Performance evaluation of Barley (*Hordeum vulgare* L.) genotypes in Dolakha, Nepal: from yielding perspective

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ABSTRACT

Lack of suitable barley varieties that exhibit high yielding is the major factor among several production constraints contributing to low productivity of barley in Nepal. The present study was done to evaluate and recommend the best performing barley genotypes. This study was conducted at research field of Hill Crops Research Program (HCRP), Dolakha, Nepal under National observation nursery (NON), initial evaluation trial (IET), coordinated varietal trials (CVT) and farmer's field trials (FFT) during winter seasons from 2017 to 2018. The results of these trials showed that in NON, genotypes namely B86023-1K2-OK3 (6.16 t/ha), Xveola-28/MATICO’S10 (4.41 t/ha) and ACC#2079 (4.41 t/ha) produced higher grain yield over Farmer’s variety (3.57 t/ha). The pooled analysis over years of IET revealed that genotypes namely LG-51/Xveola-2-77-0-3-1-1-OK (2.12 t/ha) and B86099-2-1-OK (2.06 t/ha) produced higher grain yield over standard check variety (Solu Uwa) (1.85 t/ha) and Farmer’s variety (1.95 t/ha). Similarly results of combined analysis over years of CVT showed that the genotypes namely B90K-007-0-2-2-0-OK (2.14 t/ha) and ICB90-0196-OAP-2K-OK (1.97 t/ha) produced higher grain yield over standard check variety (Solu Uwa) (1.12 t/ha) and Farmer’s variety (1.66 t/ha). In farmer's field trials (FFTs) the genotypes namely Mukinath (Coll#112-14 (2.64 t/ha)), NB-1003-37/903 (2.23 t/ha) and Xveola-45 (2.04 t/ha) produced higher grain yield which was at par to standard check variety (Soluuwa) (1.58 t/ha) and Farmer’s variety (1.85 kg/ha). It is suggested that the superior genotypes derived from CFFT could be released and then recommended to farmers for general cultivation in Dolakha and similar other environments of Nepal.

Keywords: Barley, Food security, Grain yield and Genotypes

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INTRODUCTION

Barley (*Hordeum vulgare* L.) belongs to the genus *Hordeum* in the *Triticaceae* of Gramineae family. It is self-pollinated diploid 2n=14. It is fourth important cereal crop after wheat maize and rice in the world (Akar *et al.*, 2009). It is old an essential winter crop in mountain regions of Nepal. In mountain region, large amount of diversity existed and possible to be the center of diversity of barley (Witcombe & Gilani, 1979). It is the fifth crop after rice, maize, wheat and finger millet in Nepal. It is the staple food mainly in the hills and high land regions in the western part of the country where farming system is carried out on steep slopes, terraces and river basins of small valleys. In Nepal, during 2016/17 it was cultivated in the total area of 27,370 ha and total production was 30,510 t with productivity of 1,115 kg/ha (MoALD 2017). It is one of the nutritious crops which contain 11.5% protein, 77.4% carbohydrate, 1.3% fat, 3.9% fibre and 1.5% ash (NARC, 2018). It provides nutritional and food security under the harsh environmental conditions in high-hills of Nepal (Baniya, 1989). It is an important crop in these regions because it is grown during winter season and mature approximately one month earlier than wheat which can allow to grow next crops in time. A reported that farmers of Rasuwa preferred to grow barley because it can withstand in less moisture, cold and short duration crop. The area and production of barley is declining every year in terai and stagnant in hill and mountains. It is grown under marginal land by marginalized farmers.

Data showed that area and production is largely decreased in terai and stagnant in hills and mountains. It could be the lack of high yielding and disease resistant improved varieties, poor crop management practices, cultivation in marginal land, degradation of soil fertility, no access to irrigation, low priority by farmers, researchers and extension workers, low seed replacement rate, changing food habit of local people, lack of nutritional knowledge etc. However it has great potentiality in drought prone areas and agro-based industries to manufacture beverages, noodles, bakery, baby foods and other non-alcohol drinks. It has significant role in food and nutritional security. It is important to evaluate and recommend the best-performing varieties at the major potential areas of Dolakha, Nepal in order to boost production and productivity of barley. The objective of this study was was to identify the best performing genotypes for mid hill condition of Nepal.

MATERIALS AND METHODS

Description of the experimental site

The experiments was conducted at Hill crops research program baitheshwor-4, Kabre, Dolakha of Nepal during winter season for two consecutive years 2017 and 2018.Agro climatically ,this location represents mid hill region of Nepal of country and characterized by warm temperate climate with moderate rainfall. The experimental sites have 86°9’ E longitude, 27°38’N latitude and 1740 m altitude. The soil is sandy loam and pH ranged from 4.5-6.2 i.e slightly acidic, nitrogen, extractable magnesium and available boron and organic carbon is very low. (NARC, 2018).
Experimental design, planting materials, and field management

The seeds of all genotypes evaluated in initial evaluation trial (IETs), coordinated varietal trials (CVTs) and farmer’s field trials (FFTs) were derived from Hill Crops Research Program, Kabre, Dolakha, Nepal. Barley genotypes were evaluated at Hill Crops Research Program (HCRP), Dolakha during winter seasons for two consecutive years 2017 and 2018. National observation nursery (NON) was laid out in augmented design with plot size of 1m². Similarly initial evaluation trial (IETs), coordinated varietal trials (CVTs) and farmer's field trials (FFTs) were conducted in randomized complete block design (RCBD) with three replications in plot size of 4m², 6m² and 6m² respectively. It was composed of seven genotypes including standard check Solu Uwa and local check. Spacing, fertilizer dose, source of nutrients and method of application and seed sowing method were same to all trials. Standard check Solu Uwa and local checks were planted. Local checks were varied based on locations. Chemical fertilizers was applied @ 30:30:30 NPK kg/ha and source of Nitrogen, Phosphorus and Potash was Urea, Di-ammonium phosphate (DAP) and Murat of Potash (MoP) respectively. Full dose of Phosphorus, Potash and half dose of Nitrogen was applied during final land preparation Remaining half dose of Nitrogen was applied during tillering stage. Seed rate was used @ 100 kg/ha. Rows were spaced at 25cm apart and continuous seeding was done in to the rows.

