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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 Kanglung geog under Trashigang Dzongkhag.

2. Method

The group collected the soil samples from the farmers' fields based on the list prepared by the Extension Agent (EA) and with the help of the village Chipons. 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= 1350m²). One composite sample from a minimum of 8-10 sub samples was collected from one location or site. 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 Kanglung geog

3.1.1 Total sample households

In Kanglung geog, a total of 140 households covering 21 villages were sampled. The highest number of respondents was from Yonphula village (14.3%) followed by Shingchen gonpa and Naka (10.7% each), Bramtsang gonpa (10%) and Yonphu Pam (8%) villages. Pangthang, Tsushing, Thragom, Shadang mani and Shinangkhar villages had the lowest numbers of respondents (1 farmer each). These figures suggested that there were more farmers growing potatoes in Yonphula, Shingchen gonpa, Naka, Bramtsang gonpa and Yonphu Pam villages compared to Pangthang, Tsushing, Thragom, Shadang mani and Shinangkhar 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 Kanglung geog, about 91% of the sampled plots are located at the medium range (between 2000 and 3000 m.asl). The majority of the plots (51%) of this geog are situated on steep slopes and moderately sloping areas (30%). The majority of the plots are north-westerly and north easterly facing aspects (36% and 29% respectively) and about 83% of the sampled area have small plot sizes (<1 acre). The farmers of this geog all grow potatoes mostly in their own fields (94% owned) while the landless farmers share in about 6%. About 85% of the farmers grow Desiree variety though the other varieties such as Yusikap and Kufrijyoti are also grown. The farmers start planting potatoes from December till March though the majority of the farmers plant in January (about 61%).

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 and south west facing areas, the majority of the plots are located in the steep and moderately sloping areas with north west and north east facing aspects.

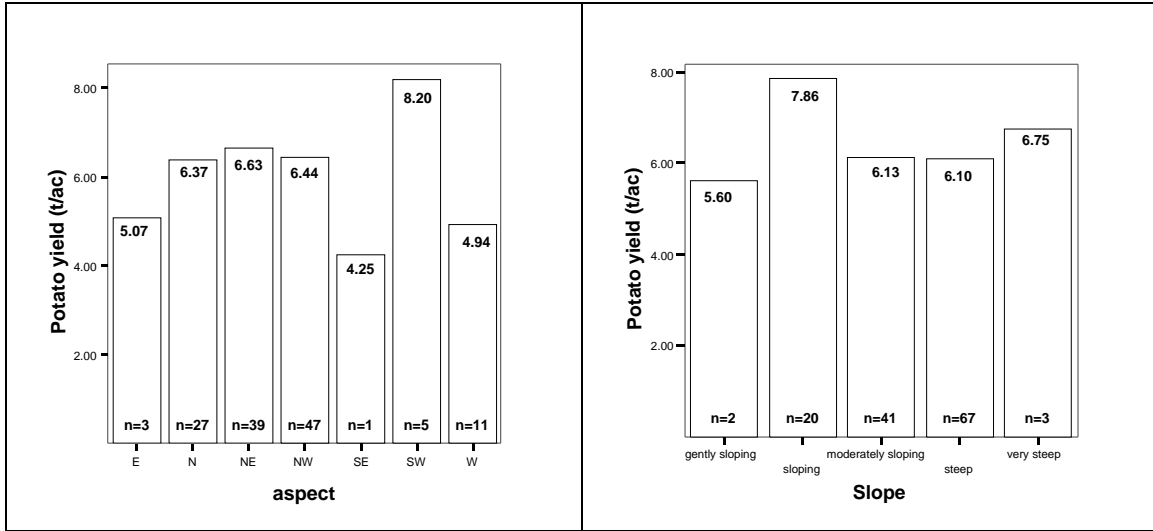


Figure 1 Potato yield in relation to aspect and slope of the plots.

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/ac¹ though on an average, the yield is about 7-8 t/ac. The highest potato yield is recorded from one farmer in Shinangkhar village with 26.3 ton/acre (t/ac) and one farmer each from Tsushing (10t/ac) and Chambari (9.7t/ac) villages while Pangthang, Fiskang and Shadang mani villages reported the least yield though the average potato yield for Kanglung geog is 6.4t/ac. The highest maize yield is recorded from Thragom (1.8t/ac) followed by Tsushing (1.5t/ac) and Shinangkhar (1.4t/ac) villages while the lowest yield is reported from Toka Phay Wok and Rithung gonpa (0.1t/ac and 0.2t/ac respectively) (see figure 2). On an average, the maize yield for this geog is 0.73t/ac.

