

Status of Farm Mechanization in Mid-Hill Region of Surkhet, Nepal

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Abbreviations and acronyms

CGIAR	Consultative Group of International Agricultural Research
CIMMYT	International Maize and Wheat Improvement Center
CSISA	Cereal Systems Initiative for South Asia
masl	Mean above sea level (m)
PCA	Principal Component Analysis
HCA	Hierarchical Clustering Analysis
MFS	Mixed Farming Systems

1 Introduction

In Nepal, agriculture is the main source of livelihood, employing two-thirds of the population and contributing one-third of the gross domestic product. However, agricultural production is insufficient to meet the food demand of the growing population. Agricultural mechanization is crucial in enhancing farm productivity and profitability by enabling the timeliness of farm operations, optimizing resources, and increasing the precision of farming operations. Although mechanization is gradually increasing, 46% of farmers still rely on animal power, 26% on manual labor, and only 28% on mechanical power (Gauchan & Shrestha, 2017).

Nepal has diverse landscapes with mountains covering an area of 35%, hills (42%), and terai (23%) (GoN, 2024). The adoption of machinery is highly heterogeneous across these regions. Despite the highest area coverage of the hills, machinery usage is far lower than in Terai. Takeshima (2017) reported that less than 8% of the farms in hills and mountains regularly use mechanical tillage, compared to 46% in Terai. National Agricultural Census, 2022 indicates a significant increase in households using different machinery in Nepal over a decade, including livestock-related equipment such as milking machines as shown in **Error! Reference source not found.** However, overall adoption remains low.

Surkhet, one of the districts in Karnali province of Nepal, like other hilly regions, faces numerous challenges for farm machinery usage due to small terraces, lack of farm roads, scattered fields, and difficulty in transporting machinery between farms. These geographical constraints significantly hinder the adoption of farm machinery in hilly areas. These challenges are further compounded by limited knowledge of machinery troubleshooting, scarcity of mechanics during peak operational periods, unavailability of spare parts, and inadequate after-sales service, all of which reduce the machinery's effective working period, adversely affecting the income generation from it. Additionally, youth migration abroad for employment opportunities, declining youth involvement in the agriculture sector driven by low profitability and high risk, and out-migration from the hills to the terai are leading to labor shortages, increasing land abandonment, and high wage rates that necessitate the adoption of suitable machinery.

To identify gaps in mechanization and devise suitable interventions, it is essential to understand the characteristics of households between machinery adopters and non-adopters. In 2023, a household survey was conducted in Surkhet, Gurbakot, under the CGIAR Initiative on Mixed Farming Systems (MFS) aimed to characterize the households and devise suitable interventions (Zepeda et al., 2023). This report summarizes the information provided by the household survey conducted in

Surkhet regarding the status of agricultural machinery. For data visualization, information from sub-module 6b under Module 2 of the farm characterization survey is utilized. This data provides insights into mechanization levels across farm types in Surkhet, including details on machinery usage during different seasons, and crops, across various farm operations such as land preparation, planting, weeding, harvesting, and threshing. Additionally, the report highlights the intensity of the labor shortage situation in different farm types and identifies the major constraints of mechanization in the Surkhet district.

1.1 Adoption pattern of Agricultural machinery over a decade in Nepal

In Nepal, there have been significant changes in the adoption of agricultural machinery over the decade. The percentage of households using tractors, power tillers, mini-tillers, threshers, and irrigation tools, has increased while the use of traditional tools such as iron plough, animal-drawn craft, and treadle pumps has declined as shown in **Figure 1**.

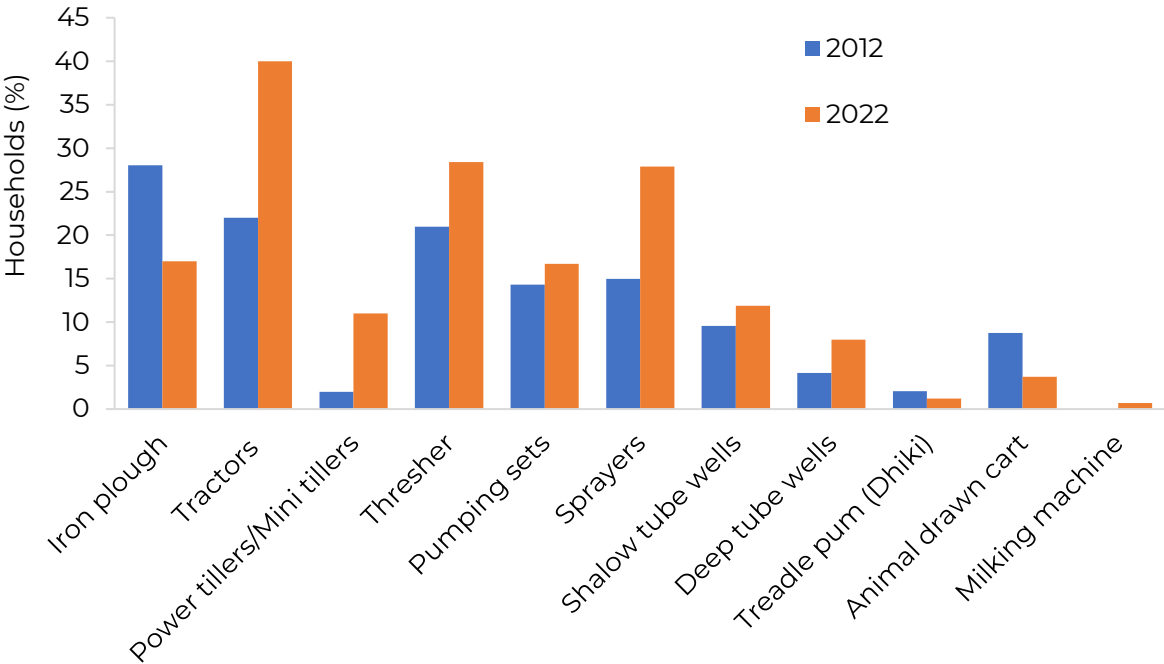


Figure 1 Percentage of households adopting agricultural machinery in Nepal for the year 2012 and 2022 (Source: National Statistics Office, 2023)

In the hills the trend of using mini-tiller is increasing. Since the introduction of mini tiller in 2011 to 2022 nearly 30,000 mini-tillers have been adopted (Figure 2).