Data collection and statistical analysis

Data were recorded of plant height (cm), days to 50% days to heading, 75% days to maturity, number of hills per m², 1000 grain weight (g), moisture (%), grain yield t/ha and straw yield t/ha (NARC, 2019). The genotypes were evaluated based on measurement of grain yield. The grain yield was calculated using below formula (MoALD, 2017)

\[
\text{Grain yield (t/ha)} = \frac{(100 - M) \times \text{Plot yield (kg)} \times 10000 \text{ (m²)}}{(100 - 12) \times \text{Net plot area (m²)}}
\]

Where, \( M \) is the moisture content in percentage of the grains.

The analysis of variance was performed using RCBD design to derive variance components derived using the software packages META-R developed by CIMMYT, Mexico (Pacheco et al., 2015). The treatment means were compared by the Least Significant Difference (LSD) test at 5% level (Gomez & Gomez, 1984; Shrestha, 2019; Jan et al., 2009).

RESULTS

National observation nursery – Mountain (NON-M)

In NON, selected genotypes were B86023-1K2-OK3 (6.16 t/ha), Xveola-28/MATICO"S"10 (4.41 t/ha), ACC#2079 (4.41 t/ha), KB-105969-3-2-2K(4.32 t/ha), B86023-1K3-2K-OK3(4.3
t/ha), LVIRING (S1121-1K) (4.18 t/ha) and ICB88-0160-1K-3K-OK (4.14 t/ha) gave higher grain yield (GY), over to Farmer’s variety (3.57 t/ha) (Table 1, 2 & 3).

**National observation nursery –Early (NON-E)**

NON-Early genotypes Acc#2013(3.51 t/ha), GHV06819 (3.47 t/ha), Acc#6316(3.41 t/ha), B86146-1-2-OK (3.21 t/ha) gave higher grain yield (Table 4).

**Initial evaluation trials (IET)**

Likewise results of combined analysis over years of IETs revealed that, genotypes LG-51/Xveola-2-77-0-3-1-1-OK (2.12 t/ha) and B86099-2-1-OK (2.06 t/ha) produced more GY over to std. check Solu Uwa (1.85 t/ha) and Farmer’s variety (1.95 t/ha) (Table 7). Whereas genotypes INBON P #3 (3.42 t/ha), GR-24-42 (3.15 t/ha), B86099-2-1-OK (3.17 t/ha) during 2017 and genotypes B90K-0114-0-0K (1.25 t/ha), ACC#2470 (1.25 t/ha), LG-51/Xveola-2-77-0-3-1-1-0K (1.16 t/ha) during 2019 were gave higher grain yield (Table 5 and Table 6).

**Coordinator varietal trials (CVT)**

Similarly results of combined analysis over years of CVT showed that, genotypes, B90K-007-0-2-2-0-OK(2.14 t/ha), ICB90-0196-OAP-2K-OK (1.97 t/ha), B86152-2-3-0-OK (1.97 t/ha) and ICB90-0203-OAP-2K-OK (1.90 t/ha) produced more GY over to std. check Solu Uwa (1.12 t/ha) and Farmer’s variety(1.66 t/ha) (Table 10). Whereas genotypes B86099-1K-2K-OK (3.17 t/ha), ICBB88-0160-1K-4K-OK (3.06 t/ha), ICB90-096-OAP-2K-OK (2.94 t/ha) and genotypes Coll#112-14 (3.62 t/ha), ICB90-0203-0OAP-2K-OK (1.72 t/ha), NB-HCRP-101 (1.62 t/ha) were gave highest grain yield during 2017 and 2018 respectively (Table 8 and Table 9).

**Farmer’s Field trials (FFT)**

In farmer's field trials (FFT) high yielded genotypes NB-1003-37/903 (2.23 t/ha) and Xveola-45 (2.04 t/ha) produced GY at par to std. check Soluuwa (1.58 t/ha) and Farmer’s variety(1.85 kg/ha) in 2017 (Table 11) whereas genotypes LG51/Xveola-2-77 (3.24 t/ha), CENTINELLA/MOY (2.69 t/ha), Muktinath (Coll#112-14 (2.64 t/ha)) gave higher GY but at par to std. check Solu Uwa (1.42 t/ha) and Farmer’s variety (1.78 t/ha) in 2018 (Table 12).Thus promising genotypes muktinath (Coll#112-14) and released variety Solu Uwa is best for cultivation for mountain region of Nepal.

