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1. Introduction

To build up a database on the soil nutrient status of the major crops in the country to develop a proper fertilizer recommendation rate for crops, soil samples are being collected from the potato maize based farming system in the Eastern Region Dzongkhags, wetland farming system in Punakha-Wangdi valley, and potato based system in Bumthang Dzongkhag. Soil samples will be collected once every two to three years from the same areas. The sampled households are interviewed on their soil fertility management practices, cropping pattern and crop yields.

Trashigang Dzongkhag in the east is the major potato growing Dzongkhags followed by Pema Gatshel and Monggar Dzongkhags. Though potatoes are grown throughout the Dzongkhag, as it is the major source of income for the farmers, the most intensively cultivated areas under Trashigang Dzongkhag are Kanglung, Khaling, Nanong, Yangneer and Thrimshing geogs.

Between 16th November and 15th December 2002, the staff of National Soil Services Centre (NSSC) together with the staff from RNRRC-Khangma, collected soil samples from Khaling geog under Trashigang Dzongkhag.

2. Method

The group collected the soil samples from the farmers' fields based on the list prepared by the village tshokpas and chipons as the EA was busy with the survey team. The farmers were explained about the rationale behind collecting soils samples from their fields. Soil samples were collected from the households growing potatoes in two or more langdos (1 langdo= 1350m^2). One composite sample from a minimum of 8-10 sub samples was collected from one field though a composite sample was collected from the clustered fields. Soil samples were collected from the depth of 0-20 cm using a soil auger and put in plastic bags and sealed with a rubber band. The samples were then stored in a room with the open ends and care was taken not to contaminate the soils. These samples were then re-sealed for transportation and submitted to the Soil and Plant Analytical Laboratory (SPAL) for analysis. Aspects, slope angles, altitudes and the GPS readings of the fields were also recorded in the questionnaire form. The analysis of this survey was done using SPSS 11 for windows.

3. Results and discussions

In the first half of the report, the general observations as recorded during the survey are presented while the soil results for each village under this geog is presented in the second half of this report.

3.1 Khaling geog

3.1.1 Total sample households

In Khaling geog, a total of 137 households covering 30 villages were sampled. The highest number of respondents was from Barshon village (16%) followed by Brekha gonpa (13%), Dowzor(11) and Gomchu (10%) villages. Daksa, Pokpong and Gonpa villages had the lowest numbers of respondents. These figures suggested that there were more farmers growing potatoes in Brekha gonpa, Dowzor and Gomchu villages compared to Daksa, Pokpong and Gonpa villages. The various management practices and other site parameters in addition to the soil results are presented below.

3.1.2 Site description:

Altitudes, slopes and aspects of the fields under potato cultivation.

In Khaling geog, about 57% of the sampled plots are located at the medium altitude range (between 2000 and 3000 m.asl) and the rest at the low altitude range (<2000 m.asl). About 38% of the plots are situated on steep slopes (angles between 26-50%) and about 29% on sloping areas while about 24% is on moderately sloping areas. About 44% of the plots are south-westerly aspects and about 23% facing north-east and about 18% facing north-west. About 89% of the sampled areas have small plot sizes (<1 acre) while about 11% have medium acreage (3-6 acres). About 99**%** of the plots under potato are owned only about 1% is shared in by the land less people**.** All the farmers (100%) of this geog grow potatoes in their fields. The farmers of this geog grow all the three varieties of potatoes in addition to their most common local white variety. About 40% of the farmers still grow the local white variety, which was initially introduced to the valley by the Kiplings family from Norway (the Principal of the Khaling Blind School) while few farmers have started growing Desiree and Yusikap. Majority of the farmers (more than 60%) have not changed their seeds for more than the last 15-20 years. More than 90% of the farmers plant their potatoes in January while the rest plant in December. Potato is usually intercropped with maize, which is sown in March (100%).

3.1.3 Potato and maize yield and other management practices.

The farmers assess their own plot fertility based on the yield, soil type and the slope gradient though different farmers have their own justifications for assessing their plots, which varies from village to village and from household to household.

From Figure 1 it can be observed that though the maximum yield (tons/acre) is obtained from sloping, gently sloping and moderately sloping and south and south west facing areas, the majority of the plots are located in the steep, sloping and moderately sloping areas with south west and north east facing aspects.

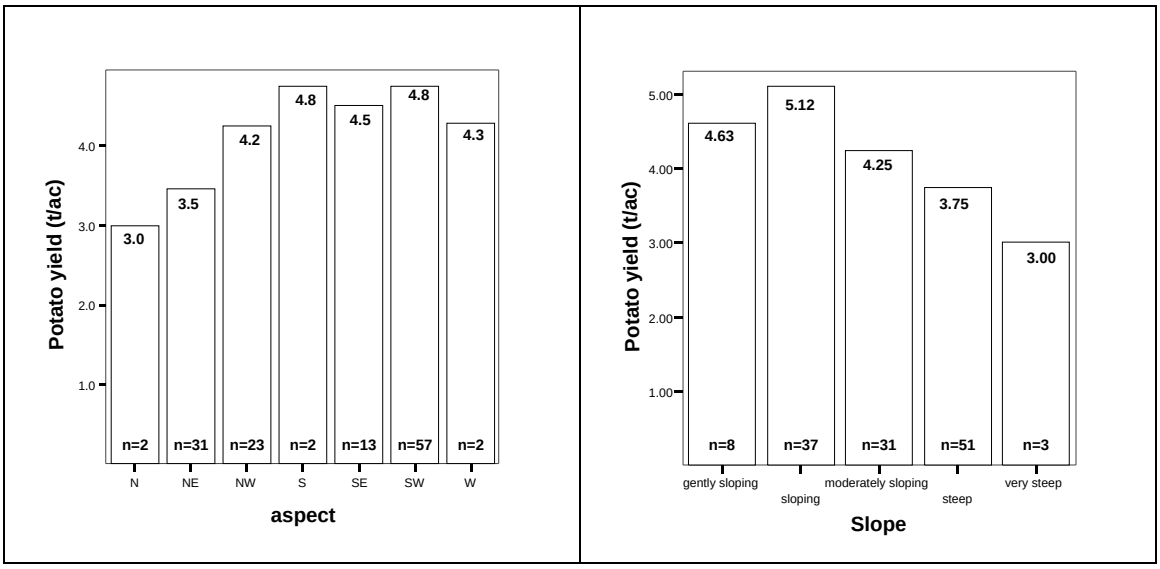

Figure 1 Potato yield in relation to aspect and slope of the plots.

As in any other village or geog in the east, potato is usually intercropped with maize. Maize is sown about a month after potato. Under favorable growing seasons, crop management and variety, the potato yield can vary from 16-20t/ac[i] though on an average, the yield is about 7-8 t/ac**.** The highest potato yield is recorded from one farmer in Chhema village (7.2t/ac) followed by Dowzor village (6.0t/ac) while Brekha gonpa reported the least yield (2.5t/ac) though the average potato yield for Khaling geog is 4.3t/ac. The highest maize yield is recorded form Pokpong (2.8t/ac) followed by Rashiwung (2.4t/ac) and Wungka chema (1.6t/ac) villages while the lowest yield is reported from Day pangthang (0.5t/ac) and Barshon (0.6t/ac). On an average, the maize yield for this geog is 1.12t/ac. (see figure 2).

[i] *According to FAO reports.*

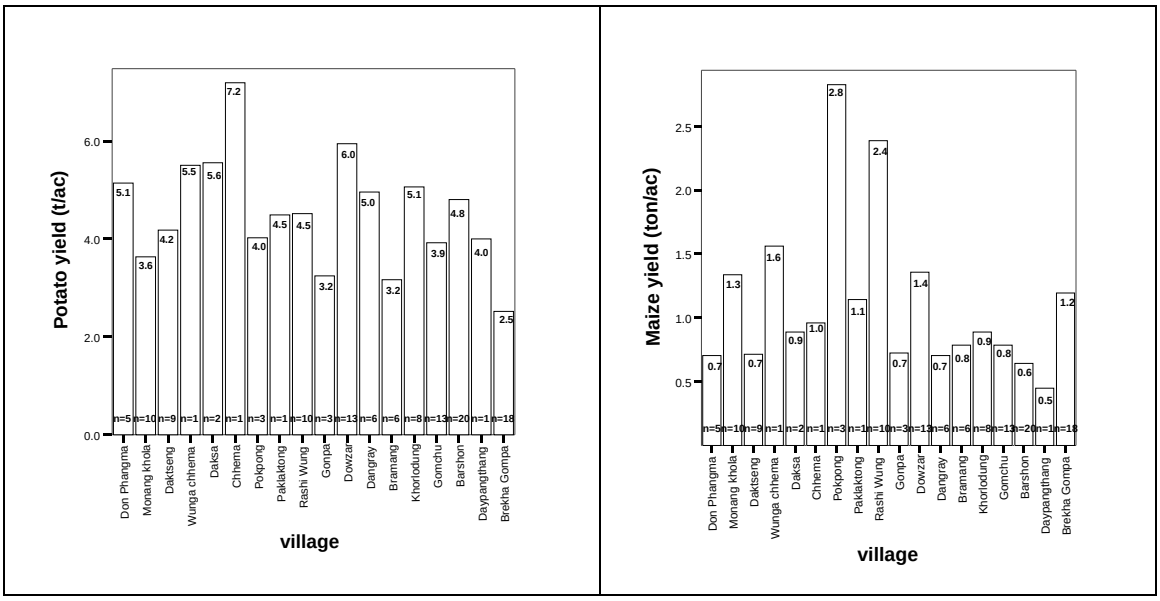

Figure 2 Average potato and maize yield (t/acre) under each village.