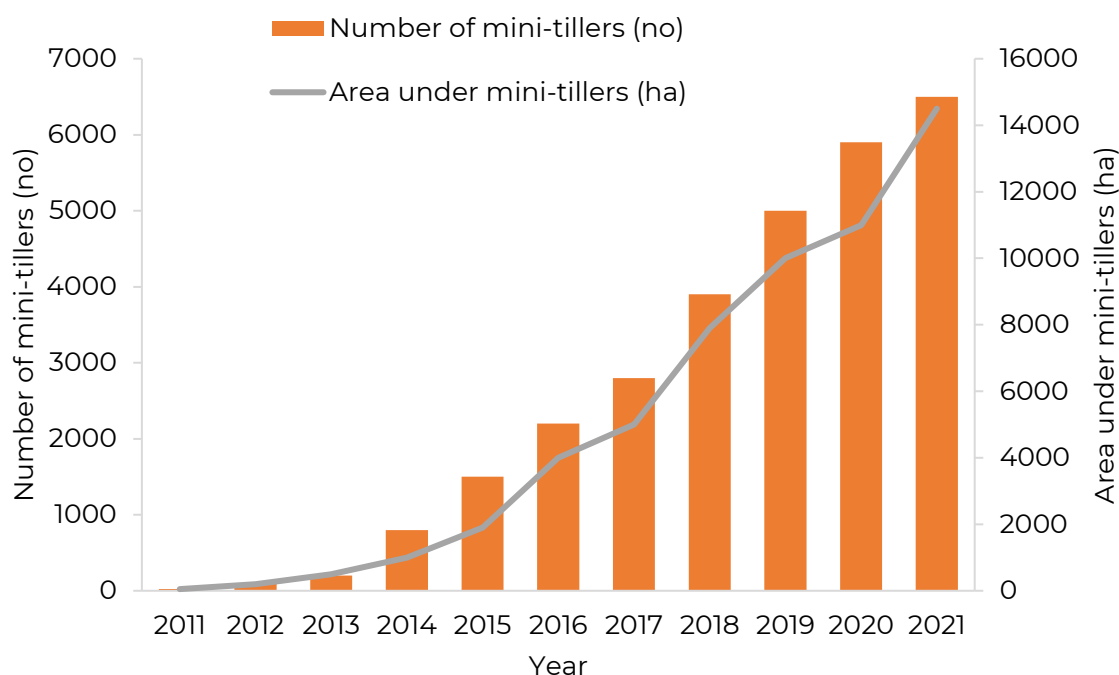


Figure 2: Annual expansion of mini-tillers in mid-hills of Nepal from 2011 to 2021. (Source: CSISA, 2021)

2 Description of Farm types

From the farm characterization household survey, five distinct farm types have been identified using the PCA-HCA approach (Zepeda et al., 2023). The details of farm types/typology are given below:

2.1 Type 1 - Smallholder intensive Rice-Wheat farm households.

These farm households are denoted as T1 and possess the highest average land holding size of 0.6 hectares which are located at a lower altitude of 530 masl. Rice, wheat, and maize are the primary crops across seasons occupying 33.5%, 35%, and 18.9 % of the cultivated land respectively. The highest income is derived from crop production (34.2%) followed by livestock (13.4%). These households are located at 3.8 km of their nearest market. 80% of households rely on family labor and 26% on machinery. The land occupancy is 192%.

2.2 Type 2 – Small-scale Intensive mixed crop-livestock farm households.

These farm households are denoted as T2. They possess an average land holding of 0.3 hectares and are situated at a low altitude of 520 masl. Their land occupancy is equal to T1 (193%). Among the crops grown, maize covers the highest share of the cultivated land (30.1%) followed by wheat (29.9%), rice (25.4%) and lentil (5%). The highest source of income is derived from animal production (21.9%) followed by off-

farm income (20.6%) and crop production (2.4%). To perform farm activities, 76% of the households rely on family labor, and 16% rely on machinery

2.3 Type 3- Diversified farm households with off-farm and livestock-driven income

These farm households are denoted as T3. They possess an average land holding of 0.4 hectares and are situated at a slightly higher altitude of 577 masl. Among the crops grown, rice covers the largest share of the cultivated land (42.3%), followed by wheat (19.3%), maize (16.3%) and lentil (8.2%). To perform the farm operation, 73% of the households rely on family labor, while 18% rely on machinery. These households have the highest income from farm assets (46%), livestock (26%) which is highest among other farm types, and crop production (10.8%). The land occupancy is 219%.

2.4 Type 4- Marginal micro-farms reliant on non-farm income.

These farm households are denoted as T4 and possess an average land holding of 0.2 hectares. They are situated at similar altitudes of T3. They have the lowest land occupancy (186.4%). The major source of income is derived from other sources and commerce (76%) while income is derived from crops (1.5%) and animals (1.7%). To perform the farm operation 79% of households, rely on family labor, while 11% use machinery.

2.5 Type 5- High Altitude and remote livestock and off-farm income-based households.

These farm households are denoted as T5 and have the biggest average land holding like T1 (0.6ha). They are located at a higher altitude of 1342 masl and are more remote 12.5 km from the nearest market. Maize and wheat are the major crop grown occupying 43% and 37.4 % of the cultivated land. The livestock number is highest compared to other farm types. The highest share of income is derived from off-farm income related to farm assets (72.3%) followed by animal production (18.2%) and crop production (1%) which is the lowest among all farms. The land occupancy is 204%, the second highest compared to other farm types. 79% of the households rely on family labor for farm operations and 11% use farm machinery.