**DISCUSSION**

The mean grain yield of barley genotypes differed across environments which could be due to different environmental conditions over years and location. The location themselves differ greatly in temperature, humidity and rainfall variation that affects yield and yield attributing traits of crop (Kole et al., 2015; Lobell et al., 2011). According to Olesen et al. (2000) and Wheeler et al. (2000), factors like weather and soils are important causes for crop yield variability. There were great differences between varieties in grain yield. The findings of the study showed that on basis of average across year and each location. The significant variation
in grain yield due to variation in yield and yield attributing traits of barley. High level of phenotypic variation can be observed in barley genotypes due to significant variation in yield attributing traits such as days to 50% heading, days to maturity, plant height and number of hill and thousand grain weights. Similar finding about high genetic variation in barley reported by Bajracharya et al. (2001). In Jumla condition, local chauli jau showed the better performance over to improved genotypes .Thus it need to be imposed through pure line selection and registered for Jumla valley and similar environment condition. Thus similar finding on lot of variation was observed among the Jumla collections of Nepalese barley for many yield attributing characters (Gupta et al., 2009). Many of these landraces possess one or more characteristics for abiotic and biotic stress tolerance (Upreti, 2005). Therefore, evaluation of Nepalese barley accessions for different agro-morphological traits is very important for crop improvement of barley.

CONCLUSION

The present study was aimed at analyzing the variability present among the barley using agro-morphological traits. The genotypes namely NB-1003-37/903 and Xveola-45, LG51/Xveola-2-77 and Muktinath (Coll#112-14) produced higher grain yield at par to std. check variety Solu Uwa at farmers’ fields. Local chauli barley showed the better performance over to improved genotypes. Therefore these promising genotypes such as muktinath (Coll#112-14), Xveola-45 and LG51/Xveola-2-77 should be released/registered for Dolakha and similar environment condition and recommended for farmer’s cultivation.

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Authors’ contribution

M. Kandel was the lead investigator and the initiator of the study. N. B. Dhami was responsible for literature search, data generation and drafting of the manuscript. J. Shrestha was responsible for data analysis, drafting and finalizing of the manuscript. All authors read and approved the final manuscript.

Conflict of Interest

The authors declare that there are no conflicts of interest regarding publication of this

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Table 1. Performance of Barley genotypes evaluated in NON-Mountain at HCRP, Dolakha in 2017.

| SN | Name of Genotype                        | 50% DTH | 75% DTM | PH (cm) | SL (cm) | LS (1-5) | GY (t/ha) |
|----|----------------------------------------|--------|--------|--------|--------|---------|----------|
| 1  | ICB-105969-3-2-2K                       | 114    | 164    | 100    | 7.5    | 4       | 6.9      |
| 2  | Xveola-28/VIRING“S”12K-1K               | 104    | 164    | 105    | 7.3    | 3       | 5.32     |
| 3  | GR-24-42                                | 96     | 160    | 86     | 9.4    | 3       | 4.92     |
| 4  | Xveola-28/MATICO“S”                     | 104    | 162    | 103    | 10.2   | 2       | 4.58     |
| 5  | ACC#5177                                | 100    | 103    | 96     | 7.7    | 4       | 4.34     |
| 6  | B90K-014-1-1-1-0-OK                     | 117    | 163    | 108    | 8.1    | 5       | 4.3      |
| 7  | B86019-1K-K-3K-OK                       | 104    | 163    | 94     | 7.3    | 5       | 4        |
| 8  | ICB88-0160-1K-3K-OK                     | 104    | 162    | 110    | 5.7    | 2       | 3.96     |
| 9  | B86023-1K-3-2K-OK                       | 95     | 164    | 105    | 6.1    | 4       | 3.94     |
| 10 | ACC#2079                                | 110    | 163    | 99     | 8.9    | 2       | 3.9      |
| 11 | Coll#112-14                             | 110    | 102    | 98     | 8.7    | 3       | 3.76     |
| 12 | Farmer’s variety                        | 105    | 163    | 93     | 8.8    | 4       | 3.74     |

Grand Mean: 105 152 100 7.97 4 4.47

Note: DTH= Days to heading, DTM= Days to maturity, PH= plant height, SL= Spike length, LS= Lodging, GY= Grain yield

Table 2. Performance of Barley genotypes evaluated in NON-Mountain at HCRP, Dolakha in 2018.

| SN | Genotypes                      | 50% DTH | 75% DTM | PH(cm) | SL(cm) | GY(t/ha) |
|----|--------------------------------|--------|--------|--------|--------|----------|
| 1  | B86023-1K2-OK3                  | 92     | 152    | 103    | 8      | 9.15     |
| 2  | KB-105969-3-2-2K                | 116    | 163    | 104    | 9      | 1.73     |
| 3  | Xveola-28LVIRING(S1121-1K)      | 104    | 166    | 91     | 10     | 3.04     |
| 4  | GR-24-42                       | 94     | 156    | 80     | 8      | 2.41     |
| 5  | Acc#2079                       | 117    | 157    | 88     | 9      | 4.91     |
| 6  | B86023-1K3-2K-OK3               | 94     | 154    | 110    | 8      | 4.65     |
| 7  | local uwa check                | 115    | 163    | 114    | 7      | 4.58     |
| 8  | Xveola-28/MAIICOS ‘10          | 94     | 153    | 99     | 9      | 4.24     |
| 9  | Farmer’s variety               | 102    | 156    | 124    | 9      | 4.46     |

Grand Mean: 103 157 101 8 4.35

Note: DTH= Days to heading, DTM= Days to maturity, PH= plant height, SL= Spike length, GY= Grain yield
Table 3. Combined Performance of Barley genotypes evaluated in NON-Mountain at HCRP, Dolakha in 2017 and 2018.