In Khaling geog, about 53% of the farmers apply Farm Yard Manure (FYM) to their fields with an average application of 5.3 t/ac. This amount of FYM applied with a dry matter content of 50% is equivalent to 2.7t/ac **(which is equivalent to 32kg N/ac, 7kg P/ac and 45kg K/ac).** FYM is usually broadcasted in the fields and incorporated into the soil by ploughing during land preparation. In addition, some farmers also tether cattle in the fields after crop harvest for almost a month. The highest rate of FYM application (t/ac) is one farmer from Daypangthang village (7.5t/ac) followed by Chhema (7.2t/ac) and Rashi wung (6.6t/ac) villages while Gomchu, Khorldung anf Bramang villages applied the least amount of FYM (<0.5t/ac) (figure 3). The majority (72%) of the farmers of this geog tether their cattle in the fields while 28% of them don't tether at all. About 96% of the farmers burn their trash after the crop harvest prior to land preparation. The weeding frequency of the potato ranges from once to thrice though about 69% of them weed twice while another 19% of the farmers weed only once and about 12% of the farmers even weed thrice.

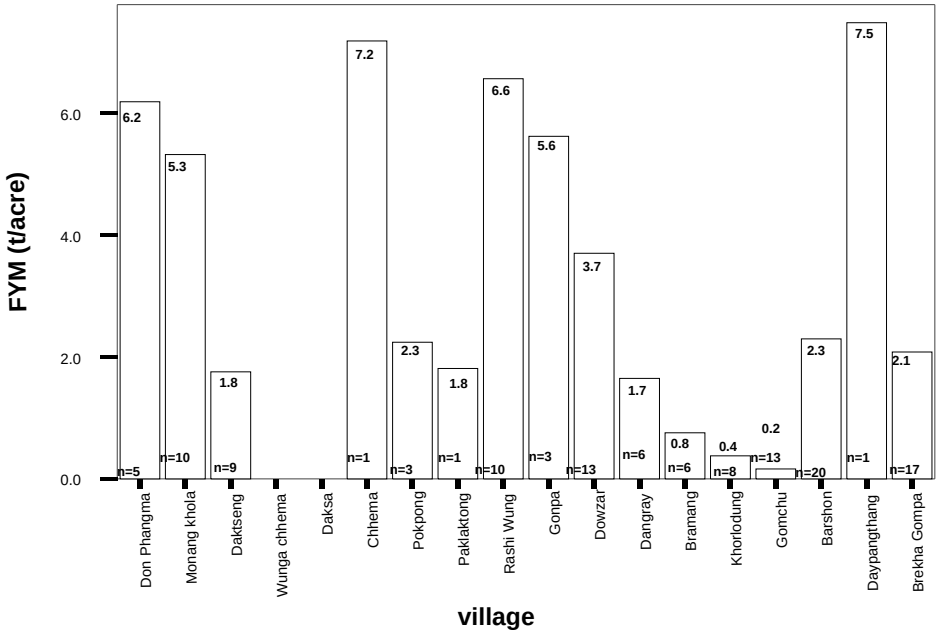

Figure 3 Amount of FYM applied (t/acre) under each village.

The survey findings indicate that 97% of the farmers apply inorganic fertilizers such as urea and suphala in addition to FYM application and tethering of cattle in the fields. The farmers of this geog do not at all apply SSP. About 89**%** of the farmers of this geog apply Supahala to potato (basal dose) while only about 10% of them apply urea as basal in potato and about 94% of them apply urea to maize as top dress. The average amount of suphala applied by the farmers of Pokpong vilage is more than the rest of the other villages while Barshon and Brekha gonpa applied the least (Figure 4). On an average, the farmers of this geog apply about 120kg/ac suphala, which is 18kg N per acre, 18kg P per acre and 18kg K per acre. On an average, about 175kg/ac of urea is applied to potato by about 10% of the farmers of this geog. The farmers of this geog do not apply SPP while about 94% of the farmers on an average apply 129kg/ac urea (i.e. about 61kg N per acre) as top dress to maize. The basal fertilizer is applied in a band while urea top dress, broadcasted near the plants is mostly applied in a single dose and is not incorporated into the soil.

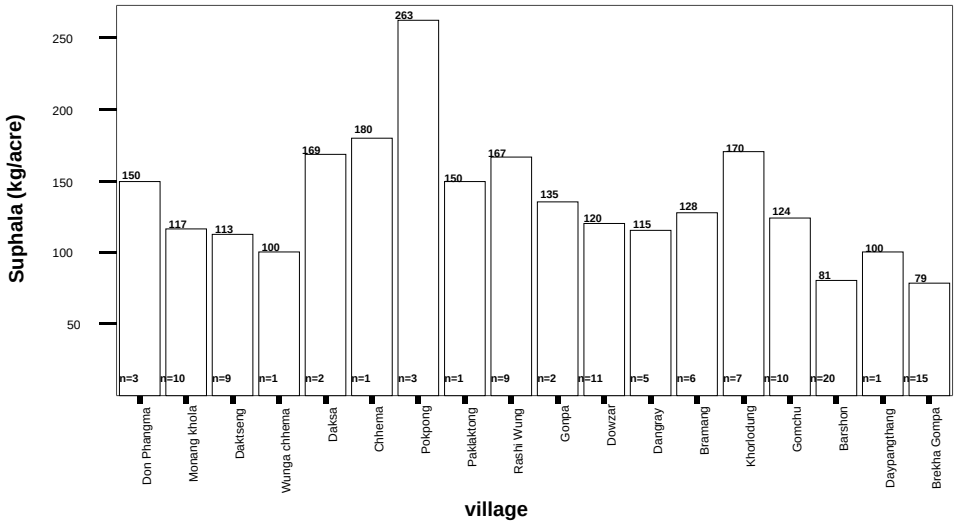

Figure 4 Amount of Suphala (kg/acre) applied under each village.

From the following figure 5, it can be seen that not all the villages apply urea to potato. Only few farmers from Monangkhola, Rashiwung, Dowzor, Dangray, Khorldung, Gomchu and Brekha gonpa apply urea to potato. As reported earlier, the average rate is about 175kg/acre of urea with the highest application rate from Gonpa followed by Paklaktong. Khorldung, Monangkhola and Rashiwung applied the least.

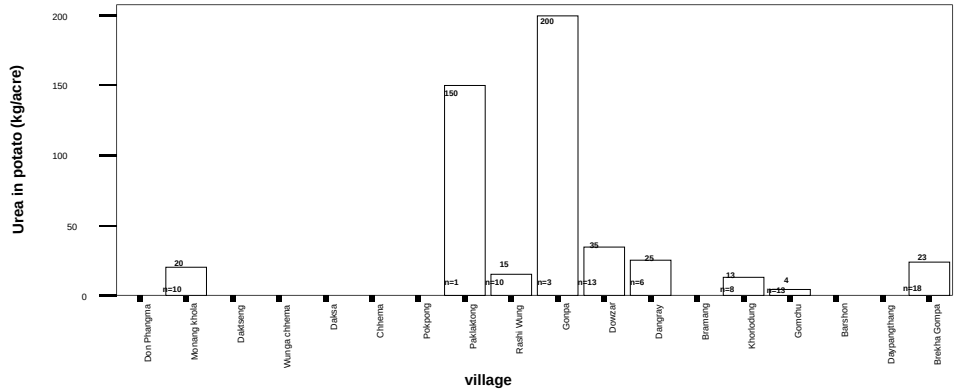

Figure 5 Amount of urea (kg/acre) applied to potato under each village

From the following figure 6, it can be seen that on an average the highest amount of urea application to maize is from Gonpa village (315kg/ac) followed by Dangray (279kg/ac) and Chhema (240kg/ac) villages while the farmers of Donphangma (65kg/ac), Barshon (69kg/ac) and Brekha gonpa (77kg/ac) applied the least amount of urea to maize.