3 Farm power usage in agricultural operations in the mid-hill region of Surkhet, Nepal

Figure 3 shows a bar graph reporting the percentage of households in Surkhet, Nepal using different farm powers for key agricultural operations, including field preparation, planting, weeding, and harvesting.

Machinery is mainly used for field preparation with limited use for harvesting while planting and weeding activities rely on manual power. 53% of the households use machinery for field preparation, 3.2% for harvesting, 0.4% for planting, and 0.1% for weeding, regardless of farm types, seasons and crops. The reliance on animal power has significantly declined across all agricultural activities.

The high reliance on machinery for field preparation is attributed to the decline in draft animals and rising labor costs, while heavy reliance on manual labor for planting, weeding, and harvesting is attributed to the lack of suitable machinery and limited availability and awareness of modern tools.

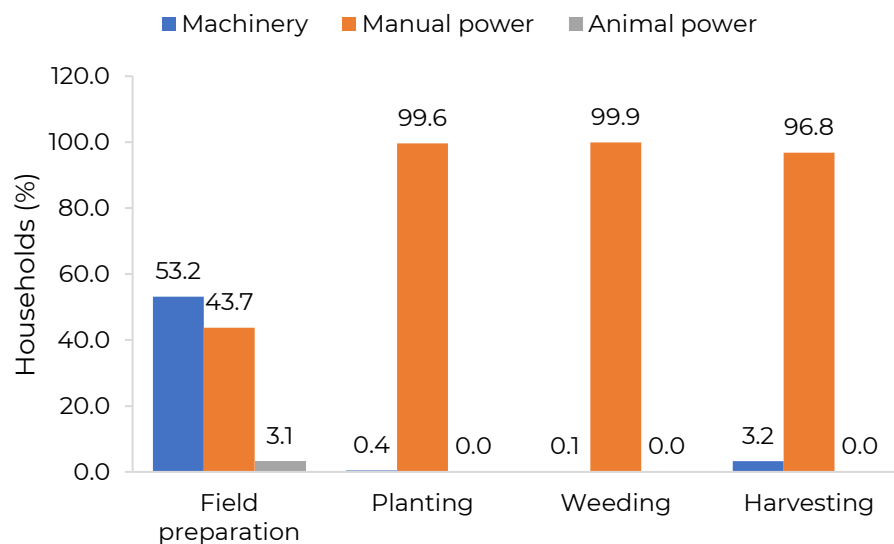


Figure 3: Percentage of households using farm power sources for different agricultural activities in Surkhet, Nepal

3.1 Distribution of machinery usage in different agricultural activities in Surkhet, Nepal

The pie-chart (Figure 4) depicted the distribution of households reporting machinery usage among machinery adopters for agricultural operations such as land preparation, planting, weeding, and harvesting in Surkhet, Nepal. Among machinery adopters, the highest percentage of households use machinery for field preparation (94%), followed by harvesting (6%), and planting (1%), irrespective of farm types, crops, and seasons.

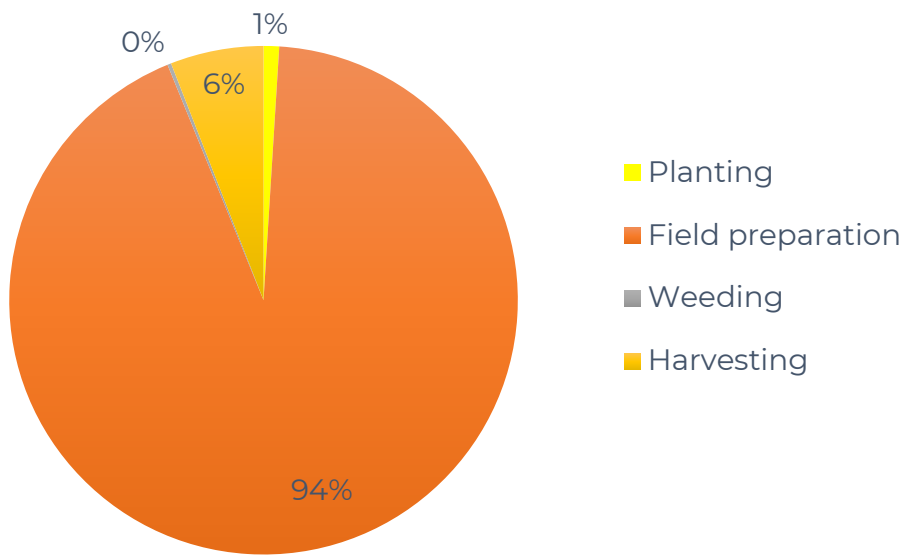


Figure 4: Percent distribution of machinery usage among machinery adopters across agricultural activities in Surkhet, Nepal

3.2 Machinery used for different agricultural operations in Surkhet

Figure 5 indicated the percentage of households in Surkhet, Nepal, using different types of farm machinery for key agricultural activities, including field preparation, planting, and weeding. Tractors and tillers are the main machinery used by the households in Surkhet for land preparation. The percentage of households using tractors is higher (44%) than that using tillers (9%).

For crop planting, manual operation is dominating. Almost all households use manual labor for planting, while a few households use seed drills and planters. Similarly, 97% of households rely on manual power for harvesting, while 1% use reapers.