| SN | Genotypes                        | 50% DTH | 75% DTM | PH(cm) | SL(cm) | GY(t/ha) |
|----|----------------------------------|---------|---------|--------|--------|----------|
| 1  | B86023-1K2-OK3                   | 94      | 158     | 97     | 8      | 6.16     |
| 2  | Xveola-28/MAICOS'10              | 99      | 158     | 101    | 10     | 4.41     |
| 3  | Acc#2079                         | 114     | 160     | 94     | 9      | 4.41     |
| 4  | KB-105969-3-2-2k                  | 115     | 164     | 102    | 8      | 4.32     |
| 5  | B86023-1K3-2K-OK3                 | 95      | 159     | 108    | 7      | 4.3      |
| 6  | Xveola-28LVIRING(S1121-1K)        | 104     | 165     | 98     | 9      | 4.18     |
| 7  | ICB88-0160-1K-3k-OK               | 110     | 163     | 115    | 7      | 4.14     |
| 8  | Mukthinath (Coll# 112-14)        | 113     | 135     | 96     | 10     | 4.05     |
| 9  | B90K-014-1-1-1-0-OK               | 110     | 161     | 107    | 8      | 3.73     |
| 10 | GR-24-42                         | 95      | 158     | 83     | 9      | 3.67     |
| 11 | ICBON-06-OAP-2K-OK               | 107     | 162     | 86     | 8      | 3.66     |
| 12 | B860191K-3K-OK                   | 98      | 158     | 89     | 7      | 3.63     |
| 13 | Farmer’s variety                 | 109     | 161     | 124    | 8      | 3.57     |
|    | Grand Mean                       | 102     | 160     | 100    | 8      | 3.04     |
|    | Genotype significance            | 0       | 0.77    | 0      | 0.32   | 0.99     |
|    | CV(%)                            | 5.83    | 5.37    | 10.52  | 14.12  | 33.8     |
|    | LSD(0.05)                        | 11.91   | 17.14   | 21.09  | 2.23   | 2.05     |

Note: DTH= Days to heading, DTM= Days to maturity, PH= plant height, SL= Spike length, GY= Grain yield

Table 4. Combined performance of Barley genotypes evaluated in NON-Early mountain at HCRP, Dolakha in 2017 and 2018.

| SN | Genotype               | 50% DTH | 75% DTM | PH(cm) | NH/m² | SL(cm) | GY(t/ha) |
|----|------------------------|---------|---------|--------|------|--------|----------|
| 1  | Acc#2456               | 100     | 151     | 108    | 148  | 8      | 1.72     |
| 2  | Acc#2013               | 100     | 155     | 104    | 353  | 8      | 3.51     |
| 3  | Acc#1555               | 98      | 156     | 114    | 172  | 7      | 2.84     |
| 4  | Acc#1607               | 99      | 156     | 91     | 159  | 7      | 3.15     |
| 5  | Acc#1603               | 96      | 156     | 107    | 176  | 6      | 2.40     |
| 6  | B86146-1-2-OK          | 98      | 156     | 103    | 177  | 7      | 3.21     |
| 7  | Acc#1614               | 111     | 157     | 100    | 171  | 7      | 2.52     |
| 8  | Acc#2494               | 93      | 157     | 103    | 162  | 8      | 2.44     |
| 9  | Acc#6316               | 111     | 157     | 100    | 259  | 7      | 3.41     |
| 10 | BN-HONA                | 113     | 157     | 100    | 218  | 8      | 3.19     |
| 11 | Acc#2033               | 104     | 157     | 95     | 183  | 6      | 2.46     |
| 12 | GHV06820               | 106     | 157     | 114    | 160  | 6      | 2.90     |
| 13 | Acc#2526               | 106     | 158     | 96     | 180  | 5      | 2.30     |
| 14 | Acc#2474               | 106     | 158     | 104    | 117  | 8      | 2.97     |
| 15 | Acc#GHV06819           | 105     | 158     | 114    | 106  | 6      | 3.47     |
| 16 | Acc#2446               | 102     | 158     | 157    | 196  | 8      | 2.97     |
### Table 5. Performance of Barley genotypes evaluated in IET-Mountain at HCRP, Dolakha in 2017.

| SN | Name of Genotypes       | 50% DTH | 75% DTM | PH (cm) | NS /m² | NR /Spike | TN /m² | SL (cm) | GY (t/ha) |
|----|-------------------------|--------|--------|--------|--------|----------|--------|--------|----------|
| 1  | INBON P #3              | 102    | 160.3  | 90.7   | 120    | 6.0      | 281    | 8.0    | 3.42     |
| 2  | B90k-004-1-2-2-2-2-0-OK | 111    | 164    | 95.5   | 188    | 2.0      | 541    | 8.7    | 2.99     |
| 3  | B90k-014-0-0-OK          | 110    | 164    | 94.5   | 168    | 2.0      | 483    | 9.0    | 2.64     |
| 4  | ICB90-0292-OAP           | 95.0   | 156    | 89.4   | 93.0   | 6.0      | 214    | 7.3    | 2.56     |
| 5  | B90k-02-06-2-0-0-OK      | 94.0   | 150    | 63.9   | 113    | 6.0      | 254    | 9.0    | 3.03     |
| 6  | MARCO SLOY -IB-OY       | 113    | 164    | 90.6   | 167    | 2.0      | 409    | 8.7    | 2.54     |
| 7  | LG-51/Xveola -2-77-0-3-1-1-OK | 97.0 | 158 | 82.8 | 122 | 6.0 | 300 | 6.7 | 3.08  |
| 8  | B90K-024-1-2-1-0-0-OK    | 103    | 160    | 85.2   | 105    | 6.0      | 267    | 9.3    | 1.69     |
| 9  | INBON#62                | 98.0   | 159    | 93.6   | 89.0   | 6.0      | 232    | 8.3    | 1.74     |
| 10 | B86099-2-1-0-OK          | 101    | 160    | 85.8   | 111    | 6.0      | 288    | 7.0    | 3.17     |
| 11 | CENTINELLA/OY           | 106    | 164    | 82.7   | 117    | 6.0      | 277    | 9.0    | 2.52     |
| 12 | INBON#17                | 98.0   | 159    | 73.5   | 112    | 6.0      | 216    | 8.7    | 2.31     |
| 13 | GR-24-42                | 111    | 160    | 103    | 96.0   | 6.0      | 302    | 6.0    | 3.15     |
| 14 | B86160-1-1-0-0-OK        | 103    | 156    | 98.9   | 142    | 6.0      | 354    | 7.0    | 2.29     |
| 15 | Soluuwa (Std. check variety) | 110    | 164    | 81.0   | 109    | 6.0      | 207    | 9.3    | 2.65     |
| 16 | Local check             | 98.0   | 164    | 94.1   | 104    | 6.0      | 281    | 7.0    | 2.88     |