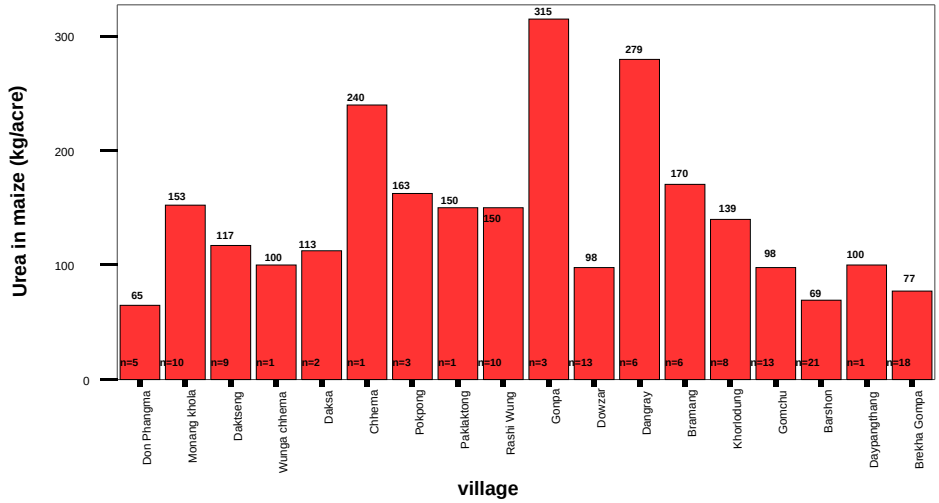

Figure 6 Amount of urea (kg/acre) applied in maize under each village

About 65% of the framers apply urea in a single dose while about 22% of the farmers apply in two split applications i.e. once when the maize is of “knee high stage” of growth and the second application at “pre-tasselling stage”. All the farmers of Wungka chhema, Daksa, Pokpong, Paklaktong, Gonpa and Bramang villages apply urea as split application while majority of the farmers of Daktseng, Rashiwung, Dowzor and Dangray also apply in split doses. All the farmers of Brekha gonpa and Daypangthang villages apply urea in single dose while the majority of the farmers of Barshon, Gomchu, Khorldung and Monangkhola villages apply mostly in a single dose, see figure 7. Though most of the farmers of this geog are aware of the importance of split application of urea, most of them do not practice it due to labor shortage.

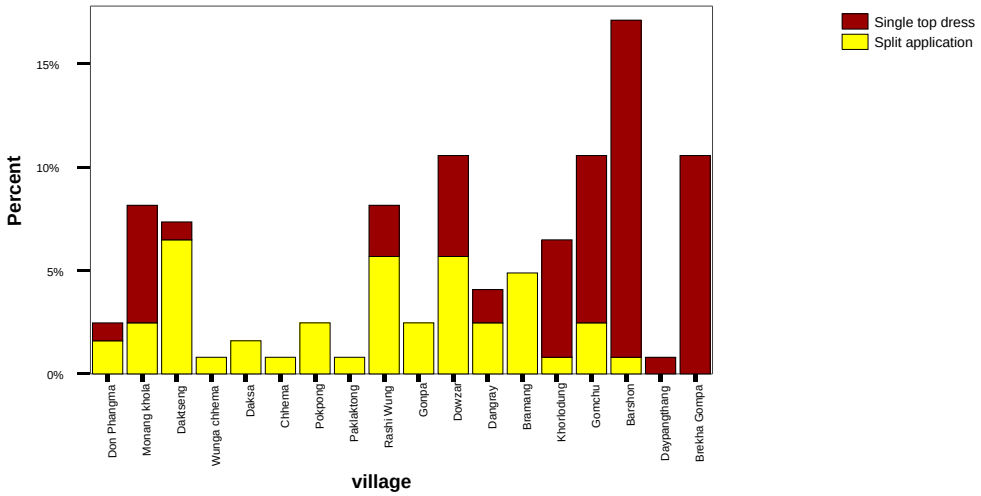

Figure 7 Type of urea applied in maize under each village.

3.1.4 Potato seed

Almost all farmers of this geog have not changed their seeds for more than the last 15-20 years. The farmers who change their seeds do so by exchanging the seeds between the neighbors in a village or between different villages.

3.1.5 Soil results of Khaling geog.

In the soil analysis result, with the exception of soil pH, the classifications are normally categorized as very low, low, moderate, high, and very high. For fertility factors (N, P, K, micronutrients) very low and low classifications indicate a high probability for obtaining a fertilizer response; moderate classifications indicate a fertilizer response may or may not occur; high and very high classifications indicate a fertilizer response is not likely to occur. Crops need all the essential nutrients but not in equal quantities and supplying of only one nutrient i.e. unbalanced nutrient such as urea leads to rapid depletion of soil reserves of other nutrients.

Potato can be grown in most soil types where though its greatest productivity is from a deep, loose, crumbly and well-aerated soil. It does well in slightly acidic soils (pH range of 5.0-5.8) while it is not suitable if the soil pH is either <4.5 or is >7.0. Alkaline soil conditions can adversely affect skin quality and high alkaline soils can also induce micronutrient deficiencies. The soil results of each village under Khaling geog is summarised as follows.

i. Soil result of Donphangma village (see figure 8).

The pH of the soils of this village is of medium (pH 5.5-6.5) range. As any other crops, potatoes also require adequate amount of N, P and K for optimum crop yield although its N and K requirements are high. Potatoes are efficient removers of K.

About 20% of these soils have low available K (40-99mg/kg) while another 20**%** is within the medium range (100mg-200 mg/kg) while the rest have high to very high ranges. More than 60% of these soils have low P ranges and the rest is in the medium range. **These figures suggest that there is a need to apply P and K containing fertilizers to improve the nutrient status of these soils.** The organic matter of these soils is of medium range while the of C:N ratio is high.

The CEC of these soils is of medium range while the BS% is high. Coarse-textured soils lack both nutrient and water holding capacities while fine-textured soils often have structural and infiltration problems. The major soil type is silty clay loam (figure 26). This soil type is of medium textured soil containing less than 40% clay content. However, for light textured soils, a split application of inorganic fertilizers especially urea (as already practiced by some farmers) is advisable.

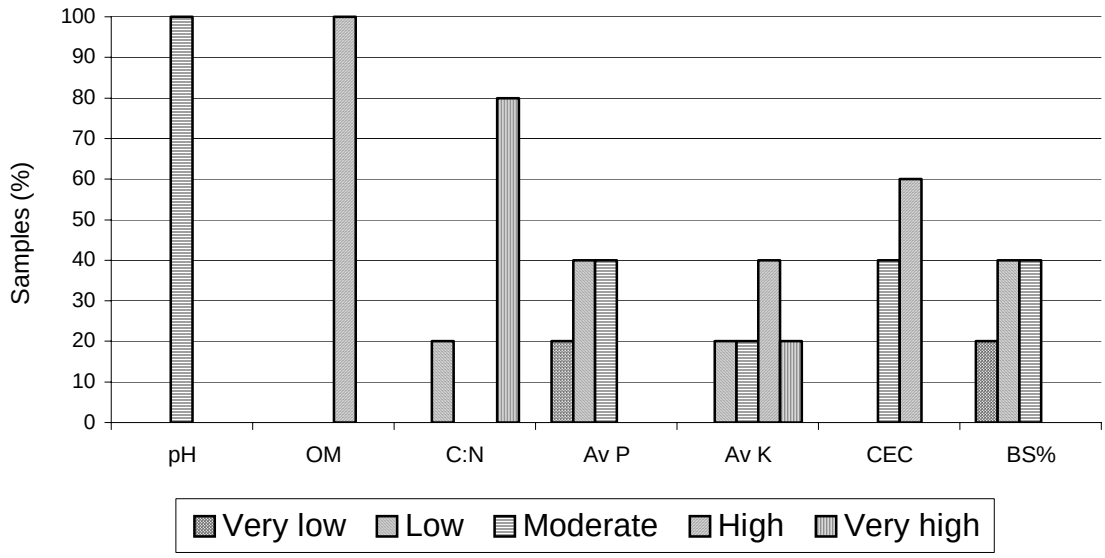

Figure 8 Soil parameters of potato fields in Donphangma village.

ii. Soil result of Daksa village (see figure 9).

The pH of the soils of this village is of medium (pH 5.5-6.5) range. The available K is within the high range while the available P of these soils is within the low to moderate range with 50% in the low range. **This low figure of available P suggests that there is the need to apply P containing fertilizers such as SSP.** All the soils in this village have high organic matter contents with low to very high C:N ratio.

The CEC and the BS% values are within the medium range. Coarse-textured soils lack both nutrient and water holding capacities while fine-textured soils or heavy soils often have structural and infiltration problems. The major soil type found in this village is silty loam and silty clay loam (figure 26). These soil types are of medium textured soils containing less than 40% clay content. However, for light textured soils, a split application of inorganic fertilizers especially urea is advisable while infiltration and structural problems are associated with heavy soils.

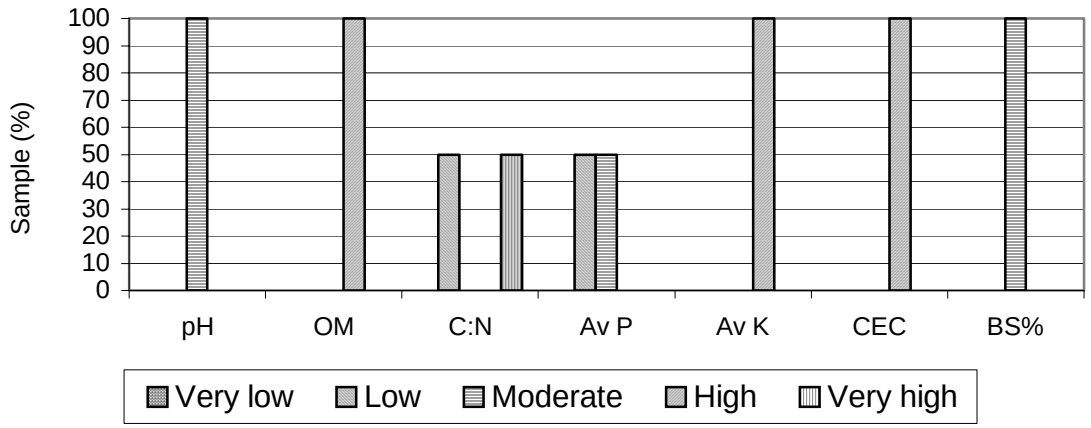

Figure 9 Soil parameters of potato fields in Daksa village.

iii. Soil result of Monangkhola village (see figure 10).