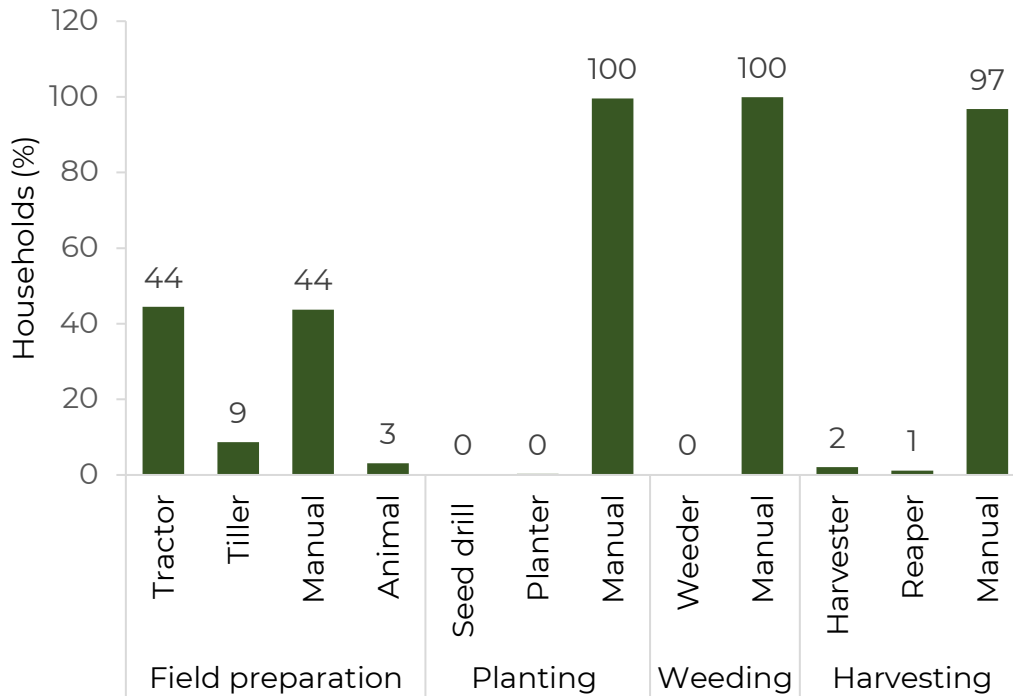


Figure 5 Percentage of households reporting farm power usage for different agricultural activities in Surkhet, Nepal

3.3 Machinery (tractor and tiller) usage for field preparation across farm types in Surkhet, Nepal

A bar graph in Figure 6 shows the percentage of households reporting tractor and tiller usage across different farm types. The percentage of households using tractors for land preparation is highest across all farm types except T5, where usage of tiller is highest. The percentage of households reliant on the tractor for field preparation is highest in T1 (59%), followed by T2 (48%), T3 (46%), T4 (39%) respectively. None of the households use tractors in the T5 farm.

Conversely, the percentage of households using tiller is highest in T5 (29%) followed by T3 (14%), T1 (6%), T2 (5%), and T4(1%).

The highest percentage of tractor use for land preparation in T1 can be attributed to the landscape type as T1 farms could be more flat areas and river basins, where the use of tractors for ploughing is more feasible. Additionally, there is likely a greater availability of tractor services in these regions, alongside farmers' preference for deep tillage in rice and wheat cultivation. Tractors are also more efficient than tillers for this purpose, allowing for quicker land preparation and ensuring the timely planting of rice and wheat.

In contrast, T5 farm types are situated at higher altitudes with steep slopes, and the use of tractors for field preparation is not common. However, tractors are utilized for

off-farm activities in these areas. Higher reliance on the tiller for field preparation is due to its smaller size and can be easily accommodated in the smaller plots.

In the T3 farm, the second highest percentage of households reporting the use of a tiller is attributed to the diversified farm, where the households grow different types of vegetables, and grass and they might have frequently used a tiller for tillage.

The lowest percentage of households using tiller is in the T4 farm type (1%). As these households' income is derived mainly from off-farm activities and whenever they need ploughing their field, they might have hired tractors.

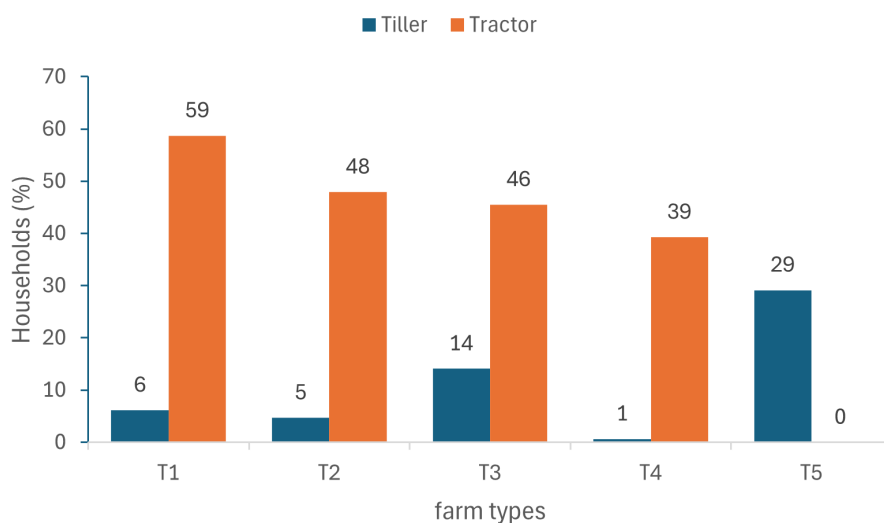


Figure 6: Households using tractors and tillers for field preparation in Surkhet, Nepal

3.4 Machinery usage for field preparation in major cereal crops across seasons in Surkhet, Nepal

A bar graph in Figure 7 shows the percentage of households using tillers and tractors for land preparation in cereal crops during different seasons (monsoon, summer, and winter). Rice, maize, millet, and barley are the major cereal crops in Surkhet. The use of tractors is highest compared to tillers for land preparation across all seasons. The percentage of households growing maize (66%) in the summer season reported the highest use of tractors for land preparation followed by wheat (48%) in the winter and rice (47%) in the monsoon season.