|           |             |             |        |        |          |        |        |          |
| Grand mean| 103          | 160          | 88.0   | 122.1  | 5.2      | 307    | 8.06   | 2.67     |
| CV%        | 8.3          | 4.7          | 11.5   | 18.9   | -        | -      | 24.6   | 9.8      |
| P value    | 0.107        | 0.641        | 0.008  | 0.008  | 0.001    | 0.001  | 0.001  | 0.012    |
| LSD (0.05) | -            | -            | 32.2   | 73.54  | -        | -      | 240    | 2.52     |

**Note:** 
- **DTH** = Days to heading, **DTM** = Days to maturity, **PH** = plant height, **NS** = Number of spike, **TN** = Tillers Number, **NR** = Row number, **GY** = Grain yield
- **CV** = Coefficient of variation
- **P value** = Probability value
- **LSD** = Least Significant Difference

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**Table 5.** Performance of Barley genotypes evaluated in IET-Mountain at HCRP, Dolakha in 2017.

**Note:** 
- **DTH** = Days to heading, **DTM** = Days to maturity, **PH** = plant height, **NS** = Number of spike, **TN** = Tillers Number, **NR** = Row number, **GY** = Grain yield

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### Table 6. Performance of Barley genotypes evaluated in IET-Mountain at HCRP, Dolakha in 2018.

| S N | Genotype                  | 50%DT | 75%DT | NS/m² | TN/m² | SL(cm) | TGW(g) | GY(t/ha) |
|-----|---------------------------|-------|-------|-------|-------|--------|--------|----------|
| 1   | B90K-011-1-1-1-0K         | 94    | 147   | 121   | 192   | 217    | 7      | 39       | 1.07     |
| 2   | GCORIA’S/OY-IB-0Y         | 113   | 161   | 88    | 177   | 213    | 9      | 48       | 0.52     |
| 3   | B90K-0114-0-0K            | 104   | 159   | 109   | 252   | 266    | 8      | 35       | 1.25     |
| 4   | ICB90-0292-OAP            | 103   | 158   | 87    | 146   | 162    | 8      | 38       | 0.72     |
| 5   | B90K-022-06-2-1-0-0K      | 96    | 150   | 120   | 230   | 239    | 7      | 38       | 0.82     |
| 6   | MARCO’S/OY-IB-OY LG-51/Xveola-2-77-0-3-1-1-0K | 97    | 152   | 105   | 154   | 162    | 7      | 36       | 0.84     |
| 7   | LG-51/Xveola-2-77-0-3-1-1-0K | 98    | 155   | 127   | 205   | 224    | 8      | 35       | 1.16     |
| 8   | B90K-024-1-2-1-1-0K       | 99    | 152   | 101   | 172   | 239    | 10     | 53       | 0.58     |
| 9   | INBON#62                 | 100   | 156   | 104   | 171   | 176    | 8      | 46       | 0.92     |
| 10  | B86099-2-1-0K             | 103   | 150   | 115   | 263   | 272    | 7      | 38       | 0.94     |
| 11  | Centinella/MOY           | 100   | 158   | 102   | 171   | 185    | 8      | 35       | 1.07     |
| 12  | ACC#5177                 | 96    | 149   | 106   | 236   | 246    | 6      | 28       | 0.84     |
| 13  | GR-24-42                 | 104   | 157   | 92    | 203   | 218    | 9      | 38       | 0.94     |
| 14  | ACC#2470                 | 96    | 155   | 115   | 293   | 261    | 8      | 33       | 1.25     |
| 15  | Solu Uwa (Std. check)    | 96    | 143   | 95    | 219   | 235    | 6      | 28       | 1.05     |
| 16  | Farmer’s variety         | 105   | 156   | 117   | 149   | 182    | 8      | 34       | 1.02     |
|     | Grand Mean               | 100   | 153   | 107   | 202   | 218    | 8      | 38       | 0.94     |

| P value | CV(%) | LSD(0.05) |
|---------|-------|-----------|
| 0.00    | 1.5   | 3.4       |
| 0.59    | 32.43 | 139.4     |
| 0.84    | 30.24 | 140.7     |
| 0.06    | 12.57 | 7.13      |
| 0.00    | 7.13  | 0.31      |