The pH of the soils of this village is mostly within the low (5.0-5.5) to medium (pH 5.5-6.5) range. The available K of these soils is within the low to high range with almost 30% in the low range while the available P of these soils is within the low range with 40% in the very low range. **These low P and K figures suggest the need to apply P and K containing fertilizers such as SSP and MoP respectively to improve the nutrient status of these soils.** All the soils have high organic matter contents while the C:N ratio varies from medium to very high range. The CEC of these soils is mostly within the medium to high range while the BS% range of these soils is mostly within the very low to medium range with 70% in the low range. The major soil types found in this village are is silty clay loam, silty clay, clay loam and to a small extend (about 3%) clay (figure 26).

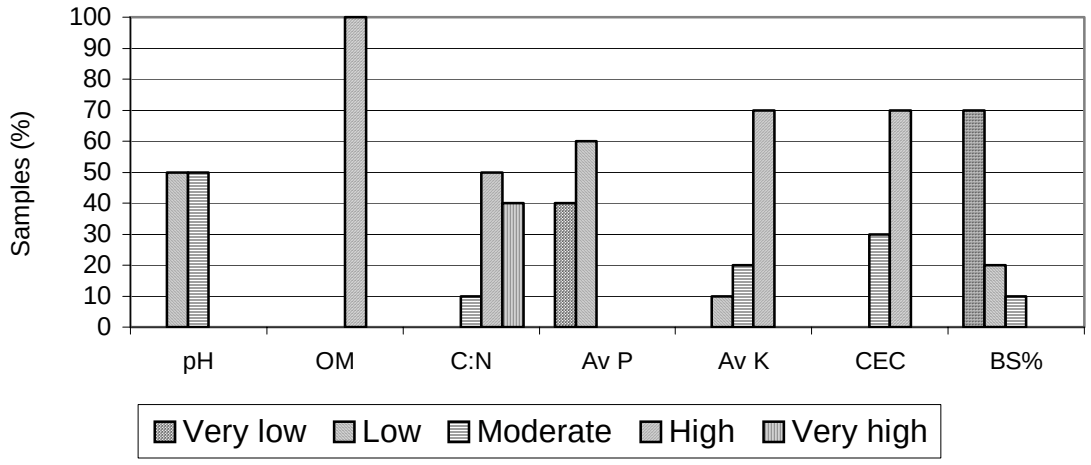

Figure 10 Soil parameters of potato fields in Monangkhola village.

iv. Soil result of Daktseng village (see figure 11).

The pH of the soils of this village is within the low to high range. The available K of these soils is distributed within the low to high range with almost 12% in the low range. The available P ranges from very low to high range with almost 80% in the low range. **This low P figure suggests the need to apply P containing fertilizers such as SSP to improve the P status of these soils**. The organic matter content of these soils is high with C:N ratio ranging from medium to very high range.

The CEC values ranges from medium to high values and the BS% range of these soils is distributed from very low to very high range with more than 75% in the low range. The major soil type is silty clay loam (figure 26).

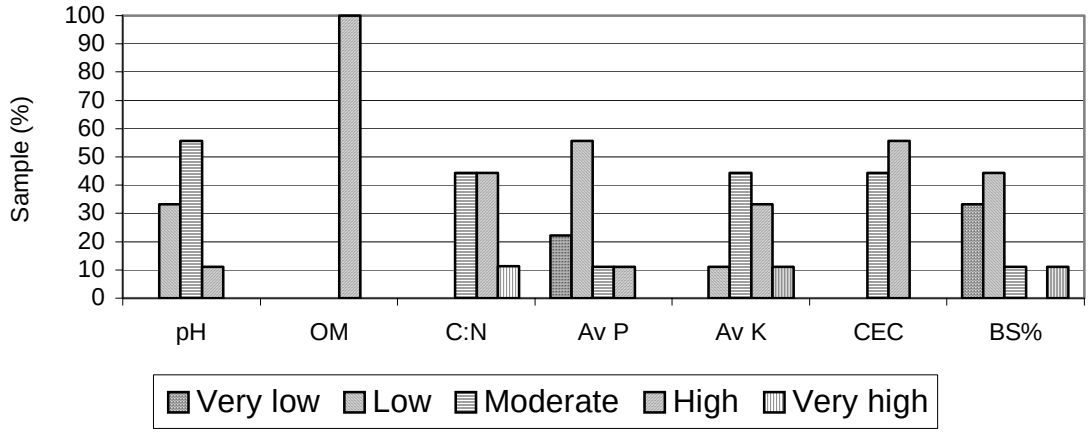

Figure 11 Soil parameters of potato fields in Daktseng village.

v. Soil result of Wungka chhema & Chhema villages (figure 12).

The pH of the soils of this village is mostly within the medium to high range. The available K is within the medium to high range with 50% in the medium range and about 25% in the low range. The available P is high range. Though both the P and K values are fairly within the adequate range it would be advisable to **apply K containing fertilizers such as MoP to improve the K status of these soils as potatoes** could remove sufficient amount of K from the soils. The organic matter content of these soils is high with very high C:N ratio. The CEC of these soils is mostly of low to medium range with 50% in the low range. The BS% range of these soils is within the medium to very high range with 50% in the medium range.

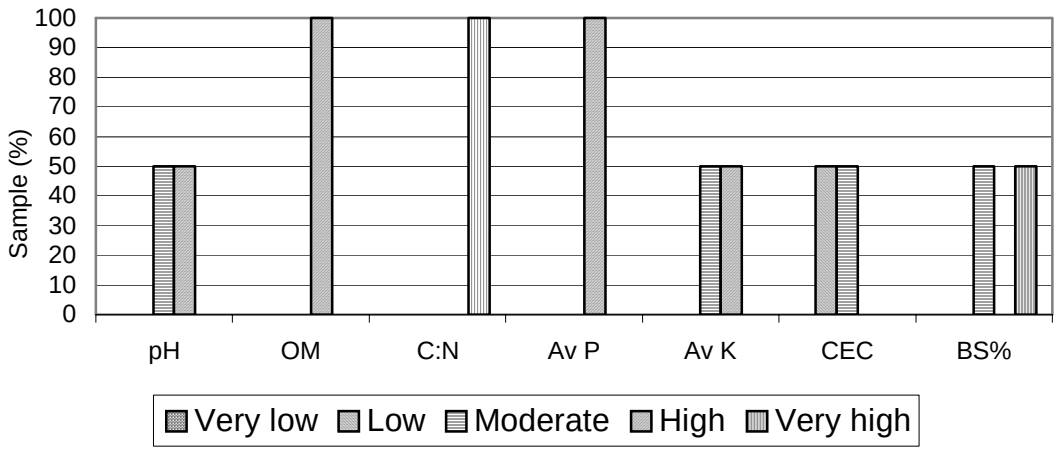

Figure 12 Soil parameters of potato fields in Wungka chhema, Chhema villages.

vi. Soil result of Pokpong & Paklaktong villages (figure 13).

The pH of the soils of this village is mostly within the low to medium range. The available K is in the low to medium (100-199mg/kg) range with 25% in the low range and the available P of these soils is low with 75% in the very low range. **These low K and P figures suggest that there is the need to apply P and K containing fertilizers such as SSP and MoP** to improve the nutrient status of these soils. The organic matter content of these soils is within the moderate to high range while the C:N ratio is equally distributed from low to very high range. The CEC values (of these soils is of medium range while the BS% range of these soils is low. The major soil types of this village is clay and silt loam.

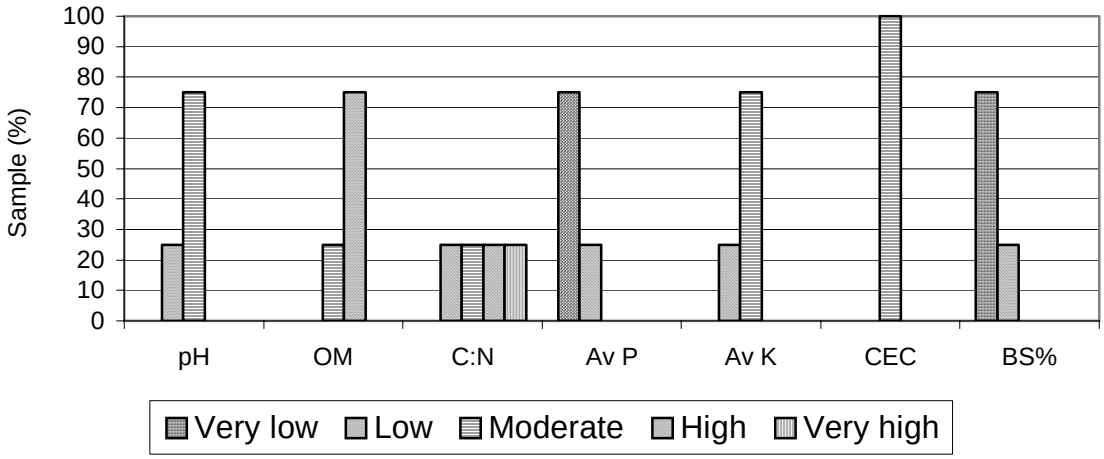

Figure 13 Soil parameters of potato fields in Pokpong & Paklaptong villages.

vii. Soil result of Rashiwung village (see figure 14).