The percentage of households using a tiller is highest for land preparation for millet (25%) followed by summer maize (16%), barley (16%) in the winter season

This shows that the households are gradually inclined to use tillers for cereal crops such as rice, wheat, maize and millet for land preparation which is a labor-intensive activity and is transitioning to mechanized tillage.

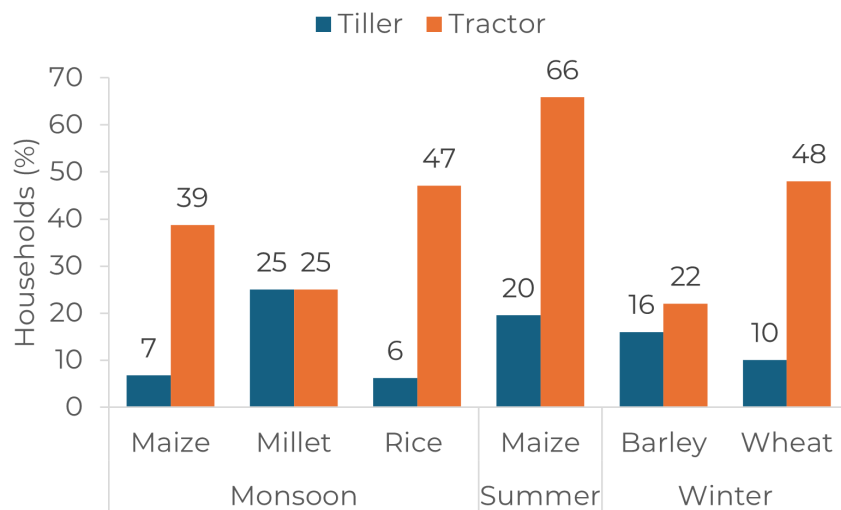


Figure 7 Percentage of households reporting tractor and tiller usage in land preparation by crops across seasons in Surkhet, Nepal

3.5 Usage of machinery and other farm powers across seasons for land preparation in Surkhet, Nepal

A bar graph in Figure 8 shows the percentage of households reporting the use of machinery in different seasons for land preparation in Surkhet, Nepal. There is significant variation in the usage of farm power across seasons. The percentage of households reporting the use of tractors is highest (62%) in the summer season followed by the winter season (45%) and monsoon season (42%). Similarly, the highest use of tiller is also reported in the summer season (17%) followed by the winter season (10%) and monsoon season (7%). Household reliance on manual power is highest in the monsoon season (48%) and lowest in the summer season (21%). The percentage of households reporting the use of animal power is highest in the monsoon season (48%) and lowest in the summer season (21%). The percentage of households reporting the use of animal power is significantly low with 3% in monsoon which is equal to the winter season and none of the households reported use of animal power in the summer season.

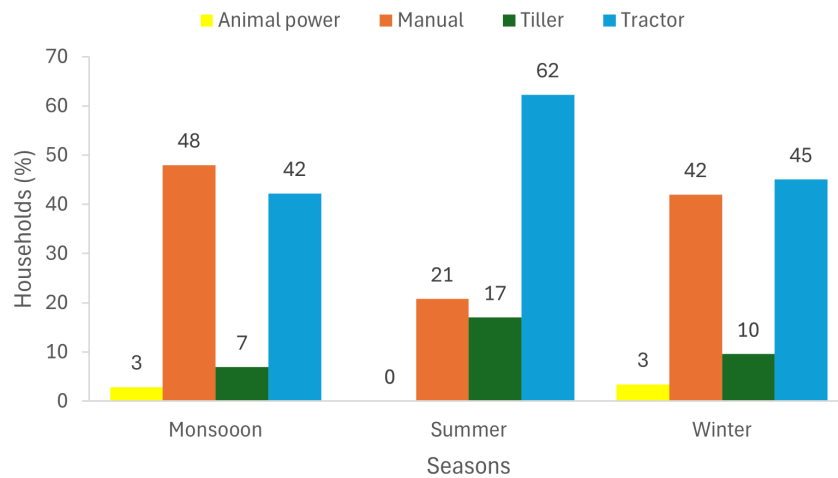


Figure 8 Percentage of households reporting the use of farm powers across seasons for field preparation in Surkhet, Nepal

3.6 Usage of agricultural machinery for field preparation of various crops in Surkhet, Nepal

A dot chart in Figure 9 shows the percentage of households reporting tractors and tillers for field preparation across various crops in Surkhet, Nepal. The chart indicates that there is significant variation in tractors and tillers usage for field preparation with the percentage of households using tractors significantly higher than tiller users across crops.

For major cereal crops tractor usage is highest in rice (47%), followed by wheat (45.6%), maize (42%), millet (25%), and barley (22%). In contrast, tiller usage is highest in millet (25%) followed by barley (16%), wheat (10%), maize (9%) and rice (6%). Groundnut and eggplant are fully mechanized with tractors.

For vegetables, tractor usage is highest for cucumber (66%), followed by tomato (60%), radish (57%) and potato (40%). Tiller usage is most frequent for cabbage (23%), potato (20%) and radish (12%).

For the leguminous pulse crop lentil tractors are used by 44% of the households and tillers by 5%. Similarly, for the field preparation of oilseed such as mustard tractor usage is 58% while tiller users are 9%. The variation in tractor and tiller usage across types is likely due to the availability of machines, household preferences, and farm typologies.