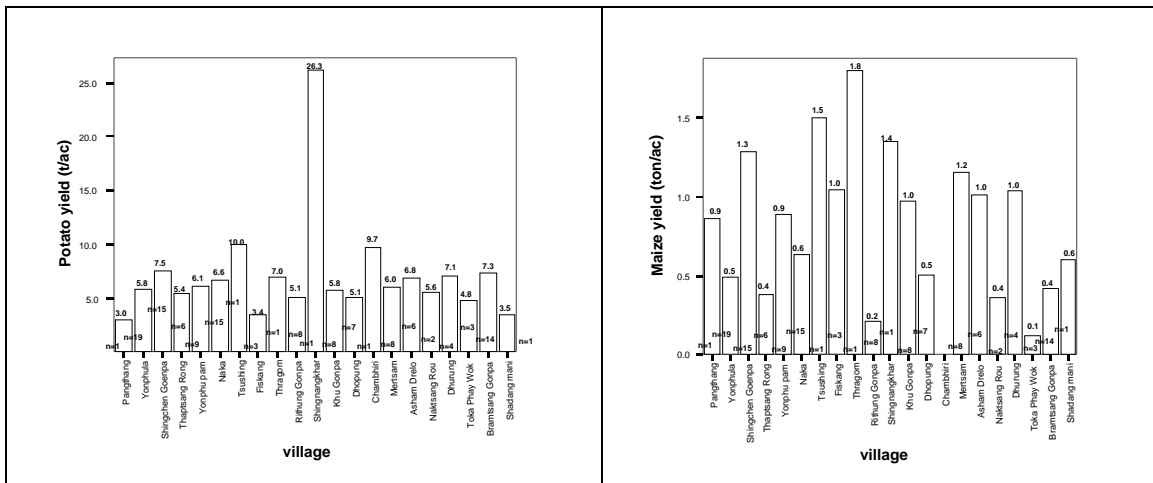


Figure 2 Average potato and maize yield (t/acre) under each village.

¹ According to FAO reports.

In Kanglung geog, about 71% of the farmers apply Farm Yard Manure (FYM) to their fields with an average application of 4.6t/ac. This amount of FYM applied with a dry matter content of 50% is equivalent to 2.3t/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. The highest rate of FYM application (t/ac) is one farmer from Tsushing village (14.4t/ac) followed by Pangthang (10.8t/ac) and Asham Drelo (8.5t/ac) villages while Shadang mani, Yonphula and Chambari villages applied the least amount of FYM (<1.5t/ac) (figure 3). The majority (91%) of the farmers of this geog do not practice tethering of cattle in the fields while 86% of them burn trash. The weeding frequency of the potato ranges from once to thrice though about 58% of them weed twice while another 39% of the farmers weed only once.

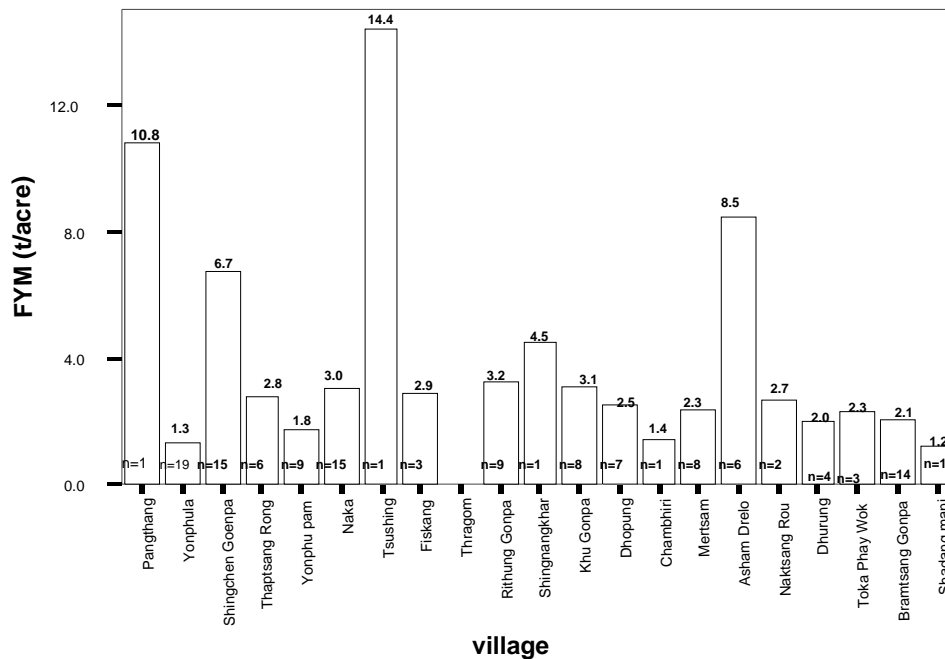


Figure 3 Amount of FYM applied (t/acre) under each village.

