td>
<td>% of postharvest loss on Rice</td>
<td>212</td>
<td>3.24</td>
<td>6.47</td>
</tr>
<tr>
<td>Rice_harvest</td>
<td>amount of rice harvest in 1,000 kg</td>
<td>212</td>
<td>4.53</td>
<td>17.32</td>
</tr>
<tr>
<td>PC_Wheat</td>
<td>% of postharvest loss on wheat</td>
<td>149</td>
<td>4.88</td>
<td>13.58</td>
</tr>
<tr>
<td>Wheat_harvest</td>
<td>amount of wheat harvest in 1,000 kg</td>
<td>149</td>
<td>1.80</td>
<td>7.21</td>
</tr>
<tr>
<td>Maize_harvest</td>
<td>amount of maize harvest in 1,000 kg</td>
<td>116</td>
<td>0.74</td>
<td>0.98</td>
</tr>
<tr>
<td>PC_Maize</td>
<td>% of postharvest loss on maize</td>
<td>116</td>
<td>4.00</td>
<td>12.66</td>
</tr>
<tr>
<td>Potato_harvest</td>
<td>amount of potato harvest in 1,000 kg</td>
<td>117</td>
<td>2.69</td>
<td>5.69</td>
</tr>
<tr>
<td>PC_Potato</td>
<td>% of postharvest loss on potato</td>
<td>117</td>
<td>3.01</td>
<td>9.46</td>
</tr>
<tr>
<td>Mustard_harvest</td>
<td>amount of mustard harvest in 1,000 kg</td>
<td>61</td>
<td>0.22</td>
<td>0.46</td>
</tr>
<tr>
<td>PC_Mustard</td>
<td>% of postharvest loss on mustard</td>
<td>61</td>
<td>5.18</td>
<td>11.90</td>
</tr>
<tr>
<td>Lentil_harvest</td>
<td>amount of lentil harvest in 1,000 kg</td>
<td>45</td>
<td>0.76</td>
<td>3.70</td>
</tr>
<tr>
<td>PC_Lentil</td>
<td>% of postharvest loss on lentil</td>
<td>45</td>
<td>5.18</td>
<td>8.00</td>
</tr>
<tr>
<td>Cabbage_harvest</td>
<td>amount of cabbage harvest in 1,000 kg</td>
<td>50</td>
<td>9.01</td>
<td>16.48</td>
</tr>
<tr>
<td>PC_Cabbage</td>
<td>% of postharvest loss on cabbage</td>
<td>50</td>
<td>4.76</td>
<td>10.99</td>
</tr>
</tbody>
</table>
Table 2. Annual mean percentage of harvest loss of different crops

<table>
<thead>
<tr>
<th>Crop</th>
<th>Mean</th>
<th>Std. Err.</th>
<th>95% Confidence Interval</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice</td>
<td>3.24</td>
<td>0.44</td>
<td>2.37</td>
<td>4.12</td>
</tr>
<tr>
<td>Wheat</td>
<td>4.88</td>
<td>1.11</td>
<td>2.68</td>
<td>7.08</td>
</tr>
<tr>
<td>Maize</td>
<td>4.00</td>
<td>1.18</td>
<td>1.67</td>
<td>6.33</td>
</tr>
<tr>
<td>Potato</td>
<td>3.01</td>
<td>0.87</td>
<td>1.27</td>
<td>4.74</td>
</tr>
<tr>
<td>Mustard</td>
<td>5.18</td>
<td>1.52</td>
<td>2.13</td>
<td>8.23</td>
</tr>
<tr>
<td>Cabbage</td>
<td>4.76</td>
<td>1.55</td>
<td>1.63</td>
<td>7.88</td>
</tr>
<tr>
<td>Lentil</td>
<td>5.18</td>
<td>1.19</td>
<td>2.78</td>
<td>7.59</td>
</tr>
</tbody>
</table>

Figure 1. Percentage Food Loss for various crops at Farm Level

Table 3. Harvest Loss in S1P1C1 (in Percentage)

<table>
<thead>
<tr>
<th>Percentiles</th>
<th>Wheat</th>
<th>Potato</th>
<th>Mustard</th>
<th>Maize</th>
</tr>
</thead>
<tbody>
<tr>
<td>25%</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>50%</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>75%</td>
<td>5.88</td>
<td>2.44</td>
<td>5.00</td>
<td>6.25</td>
</tr>
<tr>
<td>90%</td>
<td>10.00</td>
<td>5.00</td>
<td>10.00</td>
<td>8.96</td>
</tr>
<tr>
<td>95%</td>
<td>21.88</td>
<td>11.11</td>
<td>12.50</td>
<td>9.76</td>
</tr>
<tr>
<td>99%</td>
<td>50.00</td>
<td>16.67</td>
<td>25.00</td>
<td>9.76</td>
</tr>
<tr>
<td>Maximum</td>
<td>100.00</td>
<td>16.67</td>
<td>25.00</td>
<td>9.76</td>
</tr>
</tbody>
</table>

| Observation Number | 105   | 42     | 25     | 17    |
| Mean               | 5.40  | 2.00   | 3.38   | 2.99  |
| Standard Deviation | 13.10 | 3.85   | 5.92   | 3.82  |