**Note:** DTH= Days to heading, DTM= Days to maturity, PH= plant height, NS= Number of spike, TN= Tillers Number, SL= Spike length, NR= Row number, TGW= Thousand Grain Weight, GY= Grain yield
Table 7. Combined Performance of Barley genotypes evaluated in IET-Mountain at HCRP,Dolakha in 2017 and 2018

| SN  | Genotype            | 50%-DTH | 75%-DTM | PH(cm) | NS/m² | TN/m² | GY(t/ha) |
|-----|---------------------|---------|---------|--------|-------|--------|----------|
|1    | B90K-0114-0-0K       | 103     | 160     | 102    | 210   | 375    | 1.95     |
|2    | ICB90-0292-OAP      | 99      | 157     | 88     | 120   | 188    | 1.64     |
|3    | B90K-022-6-2-1-0-0K  | 95      | 150     | 92     | 172   | 247    | 1.93     |
|4    | MARCO"S"/OY-IB-OY   | 105     | 158     | 98     | 161   | 286    | 1.69     |
|5    | LG-51/Xveola-2-77-0-3-1-1-0K | 98 | 157 | 105 | 164 | 262 | 2.12 |
|6    | B90K-024-1-2-1-1-0K  | 101     | 156     | 93     | 139   | 253    | 1.14     |
|7    | INBON#62            | 99      | 158     | 99     | 130   | 204    | 1.33     |
|8    | B86099-2-1-0K       | 102     | 155     | 101    | 187   | 280    | 2.06     |
|9    | Centinella/MOY      | 103     | 161     | 92     | 144   | 231    | 1.80     |
|10   | GR-24-42            | 101     | 158     | 97     | 150   | 260    | 2.05     |
|11   | Solu Uwa(Std. check)| 103     | 154     | 88     | 164   | 221    | 1.85     |
|12   | Farmer’s variety    | 102     | 160     | 106    | 127   | 232    | 1.95     |

Grand Mean: 101, 157, 97, 155, 253, 1.79
P value: 0.86, 0.56, 0.92, 0.24, 0.28, 0.17
CV(%): 5.44, 2.85, 13.43, 19.22, 22.48, 17.61
LSD(0.05): 12.07, 9.86, 28.58, 65.74, 125.25, 0.69

Note: DTH= Days to heading, DTM= Days to maturity, PH= plant height, NS= Number of spike TN= Tillers Number, SL= Spike length, GY= Grain yield

Table 8. Performance of Barley genotypes evaluated in CVT-Mountain at HCRP,Dolakha in 2017.

| SN  | Name of Genotype | 50%-DTF | 75%-DTM | PH(cm) | SN/m² | SL(cm) | TN/m² | TGD (g) | GY(t/ha) |
|-----|------------------|---------|---------|--------|-------|--------|--------|---------|----------|
|1    | ARUPOS/OY-B-OY   | 96      | 160     | 86.1   | 75.0  | 7.7    | 380    | 54.8    | 1.62     |
|2    | ICB90-096-OAP-2K-OK | 102  | 130     | 87.1   | 88.0  | 7.4    | 226    | 39.55   | 2.94     |
|3    | B86038-1K-2K-OK3  | 110     | 165     | 87.5   | 89.0  | 7.5    | 271    | 37.48   | 1.65     |
|4    | LG51/Xveola-2-77  | 98      | 157     | 90.5   | 95.0  | 7.7    | 285    | 42.04   | 2.90     |
|5    | B86152-2-3-0-OK   | 103     | 161     | 85.1   | 102   | 8.1    | 205    | 35.86   | 2.50     |
|6    | ICB90-0203-OAP-2K-OK | 102 | 161     | 88.8   | 103   | 7.9    | 286    | 54.83   | 2.08     |
|7    | CENTINELLA/MOY   | 102     | 161     | 86.3   | 114   | 8.0    | 166    | 40.37   | 2.00     |
|8    | ICBB88-0160-1K-4K-OK | 101  | 162     | 92.5   | 120   | 8.0    | 214    | 39.44   | 3.06     |
|9    | B90K-007-0-2-2-0-OK | 104  | 163     | 88.8   | 124   | 7.2    | 261    | 40.27   | 3.17     |
|10   | B86099-1K-2K-OK   | 104     | 162     | 88.8   | 124   | 7.2    | 261    | 40.27   | 3.17     |
|11   | NB-HCRP-101       | 99.0    | 152     | 87.0   | 130   | 7.7    | 162    | 50.37   | 0.661    |
|12   | NB-HCRP-102       | 112     | 163     | 83.6   | 136   | 8.1    | 328    | 40.95   | 1.07     |
|13   | NB-HCRP-103       | 115     | 164     | 82.8   | 139   | 8.9    | 227    | 46.03   | 0.616    |
|14   | NB-HCRP-104       | 116     | 162     | 86.6   | 140   | 7.7    | 212    | 48.22   | 1.18     |
|15   | Farmer’s variety  | 104     | 168     | 95.7   | 142   | 7.3    | 219    | 41.14   | 2.18     |
|16   | Solu Uwa(Std. check variety) | 96.0 | 179 | 86.3 | 162 | 7.7 | 141 | 34.59 | 1.75 |

Grand mean: 104, 161, 86.4, 117.5, 7.7, 241, 42.61, 2.01
CV%: 4.5, 9.3, 11.9, 26.5, 13.7, 29.4, 6.2, 37.9
P value: 0.001, 0.252, 0.51, 0.09, 0.893, 0.022, 0.001, 0.001
LSD(0.05): 14.77, - , - , - , - , 225.1, 8.399, 2.42