The survey findings indicate that 100% of the farmers apply inorganic fertilizers such as urea, suphala and SSP in addition to FYM application. Only about 50% of the farmers of this geog apply Supahala to potato (basal dose) while about 55% of them apply urea and SSP as basal in potato and about 86% of them apply urea to maize. The average amount of suphala applied by the farmers of Dhurung vilage is more than the rest of the other villages while Shinangkhar applied the least (Figure 4). On an average, the farmers of this geog apply about 258kg/ac suphala, which is 39kg N per acre, 39kg P per acre and 39kg K per acre. The farmers apply 207kg/ac urea (which is 97kg N per acre) as basal dose, which is either applied singly or is mixed with SSP in the ratio of 1:2 (urea: SSP). About 55% of the farmers also apply on an average 354kg/ac SSP (which is about 57kg P per acre) as basal dose to potato while about 85% of the farmers

also apply on an average 90kg/acre of urea (i.e. about 14kg N per acre) as top dress to maize. The farmers of Naka, Yonphu Pam, Pangthang and Bramtsang Gonpa apply urea and SSP in ratio of 1:2 as basal dose instead of suphala followed by urea as top dress. 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. About 62% of the framers apply urea in a single dose while the rest 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”. Most of the farmers of Yonphula, Yonphu Pam and Rithung Gonpa villages apply urea as split application. 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.

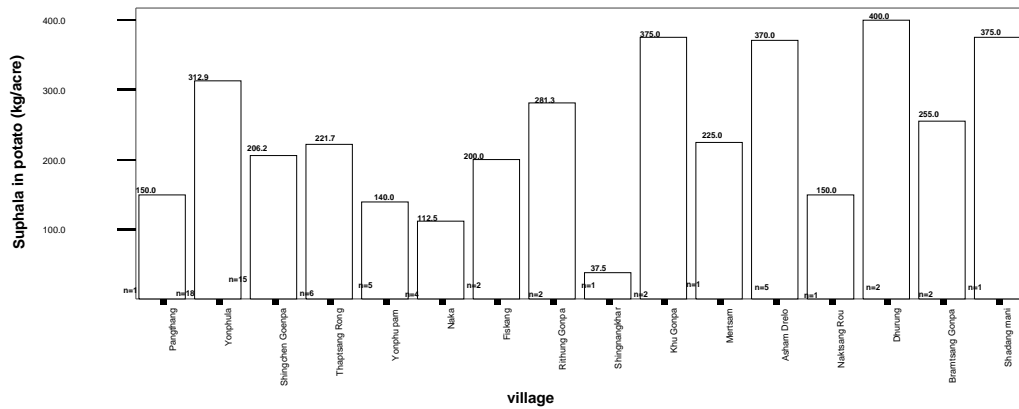


Figure 4 Amount of Suphala (kg/acre) applied under each village.

From the following figure 5, it can be seen that on an average the highest amount of urea application to potato is from Dhopung village (296kg/ac) followed by Mertsham (241kg/ac) and Naka (220kg/ac) villages while the farmers of Yonphula (18kg/ac) applied the least amount of urea to potato.

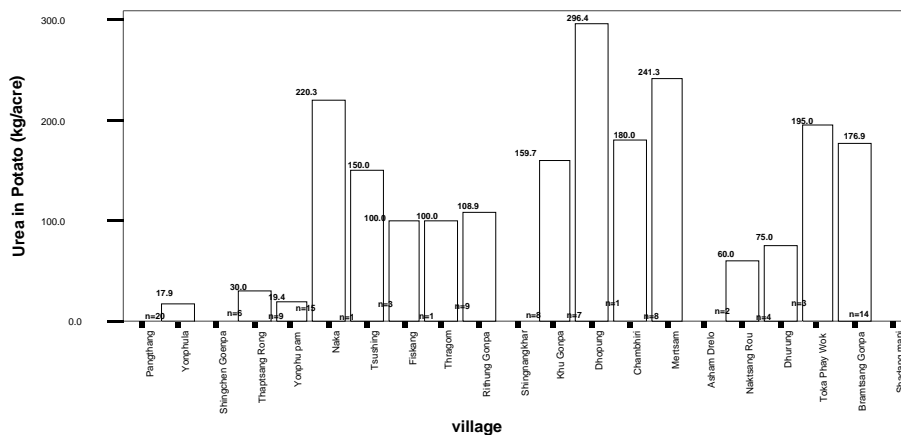


Figure 5 Amount of Urea (kg/acre) applied to potato under each village.

As reported earlier, about 50% of the farmers of this geog apply SSP as basal to potato in combination with urea. On an average, the highest application of SSP as basal dose is from Mertsham (484kg/ac) and Dhopung (464 kg/ac) while the farmers of Shinangkhar and Yonphula applied the least. See figure 6.