Table 4. Harvest Loss in S1P1C2 (in Percentage)

<table>
<thead>
<tr>
<th>Percentiles</th>
<th>Potato</th>
<th>Lentil</th>
<th>Cabbage</th>
<th>Mustard</th>
</tr>
</thead>
<tbody>
<tr>
<td>50%</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>75%</td>
<td>0.00</td>
<td>11.11</td>
<td>19.35</td>
<td>20.00</td>
</tr>
<tr>
<td>90%</td>
<td>11.67</td>
<td>16.67</td>
<td>58.33</td>
<td>50.00</td>
</tr>
<tr>
<td>95%</td>
<td>13.33</td>
<td>33.33</td>
<td>58.33</td>
<td>50.00</td>
</tr>
<tr>
<td>99%</td>
<td>88.00</td>
<td>33.33</td>
<td>58.33</td>
<td>50.00</td>
</tr>
<tr>
<td>Maximum</td>
<td>88.00</td>
<td>33.33</td>
<td>58.33</td>
<td>50.00</td>
</tr>
</tbody>
</table>

| Observation Number | 29    | 14     | 14     | 14     |
| Mean               | 4.23  | 5.78   | 7.03   | 5.71   |
| Standard Deviation | 16.44 | 10.06  | 15.77  | 13.99  |
Table 5. Harvest Loss in S1P2C1 (in Percentage)

<table>
<thead>
<tr>
<th>Percentiles</th>
<th>Wheat</th>
<th>Potato</th>
<th>Mustard</th>
<th>Lentil</th>
</tr>
</thead>
<tbody>
<tr>
<td>25%</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>50%</td>
<td>0.00</td>
<td>0.00</td>
<td>1.52</td>
<td>0.00</td>
</tr>
<tr>
<td>75%</td>
<td>4.78</td>
<td>4.84</td>
<td>9.09</td>
<td>10.00</td>
</tr>
<tr>
<td>90%</td>
<td>9.09</td>
<td>13.51</td>
<td>20.00</td>
<td>13.50</td>
</tr>
<tr>
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<td>15.89</td>
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| Observation Number | 72    | 24    | 14  | 10  |
| Mean              | 3.46  | 2.84  | 9.13 | 3.90 |
| Standard Deviation | 8.03  | 5.00  | 18.70 | 5.93 |

Table 6. Harvest Loss in S1P2C2 (in Percentage)

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<th>Lentil</th>
<th>Potato</th>
<th>Mustard</th>
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<td>10.00</td>
<td>20.00</td>
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| Observation Number | 18    | 18    | 10  |
| Mean              | 5.73  | 1.86  | 5.66 |
| Standard Deviation | 8.02  | 3.24  | 8.02 |

Table 7. Harvest Loss in S2P1C1

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<th>Percentiles</th>
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<th>Cabbage</th>
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<tr>
<td>Maximum</td>
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<td>25.00</td>
<td>4.67</td>
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</table>

| Observation Number | 170  | 45    | 12  |
| Mean              | 3.26 | 2.88  | 0.94 |
| Standard Deviation | 5.89 | 6.40  | 1.59 |

Table 8. Harvest Loss in S2P2C1

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</table>

| Observation Number | 170  | 45    | 12  |
| Mean              | 3.26 | 2.88  | 0.94 |
| Standard Deviation | 5.89 | 6.40  | 1.59 |
Table 9. Estimation of postharvest loss at the farm level for various crops by regression model

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Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1
Discussion

Rice, wheat and maize were found the major cereal crops. Besides cereals, potato, lentils, mustards and cabbages were found the most commonly grown crops. MoALD (2018) listed rice, wheat, maize, millet and buckwheat as the major cereal crops (MoALD, 2016/17).

Joshi et al (2011) and Poudel and Shaw (2016) considered rice, wheat, maize, millet and barley as the major cereal crops (Joshi, Maharjan, & Piya, 2011; Poudel & Shaw, 2016). Regarding potato, MoALD categories it into cash crops, however, Joshi et al (2011) grouped it into cereal basket. Likewise, Maharjan and Khatri-Chhetri (2006) found rice, maize, wheat, millet, barley and pulses as a major crop growing by Nepali farmers (Maharjan & Khatri-Chhetri, 2006). This study revealed that for the winter season, wheat, potato and mustard were found the major crops and for the summer season, rice and maize were found the major crop-growing by the Nepali farmers. However, maize and cabbage were found growing in both summer and winter season.