The pH of the soils of this village is mostly within the low to medium range with 20% in the low range. As in any other crops, potatoes also require adequate amount of N, P and K for optimum crop yield although its N and K requirements

are high. Potatoes are efficient removers of K. The available K of these soils ranges from low to very high range with about 10% in the very high range. The available P content also varies from low to high range with 30%in the low range. **This low P figure suggests that there is the need to apply P containing fertilizers such as SSP** to improve the nutrient status of these soils. The organic matter content of these soils is high. The C:N ratio varies from high to very high range. The CEC of these soils is within the low to medium range with 10% in the low range. The BS% of these soils is within the low to high range. Clay loam is the major soil type of Rashiwung village (figure 26).

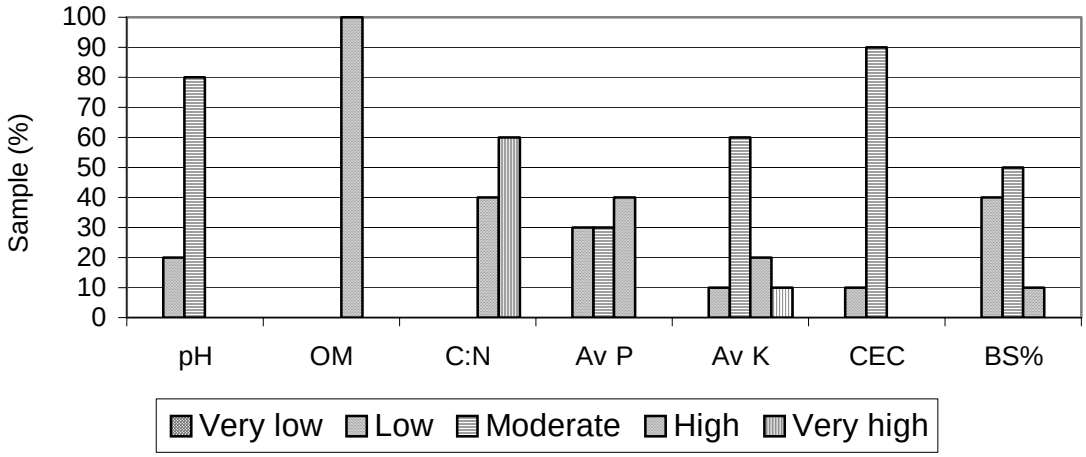

Figure 14 Soil parameters of potato fields in Rashiwung village.

viii. Soil result of Gonpa village (see figure 15).

The pH of the soils of this village is within the low to medium range. The available K is in the medium to very high range. The available P is within the low to high range with 33% each in the in the low, medium and high range. **These low P figure (for Mr. Tashi Norbu) suggest the need to apply P containing fertilizer such as SSP to improve the P status of his soil.** The organic matter content of these soils is of medium to high range and the C:N ratio is also distributed within the medium to very high range (33% each). The CEC of these soils is also distributed within the low to high range (33% each). The BS% range of these soils is within the low to high range with more than 65% in the low range**.** Silty clay is the major soil type of this village (figure18).

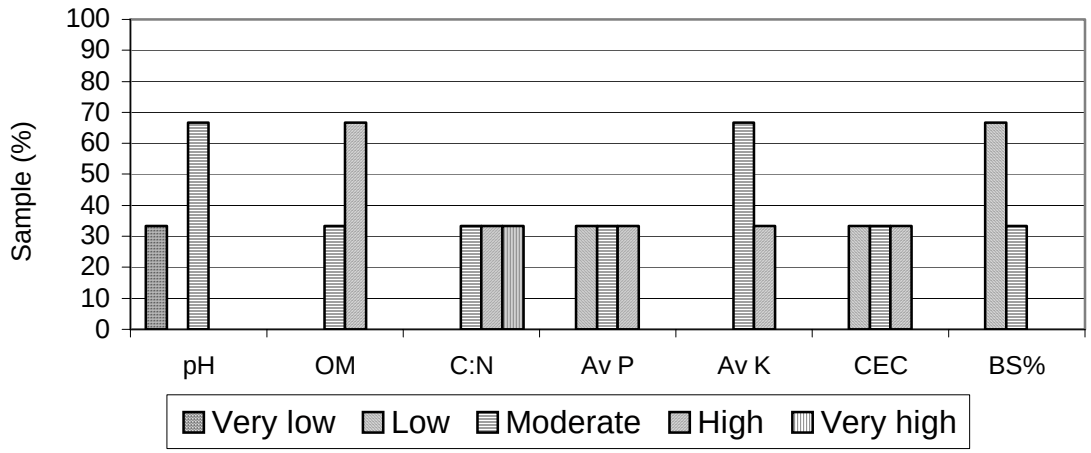

Figure 15 Soil parameters of potato fields in Gonpa village.

ix. Soil result of Dowzor village (see figure 16).

The pH of the soils of this village is within the low to medium range. The available K ranges from low to high range with about 30% in the low range. The available P is within medium to high range with 80% in the high range and the rest 20% in the medium range. The available P content of these soils is within the adequate range though few households have low K values and therefore the need to **apply K containing fertilizer such as MoP** to improve the K status of these soils. The organic matter content of these soils is within the medium to high range. The CEC of these soils is mostly within the low to medium range with 80% of these soils in the low range. In such soils with low CEC all major macro and micronutrients may be required to attain adequate growth and thereby yields. The BS% varies from low to very high ranges. Loam, clay loam and silty loam are the three soil types of this village **(figure 26).** All these soil types are of medium textured soils containing less than 40% clay content.

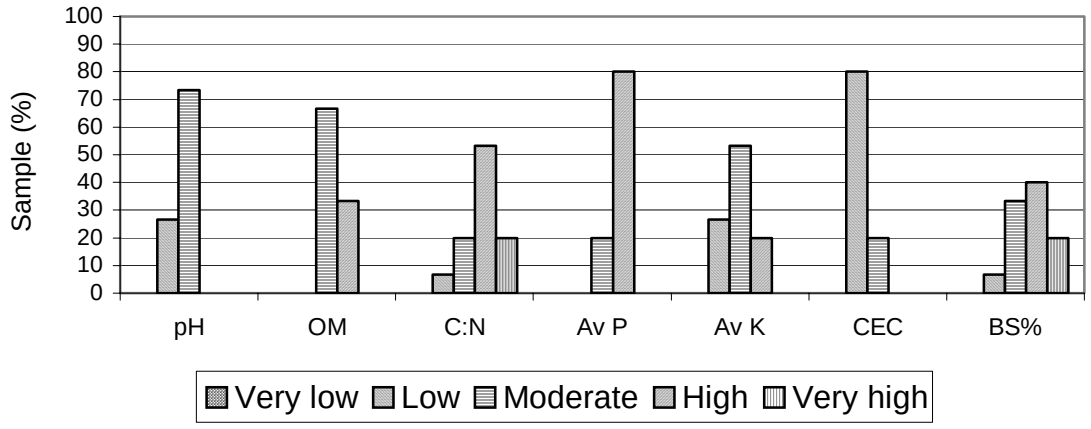

Figure 16 Soil parameters of potato fields in Dowzor village.

x. Soil result of Dangray village (see figure 17).

The pH of the soils of this village varies from very low to high range with about 16% in the very low range. The available K also varies from very low to medium range with 50% in the low range. The available P content of these soils is high. Therefore there is the need to apply **K containing fertilizers such as MoP to improve the K content of these soils.** The organic matter content of these soils is of medium range and the C:N ratio varies from medium to high range. The CEC of these soils is low while the BS% range of these soils is evenly distributed from very low to very high range with about 50% in the low range. In such soils with low CEC all major macro and micronutrients may be required to attain adequate growth and thereby yields. Silty loam is the prominent soil type though loam is also found to a smaller extend.

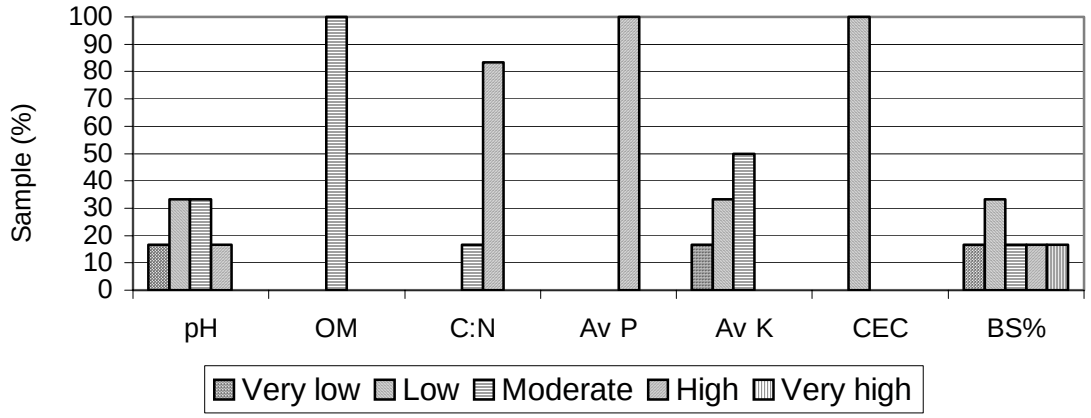

Figure 17 Soil parameters of potato fields in Dangray village.

xi. Soil result of Bramang village (see figure 18).