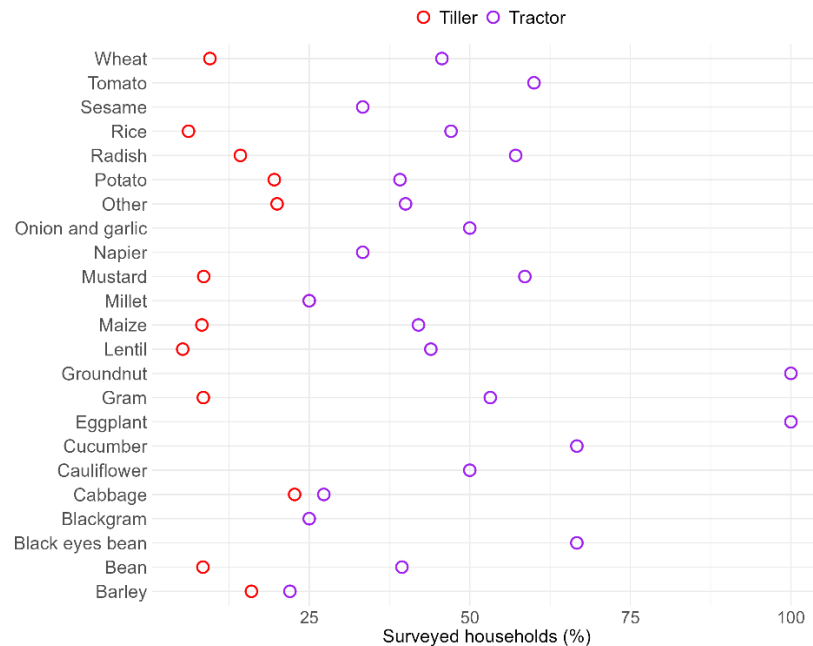


Figure 9 Percentage of households reporting tractor and tiller usage in land preparation by crops across seasons in Surkhet, Nepal

3.7 Usage of agricultural machinery for planting various crops in Surkhet, Nepal

A dot chart in Figure 10 depicts the percentage of households reporting the use of seed drill, planter, and other farm powers for planting various crops in Surkhet, Nepal, regardless of seasons and farm types. It appears that planting is entirely carried out manually for all crops, while a negligible percentage of households reported using seed drills for wheat (0.3%) and lentil (0.7%) planting and planter machines for maize (0.5%) and rice (0.3%). The low level of machinery usage for planting various crops is attributed to limited knowledge of better bet crop establishment methods, lack of appropriate machinery, and the unavailability of suitable machinery in the market.

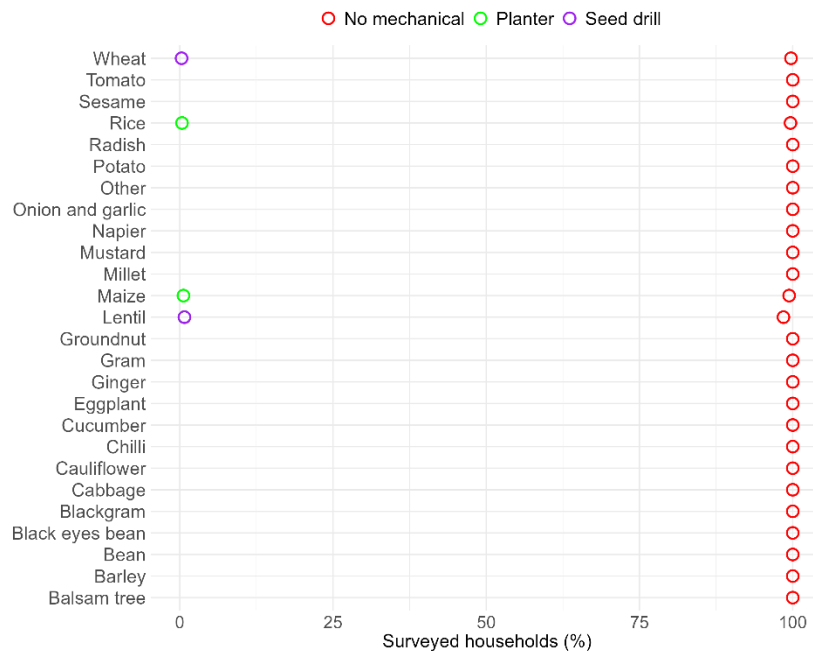


Figure 10 Percentage of households reporting planter, seed drill, and no mechanical power usage for planting various crops in Surkhet, Nepal.

3.8 Usage of agricultural machinery for weeding various crops in Surkhet, Nepal

A dot graph in Figure 11 shows the percentage of households reporting the use of weeder and manual power for various crops in Surkhet, Nepal regardless of seasons and farm types. The graph indicates that weeding is carried out entirely manually. The main reasons for this are likely the practice of feeding weeds to livestock as a result they don't use any herbicide spraying tools, and the prevalence of mixed cropping patterns, which make the mechanical options infeasible.



Figure 11 Percentage of households reporting weeder and manual power usage in weeding for different crops in Surkhet, Nepal

3.9 Usage of agricultural machinery in harvesting various crops in Surkhet, Nepal

A dot chart in Figure 12 shows the percentage of households using reaper, harvester and manual power for harvesting various crops in Surkhet, Nepal. The graph indicates that more than 85% of households harvest the crops manually. However, few cereal crops like wheat (1.4%), barley (8%) and rice (1%) use reaper for harvesting. Low usage of reaper for harvesting crops is attributed to the lack of suitable machinery, lack of machinery custom hiring service, and lack of awareness on appropriate machinery.