The postharvest loss of rice at the farm level was found 3.24±0.44 percent. In line with this FAO has reported the postharvest loss of 4-22 % in rice (FAO, 1998). Likewise, Boxall and Gillet (1984) found rice 3.3±2.2 percent postharvest loss on (Boxall & Gillett, 1984). Another study found the postharvest losses of rice in China was 7-13 percent (Kumar & Kalita, 2016). However, K.C. (1992) confirmed that the post-harvest loss in cereals was 15-20% in Nepal (KC, 1992). Pradhan and Manandhar (1992) reported the post-harvest loss of 8%, 7.4% and 13% for Mountain, Hills and Terai of Nepal respectively (Pradhan & Manandhar, 1992). Boxall and Gillett (1984) also confirmed altitudinal variation on the post-harvest loss.

The postharvest loss on wheat was found 4.88±1.11 percent. Boxall and Gillet (1984) found a postharvest loss on wheat of 2.4±1.9% in eastern Nepal. Furthermore, the quality of stored wheat was found lower in the hills of Nepal as compared to the plain area (Devkota, Devkota, Acharya, Shrestha, & McDonald, 2018). In Pakistan, the average postharvest loss on wheat is 3.5 percent (Baloch, 1999).

After harvesting, the loss on maize was found 4.00±1.18 percent. However, Paneru et al (1993) reported storage losses of up to 32 percent due to maize weevil (Paneru, Duwadi, Khanal, & Bhandari, 1996). On the other hand, some studies reported 30-35 percent loss on the grain in those ears which are stored in Kuniyo. Likewise, Manandhar and Mainali (2000) reported 7.44 percent losses in maize storage (Manandhar & Mainali, 2000). Another study found a post-harvest loss on maize up to 19.5±12.5 percent due to pests (Paneru, Poudel, & Thapa, 2018). Manandhar et al (2001) reported 40-50 percent losses in maize storage (Manandhar, Ransom, & Rajbhandari, 2001). Bhandari et al (2015) reported a 10-15 percent loss in maize storage (Bhandari, Achhami, Karki, Bhandari, & Bhandari, 2015).

Postharvest loss on cabbage at farm level was found 4.76±1.55 percent, however, another study found 9 percent on cabbage (Kader & Davis, 2009; Udas, Rai, Khatiwada, Gurung, & Thapa, 2005).

The multiple regression model suggests that socio-economic variables have a smaller influence on the postharvest loss. The R-square value for all cereals was found less than 0.35. For potato, it was just 0.09. This implies that biological, climatic and other factors may have a stronger influence on the postharvest loss. Some other socio-economic variables may have a stronger effect; however, the study has covered all socioeconomic variables generally used for the regression analysis. Nevertheless, the R-square value for crops other than cereals has demonstrated relatively higher values – up to 0.81 for lentil. Furthermore, in the multiple regression model for lentil, cabbage and rice, 14, 12 and 11 explanatory variables were found significant respectively. On the other hand, in the regression model for potato, none of the independent variables was found significant.

The majority of the variables did not produce a consistent relationship with the postharvest loss on various crops. In one crop, the same variable was found contributor for loss and in another crop, the same variable was found as a contributor to the reduction of postharvest loss. Nevertheless, some of the explanatory variables have produced a consistent result for all crops. The use of weather information announced, number of a male family member in the farming, having access to extension services, total area and having exclusively rainfed farming were found a strong contributor to the reduction of postharvest loss in all selected crops.

Conclusion

Agriculture is facing an unprecedented challenge to feed peoples inhabiting the world. More importantly, the pressure on agriculture is ever increasing. At current statistics, around one billion people are in hunger and by 2050 the population in the world is expected to become 9.7 billion. Furthermore, climate change is exerting pressure on agriculture – mainly due to change in precipitation pattern, temperature, drought and other climate-induced disasters. However, production alone might not a single issue because it is estimated that around one-third of all food produced globally is never consumed which is a misuse of the scarce natural resources along with the labour. Developing countries have more issue on the post-harvest loss. However, an appropriate level of attention was not found regarding food loss and waste. Therefore, postharvest loss at the farm level has been estimated for rice, wheat, maize, potato, mustard, cabbage and lentils, which was found the major crops grown by the farmers. The average postharvest loss for those crops were found around 5 percent. Furthermore, multiple regression model suggested that the postharvest loss for those crops can be explained by various socio-economic variables. However, the level of explanation was found widely different from one crop to another. Therefore, careful selection of variables is very important. Moreover, food loss should be addressed from technological, cultural and behavioral and policy solutions which make the agriculture system more sustainable and improve the food security situation. The study concluded that existing postharvest loss can be reduced through effective agriculture extension service and by providing timely and reliable weather informa-
tion to the farmers. Moreover, increasing farm size may also reduce postharvest loss, which could be achieved through land consolidation.

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