The pH of the soils of this village ranges from low to medium range. The available K of these soils also varies from very low to high range more than 30% in the low range. The available P is high. In this village, there is the need to apply **K containing fertilizers** since the K values are in the lower range though the P values are quite sufficient. The organic matter content of these soils is of medium range and the C:N ratio is within the medium to very high range. The CEC of these soils is low while the BS% varies from very low to very high values. In such low CEC soils all the major nutrients are required for proper growth and yield.

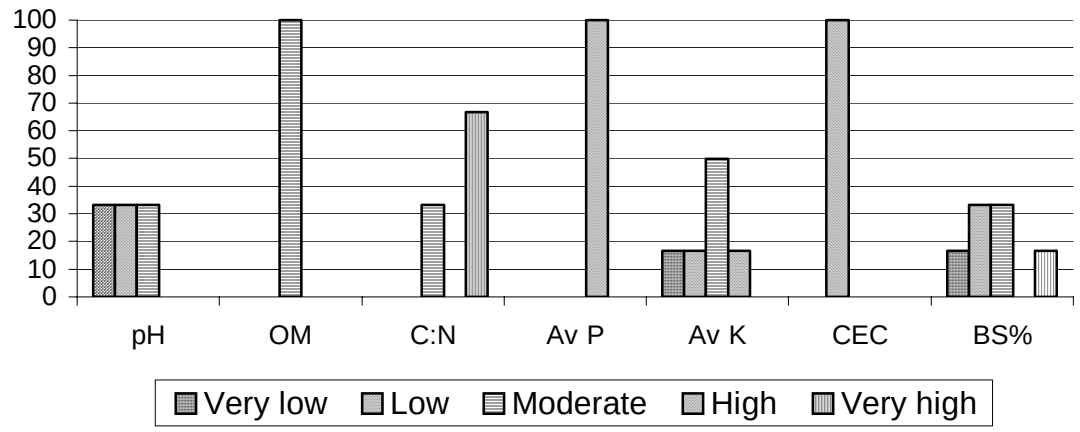

Figure 18 Soil parameters of potato fields in Bramang village.

xii. Soil result of Khorldung village (see figure 19).

The soil pH of this village is of low and medium range. The available K ranges from low to very high values about 12% in the low range and another 25% in the medium range and with more than 67% in the high range. The available P content of these soils is high. With the exception for the few households with low K contents (viz. Mr Chana and Jigme) and for the moderate K values (Am Damchu and Nima), the rest of the farmers have adequate P and the K contents. **Therefore there is the need to apply K containing fertilizers for those with low and medium values only.** The organic matter content of these soils are within the medium to high range with high to very high C:N ratios. The CEC of these soils is within the low to medium range while the BS% range of these soils is range from medium to very high.

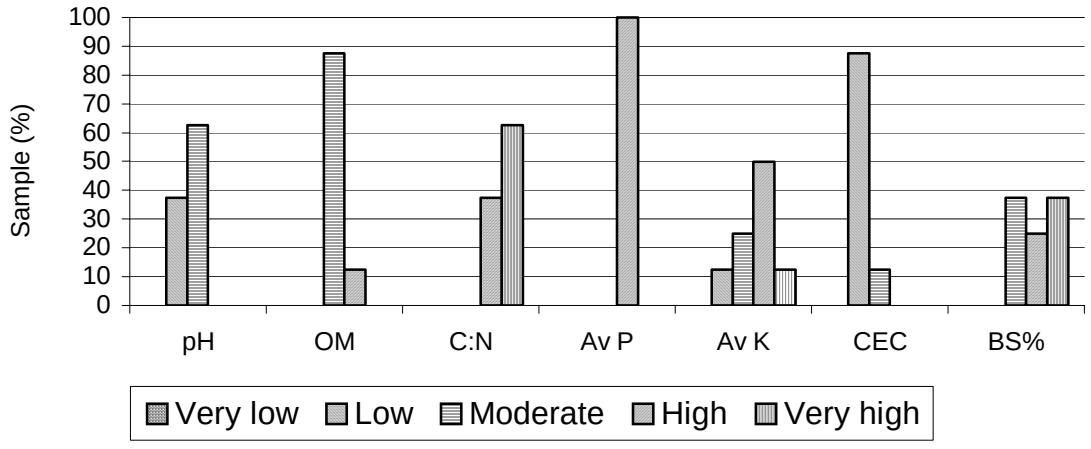

Figure 19 Soil parameters of potato fields in Khorldung village.

xiii. Soil result of Daewong village (see figure 20).

The farmers of this village have stopped growing potatoes for the last 4-5 years due to the problems associated with the workability of these soils. The sol type of this village is that of the deep cracking clays and there fore the farmers find it difficult to work with. They only grow maize in this village. Therefore, from this village only one composite sample was taken.

The pH, available K, BS% of the soils of this village are low. The available P is high while the organic matter and CEC are of medium range while the C:N ratio is very high. For this village, no fertilizer recommendation for potato can be made, as there is no cultivation of potatoes.

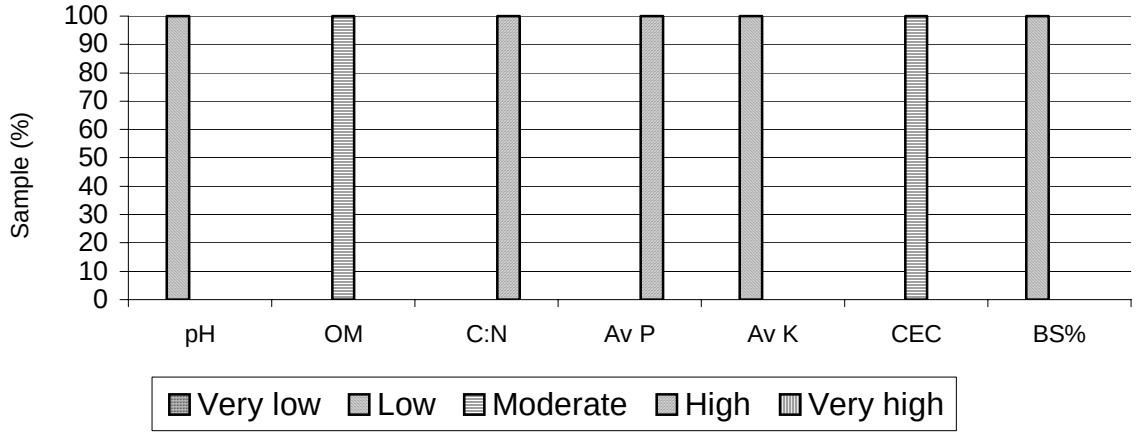

Figure 20 Soil parameters of potato fields in Daewong village.

xiv. Soil result of Gomchu village (see figure 21).

The pH of the soils of this village is within the low to medium range. The available K is in the low to medium range with more than 50% in the low range. The available P of these soils is in the medium to high range with more than 90% in the high range. The available P is of adequate range though there is the need to apply **K containing fertilizer since 50% of these soils have low K values** in addition to the K removal by the crop. The organic matter content of these soils is high within the medium to high range. More than 90% of these soils have low CEC values. The BS% range of these soils varies from very low to very high range.

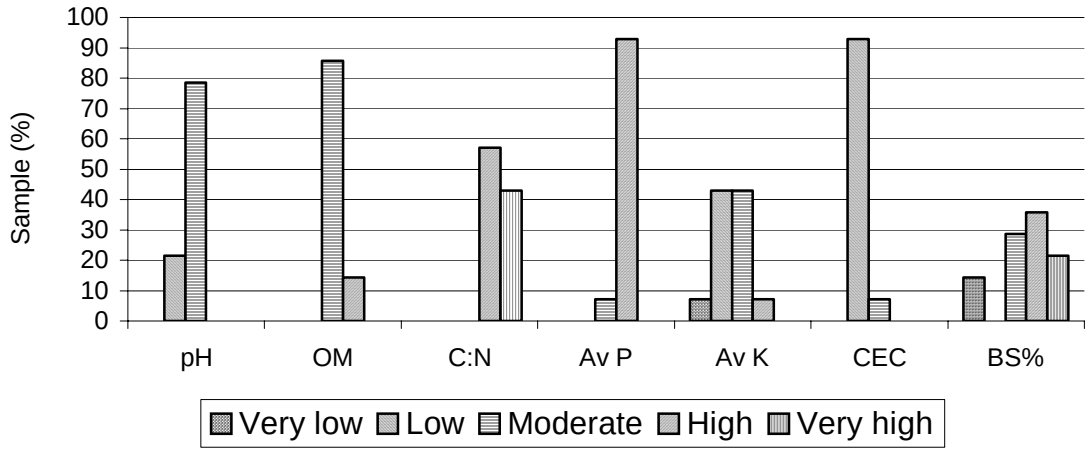

Figure 21 Soil parameters of potato fields in Gomchu village.

xv. Soil result of Barshon (see figure 22).