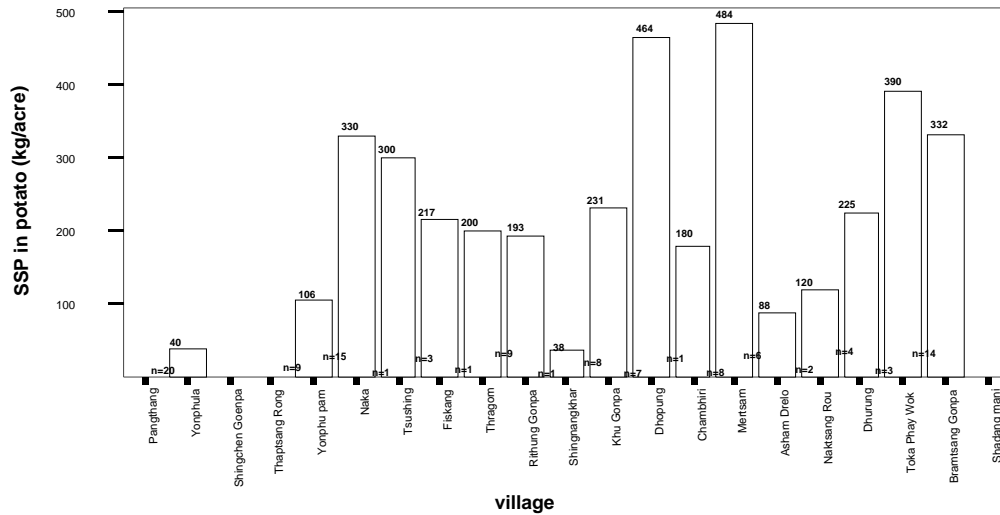


Figure 6 Amount of SSP (kg/acre) applied in potato under each village.

In addition, the farmers of this geog also apply urea to maize at an average application rate of 90kg per acre. The highest amount of urea application as top dress in maize is reported from one farmer of Thragom (200kg/ac) village and on an average the farmers of Asham Drelo and Tsushing applied the highest amount and the framers of Tok Phay Wok and Rithung gonpa applied the least amount. See figure 7.

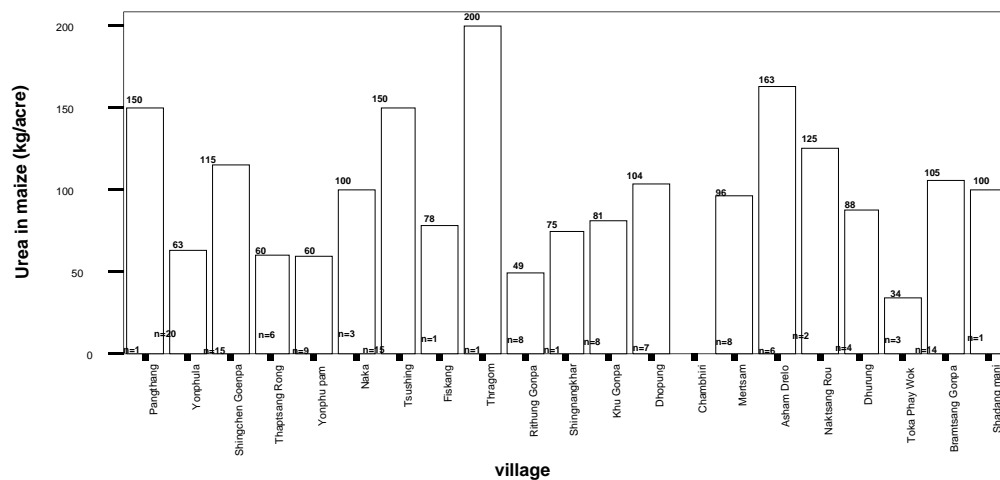


Figure 7 Amount of Urea (kg/acre) applied in maize under each village.

The average potato yield for Kanglung geog is 6.4t/ac. The average maize yield of this geog is less than a ton per acre (0.8t/ac).

3.1.4 Potato seed

About 46% of the farmers of this geog have changed their seeds within the last 5 years while 54% of them have not changed their seeds for more than the last 5-15 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 Kanglung 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 Kanglung geog is summarised as follows.

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

The pH of the soils of this village is mostly within the low (pH <5) to 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.

More than 60% of these soils have low available K (40-99mg/kg) while another 10% are within the very low range (<40mg/kg). The available P is mostly within the low to medium range with more than 30% in the low range (5-15mg/kg). **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 high (OM%> 5) and about 90% of these soils have very high C:N ratio (>12).

About 80% of these soils have medium CEC range (15-25 meq/100g) with very low BS% (<35%). 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 clay loam (figure26). 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.