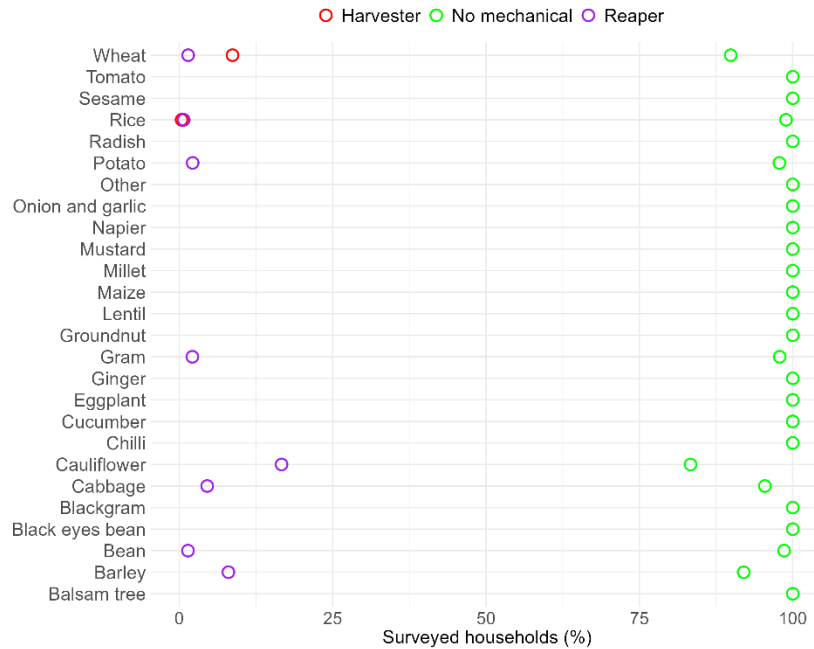


Figure 12 Percentage of households using machinery and manual power for harvesting various crops in Surkhet, Nepal

3.10 Severity of labor shortage for land preparation in Surkhet, Nepal

The bar graph in Figure 13 illustrates the distribution of labor shortage across various farm typologies. Farm types T1, T2, and T5 experience the least labor shortage, with 80%, 75%, and 72% of households, respectively, reporting no shortage. In contrast, farm types T3 and T4 experience a higher level of labor shortage, with 73% and 49% of the households respectively. The higher incidence of labor shortages in T3 and T4 could be due to a greater focus on off-farm activities, potentially reducing the availability of labor for agricultural activities.

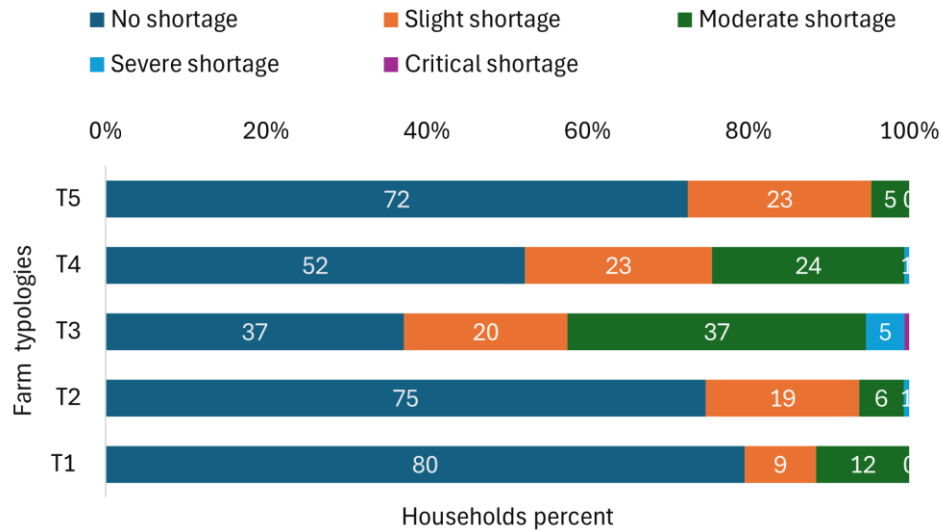


Figure 13 Severity of labor shortages in different farm typologies for land preparation in Surkhet, Nepal

3.11 Labor availability and shortages across farm types in Surkhet, Nepal

A bar graph in Figure 14 illustrates the percentage of households reporting the status of labor shortage and availability for various agricultural operations in Surkhet, Nepal. Labor scarcity is highly seen in harvesting compared to planting, weeding, and spraying across all the farm types. The highest labor shortage in harvesting is reported by the households of farm types T3(57%) followed by T4 (44%), T5 (20%), T2 (18%), and the lowest T1 (16%). Similarly, labor scarcity during planting is highest in T4 (26%), followed equally by T1 and T3 (15%), and the lowest in T2 (12%).