The pH of the soils of this village varies from low to high range though the majority of them are within the medium range. The available K content of these soils is mostly within the low to high range with more than 35% in the low range and about 40% in the medium range. The available P ranges from low to high values with about 25% in the low range. **These low values of P and K suggest the need to apply P and K containing fertilizers such as SSP and MoP respectively to improve the nutrient status of these soils.** The organic matter content of these soils is of medium to high range with very high C:N ratio. The CEC of these soils is mostly within the low to medium range with 40% in the low range. The BS% range of these soils is distributed ranging from very low to very high values.

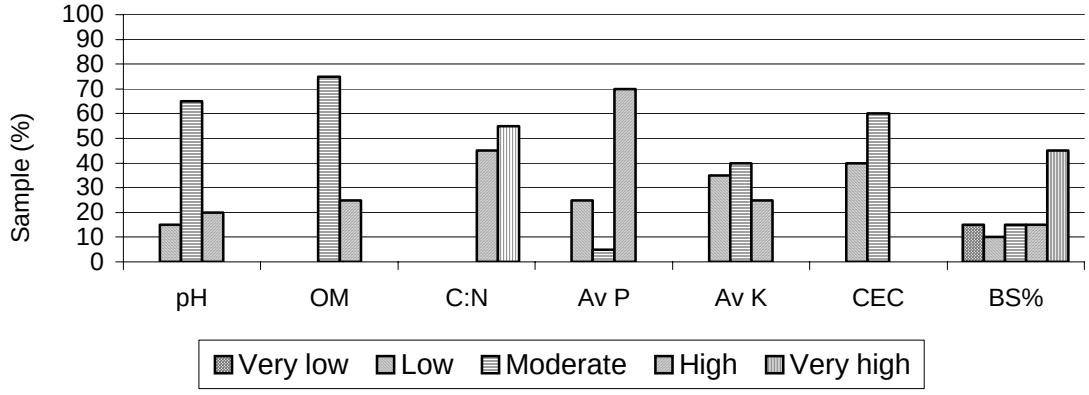

Figure 22 Soil parameters of potato fields in Barshon village.

xvi. Soil result of Daypangthang village (see figure 23).

The pH of the soils of this village is of low. About 50% each of these soils have low and medium available K contents. The available P of these soils is very low.

These figures suggest that there is the need to apply P and K containing fertilizers such as SSP and MoP respectively to improve the nutrient status of these soils. The organic matter content of these soils is high and the C:N ratio is very high. The CEC of these soils is high while the BS% is very low.

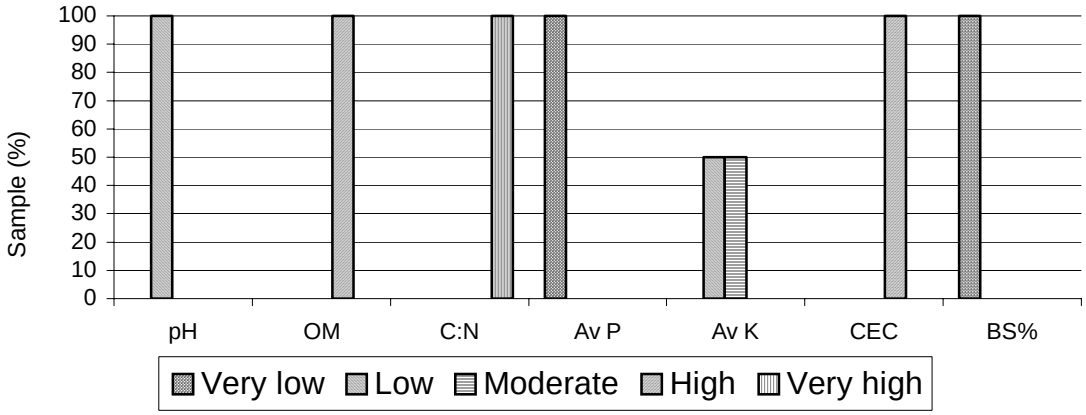

Figure 23 Soil parameters of potato fields in Daypangthang village.

xvii. Soil result of Brekha gonpa village (see figure 24).

The pH of the soils of this village is of medium range though about 6% each have low and high values. The available K varies from very low to high values with more than 55% in the low range. The available is within the very low to medium range with about 50% in the low range. These low figures of P and K suggest that there is a need to **apply P and K containing fertilizers such as SSP and MoP** to improve the nutrient status of the soil. The organic matter content and the C:N ratio is within the moderate to high range. The CEC and the BS% of these soils are within the low to high range.

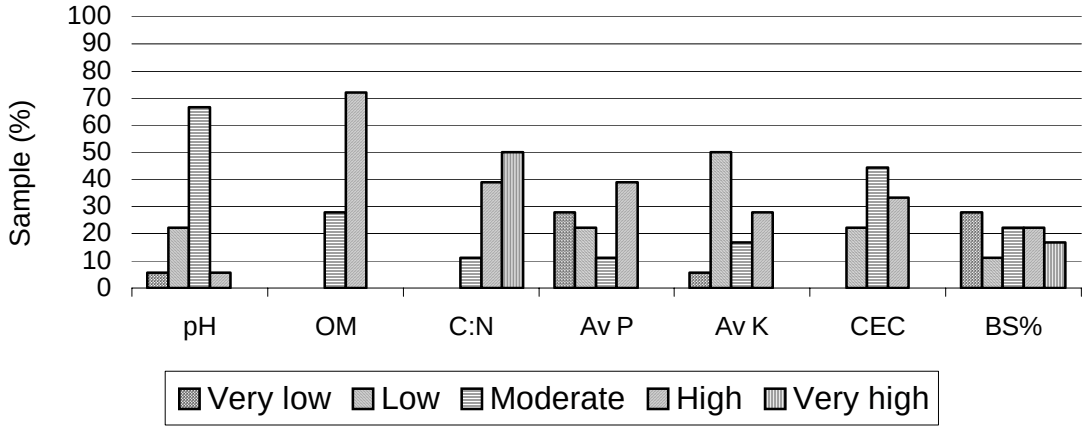

Figure 24 Soil parameters of potato fields in Brekha gonpa village.

xviii. Soil texture of different villages under Khaling geog (see figure 25)

The different soil textures found in each village under Khaling geog is presented in the following figure.

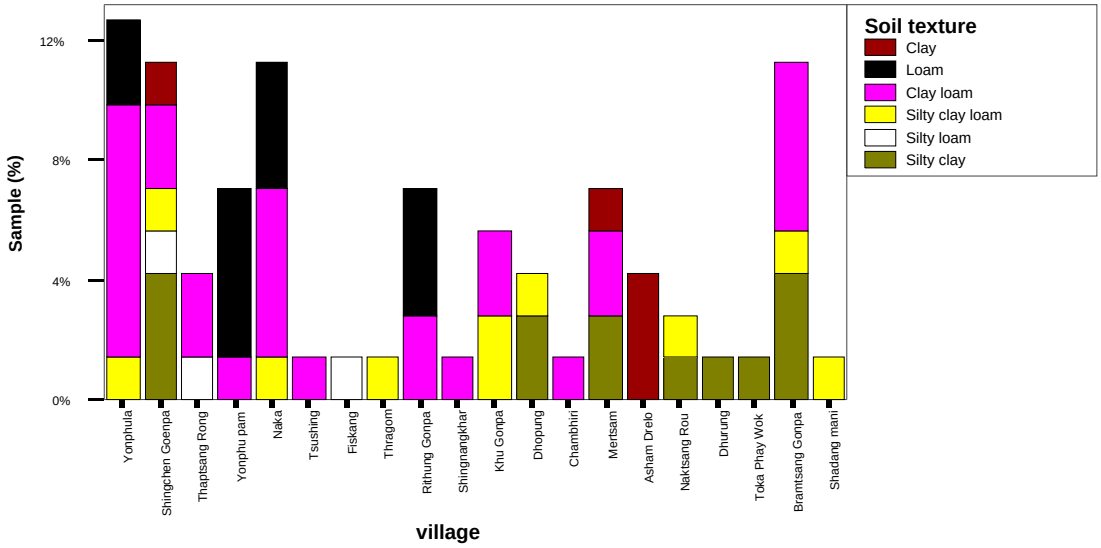

Figure 26 Soil textures of potato fields in different villages (Khaling geog).

The following figure shows the local soil types as classified by the farmers of Khaling geog**.** The most common local soil type is “Munangsa” which as described by the farmers is of medium textured, black humic soil and “Betsisa” a light, loose textured soil is also found in this geog.