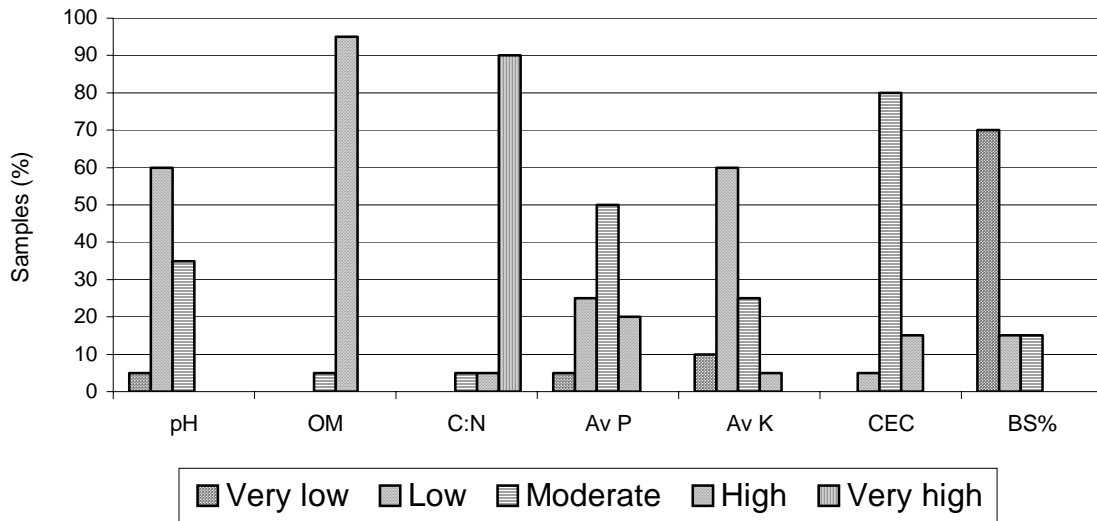


Figure 8 Soil parameters of potato fields in Yonphula village.

ii. Soil result of Shingchen gonpa village (see figure 9).

The pH of the soils of this village is mostly within medium (pH 5.5-6.5) range. The available K is mostly (about 47% of these soils) is within the moderate range ((100-200mg.kg) while another 33% are within high (200-300mg/kg). The available P of these soils is within the moderate range. **These figures suggest that the available P and K content of these soils are within the moderate range however; it would be advisable to apply K containing fertilizers since potatoes are good removers of K.** All the soils in this village have high organic matter contents (> 5%) with very high C:N ratio (>12).

The CEC values are within the medium to high range with more than 70% in the high range. The BS% range of these soils is evenly distributed from very low to very high 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 is silty clay and clay loam (figure 26) and as reported by the farmers, clay soil (locally known as Gumsa) is also found in this village though to a lesser extent. These soil types (with the exception of clay and silty clay) is of medium textured soils containing less than 40% clay content while silty clay soils contain more than 40% clay. 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.

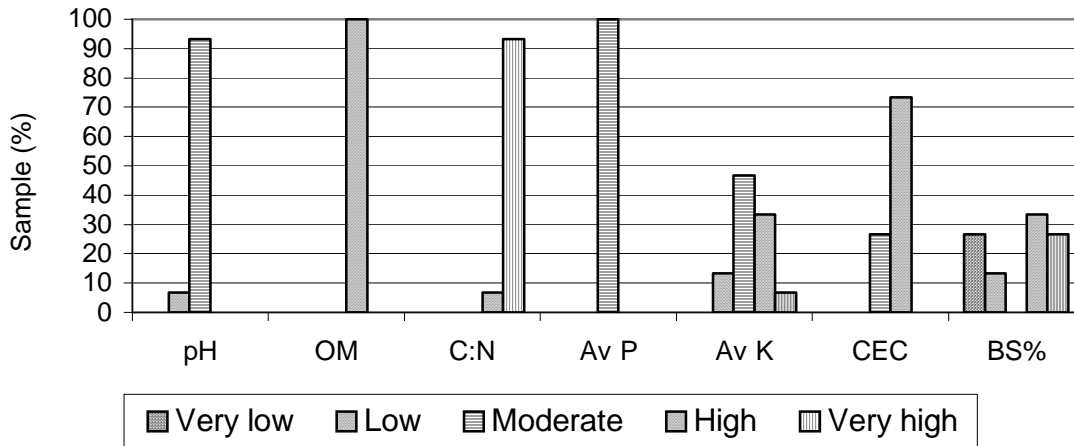


Figure 9 Soil parameters of potato fields in Shingchen gonpa village.

iii. Soil result of Thaptsang rong 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. 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. The available K is equally distributed from very low (<40mg/kg) to high (200-299mg/kg) range with more than 35% in the low range. About 50% of these soils have low available P (5-15mg/kg) while the other 50% is in the medium range (15-30mg/kg). **This figure suggests that there is a 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 (> 5%) with very high C:N ratio (>12). The CEC of these soils is mostly within the medium (15-25 meq/100g) to high range (25 - 40meq/100g) while the BS% range of these soils is mostly in the very low range (<35%). 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 loam and clay loam (figure 26). This soil type is 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.