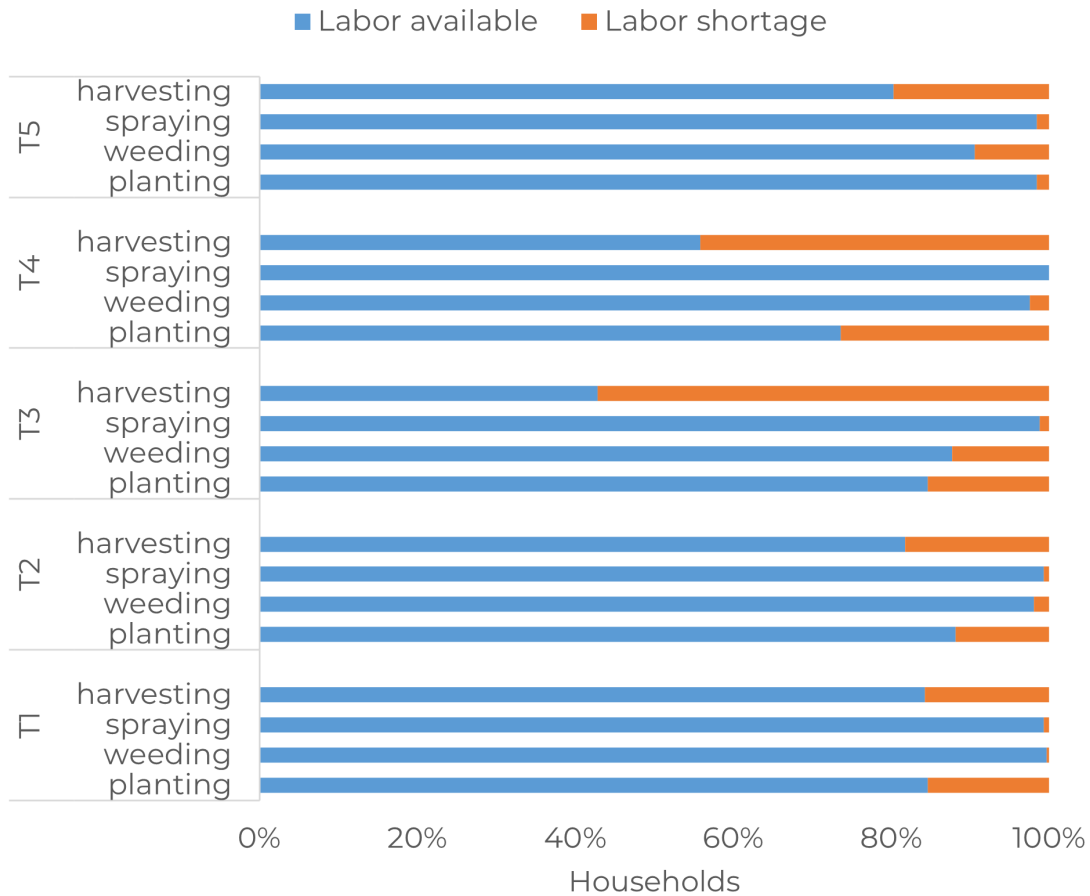


Figure 14 Percentage of households showing status of labor availability by agricultural operations across farm types in Surkhet, Nepal

4 Constraints of machinery adoption in Surkhet, Nepal

Although the draft animals are declining and labor costs are increasing in Surkhet, machinery adoption remains low, and manual power is high making the food production system more labor-intensive. Several challenges prevail for the low adoption of agricultural machinery in Surkhet which are discussed below.

A pie chart in Figure 15 shows the percentage of households reporting reasons for not using machinery in Surkhet. Notably, 52% of the households did not mention anything about the reasons for not using machinery, while 27% reported financial constraints as the major issue, likely due to low household income, higher machinery costs and services, and limited access to loans or credit facilities. Additionally, 15% of the households reported waiting for a government subsidy program to purchase new machinery and 6% of households reported being unaware of the machinery supplier for machinery availability and machinery service provider offering rental service of machinery in that locality. Furthermore, 1% reported a knowledge gap about scale-appropriate machinery and its usage in agricultural activities.

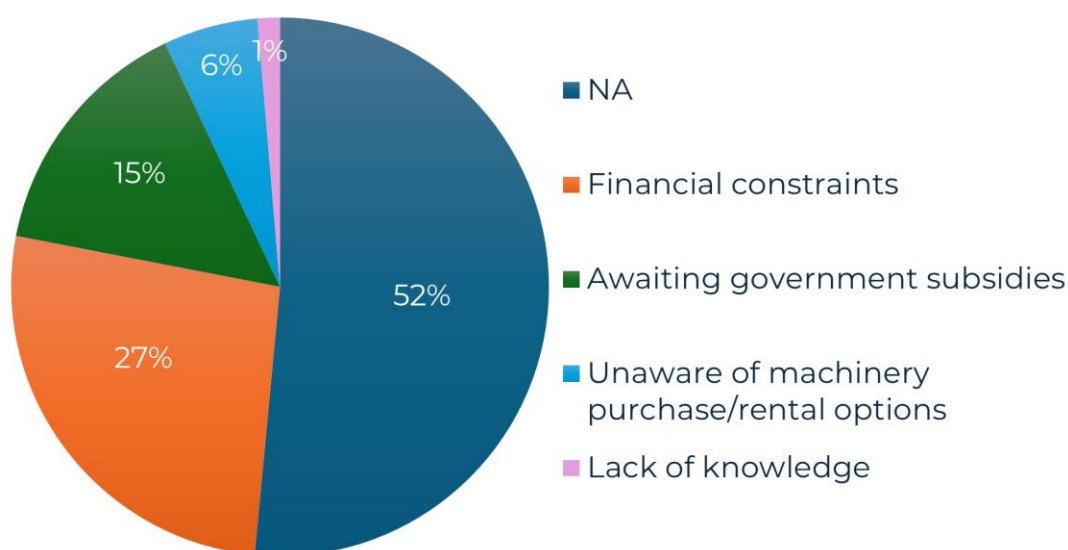


Figure 15 Distribution of households reporting the reasons for not using machinery in Surkhet, Nepal

5 Conclusions

The usage of machinery in the hilly region is low. Machinery especially tractor and tiller usage are limited for field preparation while for other agricultural operations such as planting, weeding, harvesting, and threshing manual power is predominated. The usage of draft power has significantly declined across all agricultural operations. While observing the tractor usage, it seems that tractor usage is more concentrated in the river-basin area where the flat area facilitates easy operation of tractors. Tillers are mostly used in high-altitude areas and notably in households with diversified crop production such as vegetables, leguminous grass, and pulses. As farmers have experienced labor shortage in planting and harvesting appropriate intervention should be devised. There are several factors affecting machinery adoption, among them financial issues, lack of custom hiring service business model, and lack of awareness of scale-appropriate modern tools are major constraints.

These findings highlight the need for targeted interventions to promote machinery adoption in hilly areas. Key strategies include improving access to agricultural loans, strengthening machinery supply chains and services, conducting awareness campaigns on scale-appropriate machinery, and providing government support to poor and needy farmers as well as research and development on women-friendly machinery in the context of rising trend of male outmigration and feminized agriculture.

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