Note: DTH= Days to heading, DTM= Days to maturity, PH= plant height, NS= Number of spike TN= Tillers Number, SL= Spike length, NR= Row number, TGD= Thousand Grain Weight, GY= Grain yield
Table 9. Performance of Barley genotypes evaluated in CVT-Mountain at HCRP,Dolakha in 2018.

| SN | Genotypes                      | 50% DTH | 75% DTM | PH(cm) | NS/m² | SL(cm) | TN/m² | TGW | GY(t/ha) |
|----|--------------------------------|---------|---------|--------|-------|--------|-------|-----|----------|
| 1  | INBON P#3                      | 104     | 171     | 61     | 130   | 7.9    | 160   | 59  | 1.45     |
| 2  | NB-HCRP-102                    | 96      | 168     | 98     | 121   | 6.7    | 131   | 53  | 0.59     |
| 3  | NB-HCRP-103                    | 104     | 162     | 93     | 191   | 8.5    | 203   | 55  | 0.96     |
| 4  | NB-HCRP-104                    | 100     | 160     | 109    | 219   | 8.5    | 259   | 39  | 1.17     |
| 5  | B90K-004-0-1-2-2-2-0K           | 105     | 164     | 112    | 200   | 7.9    | 231   | 37  | 0.98     |
| 6  | B86160-1-1-0-0K                 | 103     | 165     | 113    | 282   | 8.1    | 309   | 53  | 1.44     |
| 7  | B90K-007-0-2-2-0-0K             | 112     | 171     | 104    | 163   | 7.6    | 209   | 37  | 1.50     |
| 8  | Solu Uwa(Std. check variety)   | 98      | 168     | 99     | 150   | 8.0    | 166   | 56  | 0.48     |
| 9  | Farmer’s variety               | 118     | 170     | 86     | 131   | 7.7    | 147   | 47  | 1.13     |
| 10 | INBON P#17                     | 118     | 170     | 92     | 112   | 9.0    | 114   | 51  | 0.84     |
| 11 | ARUPOS/OY-B-OY                 | 115     | 169     | 91     | 133   | 8.2    | 180   | 52  | 0.17     |
| 12 | ICB90-0196-OAP-2K-0K           | 103     | 164     | 134    | 139   | 7.6    | 168   | 42  | 1.00     |
| 13 | B86152-2-3-0-0K                | 118     | 166     | 114    | 186   | 8.9    | 206   | 37  | 1.44     |
| 14 | ICB90-0203-0OAP-2K-0K          | 94      | 156     | 99     | 188   | 7.7    | 206   | 39  | 1.72     |
| 15 | Muktinath(Coll#112-14)         | 96      | 156     | 88     | 154   | 6.6    | 177   | 29  | 3.62     |
| 16 | NB-HCRP-101                    | 114     | 164     | 121    | 194   | 6.6    | 175   | 45  | 1.62     |

|                | Grand Mean                      | 106     | 165     | 101    | 168   | 7.9    | 190   | 46  | 1.26     |
|                | P value                         | 0.00    | 0.00    | 0.02   | 0.10  | 0.03   | 0.01  | 0.00| 0.01     |
|                | CV(%)                           | 6.07    | 2.41    | 18.29  | 34.79 | 10.76  | 26.71 | 4.32| 65.97    |
|                | LSD(0.05)                       | 10.75   | 6.63    | 30.76  | 97.68 | 1.41   | 84.71 | 1.64| 1.38     |

Note: DTH= Days to heading, DTM= Days to maturity, PH= plant height, NS= Number of spike TN= Tiller number, SL= Spike length, TGW= Thousand Grain Weight, GY= Grain yield
Table 10. Combined Performance of Barley genotypes evaluated in CVT-Mountain at HCRP, Dolakha in 2018.

| S   | Genotypes                  | 50%DT H | 75%DT M | PH(cm) | NS/m² | SL(cm) | TN/m² | TGW | GY(t/ha) |
|-----|----------------------------|---------|---------|--------|-------|--------|-------|-----|----------|
| 1   | NB-HCRP-102                | 104     | 166     | 91     | 129   | 7      | 230   | 34  | 0.83     |
| 2   | NB-HCRP-103                | 110     | 163     | 88     | 165   | 9      | 215   | 37  | 0.81     |
| 3   | NB-HCRP-104                | 108     | 161     | 98     | 180   | 8      | 236   | 34  | 1.18     |
| 4   | B90K-007-0-2-2-0-0K        | 108     | 167     | 86     | 142   | 7      | 239   | 27  | 2.14     |
| 5   | Solu Uwa (Std. check variety) | 97     | 174     | 93     | 156   | 8      | 154   | 31  | 1.12     |
| 6   | Farmer’s variety           | 111     | 169     | 91     | 137   | 8      | 183   | 32  | 1.66     |
| 7   | ARUPOS/OY-B-OY             | 106     | 165     | 89     | 104   | 8      | 280   | 40  | 0.90     |
| 8   | ICB90-0196-OAP-2K-OK       | 103     | 147     | 111    | 114   | 8      | 197   | 30  | 1.97     |
| 9   | B86152-2-3-0-0K            | 111     | 164     | 100    | 144   | 9      | 206   | 27  | 1.97     |
| 10  | ICB90-0203-OAP-2K-0K       | 98      | 159     | 94     | 146   | 8      | 246   | 37  | 1.90     |
| 11  | NB-HCRP-101                | 107     | 158     | 104    | 162   | 7      | 169   | 36  | 1.12     |