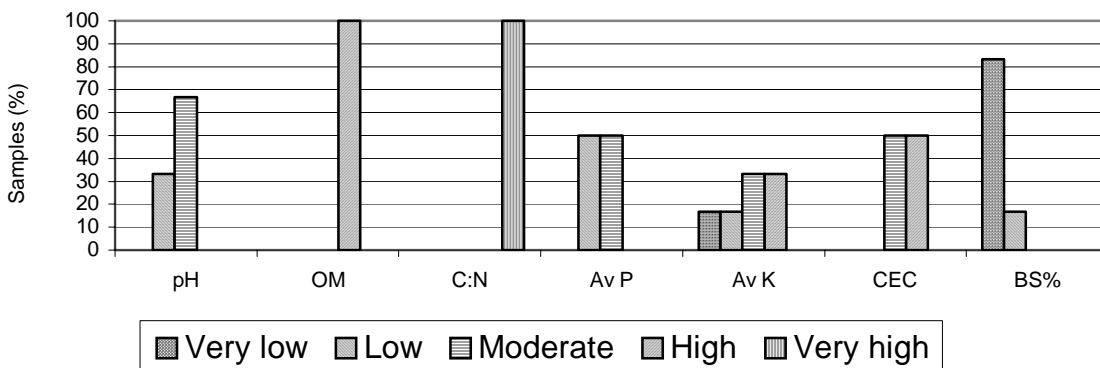


Figure 10 Soil parameters of potato fields in Thaptsang rong village.

iv. Soil result of Yonphu pam village (see figure 11).

The pH of the soils of this village is of medium (pH 5.5-6.5) range. The available K is distributed within the very low to high (200-299mg/kg) range with almost 40% in the low (5-15mg/kg) to very low (<5mg/kg) range. More than 35% of these soils have low available P and another 35% in the medium range. These 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 mostly within the medium to high range with very high C:N ratio (>12).

More than 90% of these soils have medium CEC values (15-25 meq/100g) while the BS% range of these soils is evenly distributed from very low to very high range with more than 27% in the low range (<35%). 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 loam (figure 26). This soil type is 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.

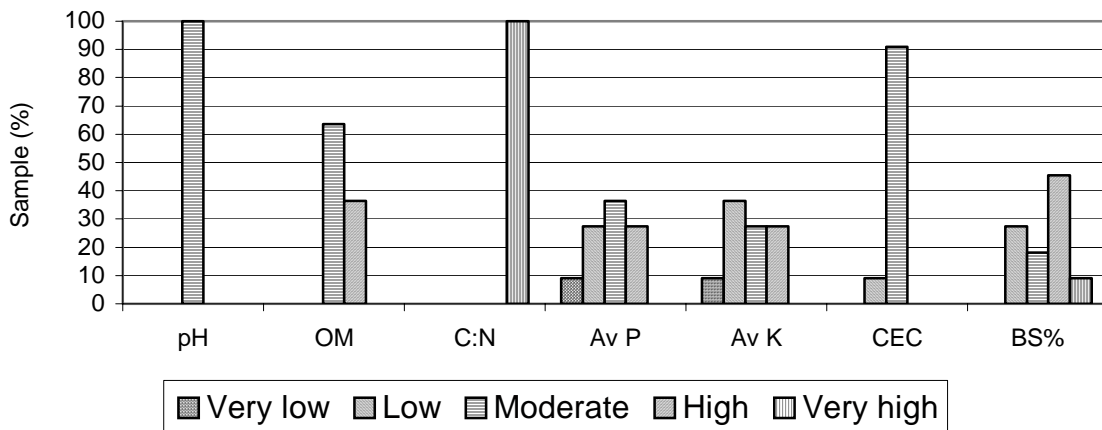


Figure 11 Soil parameters of potato fields in Yonphu pam village.

v. Soil result of Naka village (see figure 12).

The pH of the soils of this village is mostly within the 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.

The available K is in the low to medium (100-200mg/kg) range with more than 60% in the low range (40-100mg/kg). The available P is mostly within the moderate to high range. **This figure suggests that there is a need to apply K containing fertilizers such as MoP to improve the nutrient status of these soils**

though the P levels are fairly adequate. More than 85% of these soils have high organic matter contents (> 5%) and C:N ratio (>12).

The CEC of these soils is mostly of medium (15-25 meq/100g) range. The BS% range of these soils is evenly distributed from low to very high range with more than 50% in the medium range (50-64%). 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 and clay loam (figure 26). Clay loam and loam are the two major soil types found in this village. This soil type is 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.