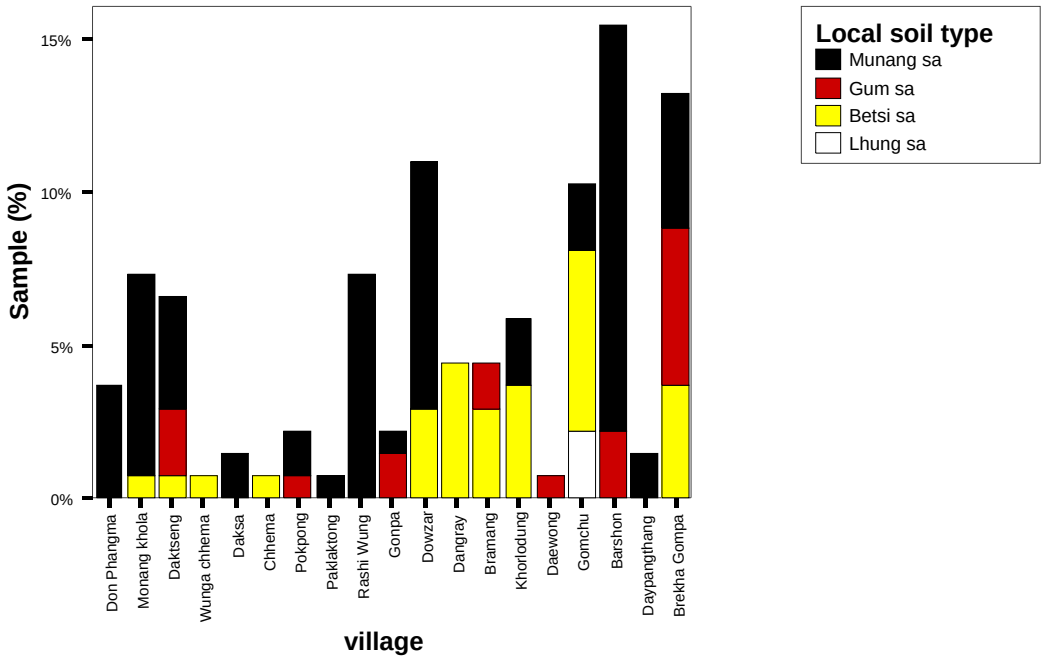

Figure 27 Local soil types found in Khalinggeog.

4. Conclusions

In Khaling geog the potato fields are mostly located at the medium altitude range with the majority of the plots on steep slopes with aspects facing mostly south westerly with small land holdings. Yusikap, the white variety is the most preferred potato variety grown by the farmers, which is mostly planted in the month of January. More than 60% of the farmers have not changed their potato seeds for the last 15-20 years. Potato is intercropped with maize, which is sown within one to two months after planting potato. Majority of the farmers apply FYM to potato at an average rate of 2.78t/acre. Other inorganic fertilizers like suphala in addition to urea is applied to potato and maize. Urea in maize is mostly applied as a single top dress either during the “pre-tasselling” stage or when the plants are of “knee-high” though few farmers apply it in split dose as well. FYM is usually broadcasted prior to ploughing. The average yield of potato and maize is 4.3t/ac and 1.12t/ac respectively. Tethering of cattle is not a common practice while all the farmers burn the crop residues prior to land preparation. Weeding is done at least twice by most of the farmers.

The soil pH is mostly within the moderate range while the available P on an average is high though few villages have low values and K content on an average is of medium range while few villages have low values too. Therefore, the need to improve the soil nutrient status and hence the yield by applying P and K containing fertilizers for those villages with low values. In general, the

organic matter content is high while the CEC and BS% are within the medium range. The soil texture varies from village to village and from plot to plot and therefore a variety of soil types ranging from clay to silty loam is found in this village.

5. Recommendations

For a precise fertilizer recommendation, yield and management history, sources of plant nutrient applied in the past in particular are required in addition to the soil information. Given the above soil results (Section 3.2.3) the following recommendations are suggested to improve the soil nutrient status in this geog.

- The available P content of the soils in most of the villages is high though few villages have low values and for these low values, applying P containing fertilizer such as SSP together with urea as a basal dose could improve the P content in these soils.

- The available K content of these soils is mostly within the low to medium range. Though K might be adequate for those villages with moderate values, it might not be sufficient for those with low K values and hence the need to apply K containing fertilizer such as MoP to replenish the K content of these soils as potatoes are efficient removers of K.

- The CEC of most of these soils is within the low to medium range and this low value indicates that almost all the major macronutrients are required to obtain adequate yield.

- An application of balanced nutrients with proper recommended rate needs to be encouraged. For this geog, more than one set of recommendation needs to be encouraged, viz. for those villages with low values for both P and K and the other set for those with only one nutrient in the lower range (for the village grouping refer the following table 1). From the above mentioned soil information, the following recommendations are suggested to improve the soil nutrient management program: What, when, how and why are answered below.

  A. **Thus the recommended rate of 100:100:100 kg/ha of N,P,K *(i.e. for those villages with low values of both P and K) :***

  1. <u>Using Suphala is as follows:</u>
     - Apply about 270 kg/acre of Suphala as basal dose during land preparation (i.e. about $5^1/_2$ bags of Suphala @50 kg per bag per acre) as one straight dose or
     - Apply about 216kg/acre of suphala as basal dose during land preparation (i.e. about $4^1/_3$ bags of suphala @50kg per bag per acre) together with 50kg of SSP (i.e. 1 bag of SSP @50kg per bag

per acre) and about 14 kg of MoP as basal dose; followed by about 17 kg of urea as top dress either when the plants are of 15-20 cm high (after 30-45 days of planting) or at the time of potato flowering (i.e. when the maize plants are of "knee high" stage).

2. **Using SSP, MoP and Urea [ii] is as follows:**
    - Apply 69kg/acre of Urea as basal dose during land preparation (i.e. about 1 bags of Urea @50 kg per bag per acre).
    - Apply about 253kg/acre of SSP as basal dose during land preparation (i.e. 5 bags of SSP @ 50 kg per bag per acre).
    - Apply about 67kg/acre of MoP as basal dose during land preparation (i.e. about 1 bag of MoP @ 50 kg per bag per acre).
    - Followed by 17 kg urea as top dress either when the plants are of 15-20 cm high (after 30-45 days of planting) or at the time of potato flowering (i.e. when the maize plants are of "knee high" stage).

B. Thus the recommended rate of 100:100:80 kg/ha of N,P,K (i.e. for *those villages with low P values):*

1. **Using Suphala is as follows:**
    - Apply about 216 kg/acre of Suphala as basal dose during land preparation (i.e. about $5^{1}/_{3}$ bags of Suphala @50 kg per bag per acre)
    - together with 51kg/acre of SSP as basal dose during land preparation (i.e. about 1 bag of SSP @50kg per bag per acre)
    - Followed by about 17 kg/acre of urea as top dress either when the plants are of 15-20 cm high (after 30-45 days of planting) or at the time of potato flowering (i.e. when the maize plants are of "knee high" stage

2. **Using SSP, MoP and Urea is as follows:**
    - Apply 69kg/acre of Urea as basal dose during land preparation (i.e. about 1 bags of Urea @50 kg per bag per acre).
    - Apply about 253kg/acre of SSP as basal dose during land preparation (i.e. 5 bags of SSP @ 50 kg per bag per acre).

[ii] If the farmers are willing, this second type of application is more advisable than the first type as the SSP contains additional nutrient (sulphur), which helps in better production of yield.

- Apply about 54kg/acre of MoP as basal dose during land preparation (i.e. about 1 bag of MoP @ 50 kg per bag per acre).

- Followed by 17 kg urea as top dress either when the plants are of 15-20 cm high (after 30-45 days of planting) or at the time of potato flowering (i.e. when the maize plants are of "knee high" stage).

C. Thus the recommended rate of 100:80:100 kg/ha of N,P,K (i.e. for *those villages with low K values):*

1. <u>Using Suphala is as follows:</u>

- Apply about 216 kg/acre of Suphala as basal dose during land preparation (i.e. about $5^1/_3$ bags of Suphala @50 kg per bag per acre)
- together with 14kg/acre of MoP as basal dose during land preparation
- Followed by about 17 kg/acre of urea as top dress either when the plants are of 15-20 cm high (after 30-45 days of planting) or at the time of potato flowering (i.e. when the maize plants are of "knee high" stage

2. <u>Using SSP, MoP and Urea is as follows:</u>

- Apply 69kg/acre of Urea as basal dose during land preparation (i.e. about 1 bags of Urea @50 kg per bag per acre).

- Apply about 203kg/acre of SSP as basal dose during land preparation (i.e. 4 bags of SSP @ 50 kg per bag per acre).

- Apply about 68kg/acre of MoP as basal dose during land preparation (i.e. about 1 bag of MoP @ 50 kg per bag per acre).

- Followed by 17 kg urea as top dress either when the plants are of 15-20 cm high (after 30-45 days of planting) or at the time of potato flowering (i.e. when the maize plants are of "knee high" stage).

- In addition to this the major soil type is of medium textured and so a split application of urea is even more advisable for better utilisation of the N nutrient.

- The timing of fertilizer application with adequate soil moisture is crucial for obtaining good yield and therefore, application of fertilizers on dry soil is not encouraged.

- Urea topdress of incorporating it into the soil needs to be encouraged as all the farmers reported of broadcasting it without incorporating it into the soil.

Table 1. Village categorization for fertilizer recommendations.

Villages		
Low P & K[iii]	**Low P[iv]**	**Low K[v]**
Monangkhola	Daksa	Wungka Chhema
Pokpong	Daktseng	Chhema
Paklakpong	Gonpa	Dowzor
Barshon		Dangray
Daypangthang		Bramang
Brekha gonpa		Khorldung
Donphangma		Gomchu
Rashiwung		

[iii] Fertilizer recommendation of N:P:K of 100:100:100 kg/ha
[iv] Fertilizer recommendation of N:P:K of 100:100:80 kg/ha
[v] Fertilizer recommendation of N:P:K of 100:80:100 kg/ha