Grand Mean 106 163 95 143 8 214 33 1.42
P value 0.84 0.31 0.60 0.32 0.19 0.63 0.48 0.30
CV(%) 8.80 5.10 12.18 19.02 6.82 27.20 129.5 43.45
LSD(0.05) 20.69 18.49 25.72 60.73 1.18 9 1 1.37

Note: DTH= Days to heading, DTM= Days to maturity, PH= plant height, NS= Number of spike TN= Tiller Number, SL= Spike length, TGW= Thousand Grain Weight, GY=Grain yield
Table 11. Performance of Barley genotypes evaluated in FFT-Mountain at HCRP, Dolakha in 2017.

| SN | Name of Genotype | 50% DTH | 75% DTM | PH (cm) | NS/m² | RN/Head | TN/m² | TGW (g) | GY (t/ha) |
|----|------------------|---------|---------|---------|--------|----------|--------|----------|-----------|
| 1  | NB-1003-37/1034  | 102     | 162     | 71.9    | 167    | 6.0      | 230    | 40.83    | 1.72      |
| 2  | Xveola -45       | 109     | 164     | 88.1    | 153    | 6.0      | 261    | 40.7     | 2.04      |
| 3  | NB-1003-37/903   | 110     | 165     | 78.3    | 155    | 6.0      | 226    | 42.61    | 2.23      |
| 4  | Xveola -38       | 106     | 163     | 82.1    | 118    | 6.0      | 215    | 38.62    | 1.27      |
| 5  | Soluuwa (Std. check variety) | 90.0 | 157 | 73.5 | 78.0 | 6.0 | 179 | 36.73 | 1.58 |
| 6  | Farmer’s variety | 85.7 | 158 | 75.3 | 117 | 6.0 | 224 | 37.25 | 1.85 |
| 7  | Xveola -2        | 93.3 | 160 | 87.1 | 192 | 6.0 | 309 | 40.48 | 1.77 |
|    | Grand mean       | 99.5   | 161     | 79.5    | 140    | 6.0      | 235    | 39.60    | 1.78      |
|    | CV%              | 10.4   | 1.2     | 8.6     | 30.5   | -        | 22.6   | 6.1      | 15.9      |
|    | P value          | 0.070  | 0.001   | 0.070   | 0.095  | -        | 0.190  | 0.008    | 0.028     |
|    | LSD (0.05)       | 7.406  | -       | -       | -      | -        | 6.298  | 1.09     |

Note: DTH= Days to heading, DTM= Days to maturity, PH= plant height, NS= Number of spike, RN= Row number, TN= Tillers Number, SL= Spike length, TGW= Thousand Grain Weight, GY=Grain yield.

Table 12. Performance of Barley genotypes evaluated in FFT-Mountain at HCRP, Dolakha in 2018.

| SN | Genotypes       | 50% DTH | 75% DTM | PH (cm) | NS/m² | TN/m² | SL(cm) | GY (t/ha) |
|----|-----------------|---------|---------|---------|--------|--------|--------|-----------|
| 1  | Xveola-45       | 109     | 167     | 95      | 151    | 191    | 7      | 2.18      |
| 2  | Muktinath(Coll#112-14) | 109 | 167 | 96 | 143 | 178 | 9 | 2.64 |
| 3  | Solu Uwa(std check) | 88 | 146 | 84 | 134 | 148 | 7 | 1.42 |
| 4  | Local jau/Uwa   | 95      | 164     | 104     | 124    | 144    | 6      | 1.78      |
| 5  | CENTINELLA/MOY  | 96      | 159     | 90      | 127    | 165    | 8      | 2.69      |
| 6  | ICB88-0160-1K-4K-0K | 100 | 159 | 92 | 134 | 149 | 7 | 2.58 |
| 7  | LG51/Xveola-2-77 | 94      | 149     | 100     | 106    | 133    | 8      | 3.24      |
|    | Grand Mean      | 99      | 159     | 94      | 131    | 158    | 7      | 2.36      |
|    | P value         | 0.00    | 0.00    | 0.18    | 0.85   | 0.45   | 0.00   | 0.11      |
|    | CV (%)          | 5.18    | 1.01    | 8.78    | 29.35  | 22.13  | 5.93   | 29.98     |
|    | LSD (0.05)      | 9.10    | 2.84    | 0       | 0      | 1.51   | 0      |

Note: DTH= Days to heading, DTM= Days to maturity, PH= plant height, NS= Number of spike TN= Tillers Number, SL= Spike length, GY=Grain yield.
Table: Mean climate data of the experimental site (2017 and 2018)

| Month    | Maximum Temp (°C) | Minimum Temp (°C) | Total Rainfall (mm) |
|----------|-------------------|-------------------|---------------------|
| January  | 18.15             | 6.75              | 22.6                |
| February | 22.15             | 9                 | 54                  |
| March    | 22.75             | 11.15             | 49                  |
| April    | 25.75             | 13.75             | 86.3                |
| May      | 26.75             | 14.65             | 234.65              |
| June     | 27.4              | 18                | 383.15              |
| July     | 26.5              | 18.75             | 524.8               |
| August   | 27.25             | 18.5              | 428.25              |
| September| 27.75             | 17.85             | 238.2               |
| October  | 27.55             | 11.9              | 56                  |
| November | 23.45             | 9.55              | 0                   |
| December | 20.95             | 8                 | 0                   |