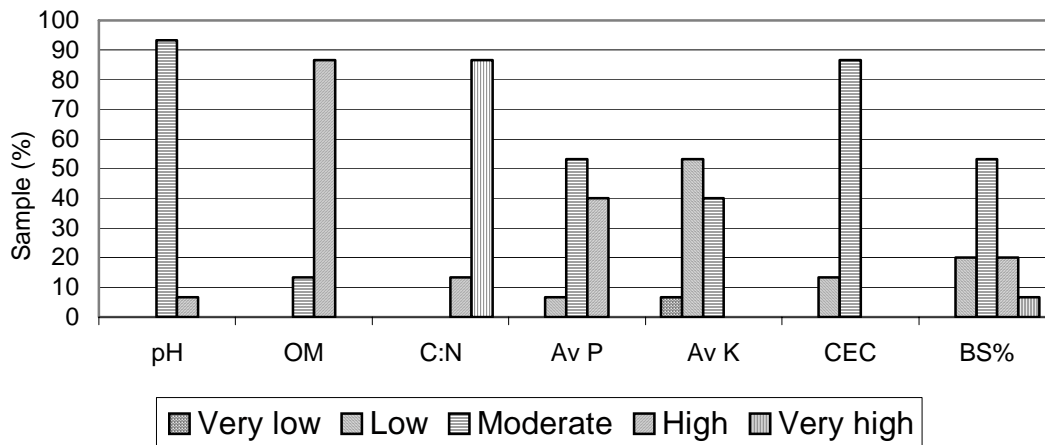


Figure 12 Soil parameters of potato fields in Naka village.

vi. Soil result of Pangthang, Fiskang, Tsushing villages (see figure 13).

The pH of the soils of this village is mostly within the medium (pH 5.5-6.5) to high (pH 6.5-7.5) range. The available K is in the low to medium (100-199mg/kg) range with more than 60% in the low range (5-15mg/kg). More than 80% of these soils have low available P contents with more than 20% in the very low range. **These 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 (> 5%) while 80% these soils have very high C:N ratio (>12).

About 80% of these soils have low CEC values (5-15 me/100g) and in such low CEC soils all major and minor nutrients may be required to attain adequate growth and hence yields. Incorporating more organic substances such as FYM can increase the CEC of these soils. The BS% range of these soils is mostly within the moderate ((50-64%) to very high range (>80%). Coarse-textured soils lack both nutrient and water holding capacities while fine-textured soils often have structural and infiltration problems. The major soil type of Tsushing is clay

loam while that of Fiskang is silty loam (figure 26). This soil type is 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.

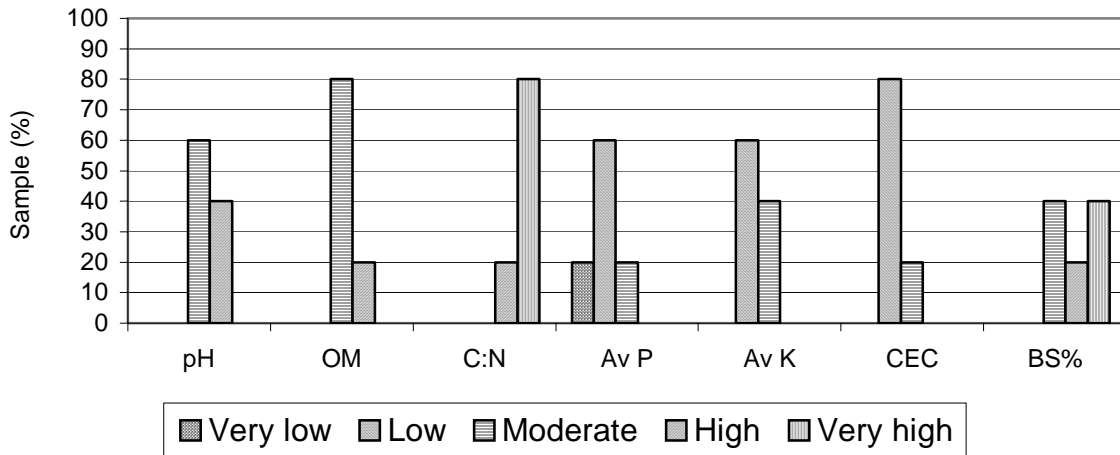


Figure 13 Soil parameters of potato fields in Pangthang, Fiskang and Tsushing villages.

vii. Soil result of Rithung gonpa village (see figure 14).

The pH of the soils of this village is mostly within the medium (pH 5.5-6.5) 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 is mostly within the low to medium range with more than 70% in the low range and another 10% in the very low range. The available P content also varies from low to high range with 40% in the low range. **These low P and K 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.** About 90% of these soils have high organic matter contents (> 5%) with very high C:N ratio (>12).

The CEC of these soils is mostly within the medium (15-25 meq/100g) to high range (25 - 40meq/100g) with 90% in the medium range. The BS% range of these soils is evenly distributed from very low to very high range with 50% of these soils in the very low range. Coarse-textured soils lack both nutrient and water holding capacities while fine-textured soils often have structural and infiltration problems. The major soil types are clay loam and loam (figure 26). This soil type is 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.

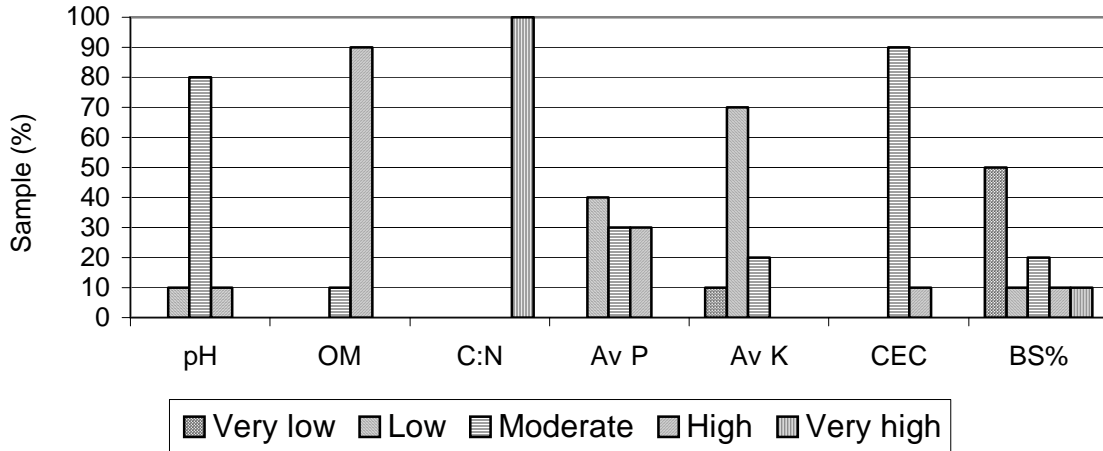


Figure 14 Soil parameters of potato fields in Rithung gonpa village.

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

The pH of the soils of this village is in the medium (pH 5.5-6.5) 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 is in the low to medium range with more than 37% in the low range while the available P is low. **These low P and K figures suggest the need to apply P and K containing fertilizers such as SSP and MoP to improve the nutrient status of these soils.** Almost 80% of these soils have high organic matter contents (> 5%) and almost 90% these soils have very high C:N ratio (>12). The CEC of these soils is of medium (15-25 meq/100g) range. The BS% range of these soils is evenly distributed from very low to very high range with almost 30% in the low range. Coarse-textured soils lack both nutrient and water holding capacities while fine-textured (heavy) soils often have structural and infiltration problems. The major soil type is silty clay loam and clay loam (figure18). This soil type is 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.

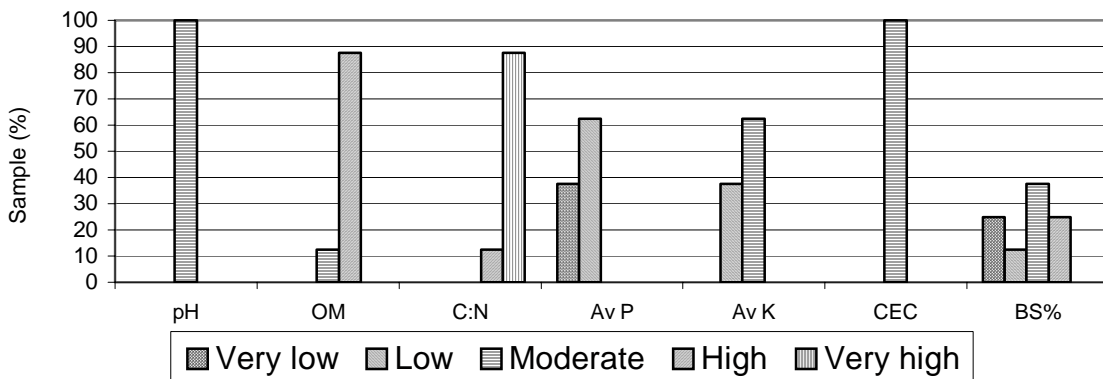


Figure 15 Soil parameters of potato fields in Khugonpa village.

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

The pH of the soils of this village is mostly within the low to medium 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. The available K is within the low to medium range with more than 70% in the low range. All the soils of this village very low available P contents with more than 85% in the very low range. These very low P and K figures suggest 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 high with very high C:N ratio.

The CEC of these soils is mostly within the medium (15-25 meq/100g) to high range (25 - 40meq/100g) while that of he BS% is very low. Coarse-textured soils lack both nutrient and water holding capacities while fine-textured soils often have structural and infiltration problems. The major soil types are silty clay and silty clay loam (figure 26). Silty clay loam is of medium textured soils containing less than 40% clay content while silty clay soil contains more than 40% clay content. For light textured soils, a split application of inorganic fertilizers especially urea is advisable.

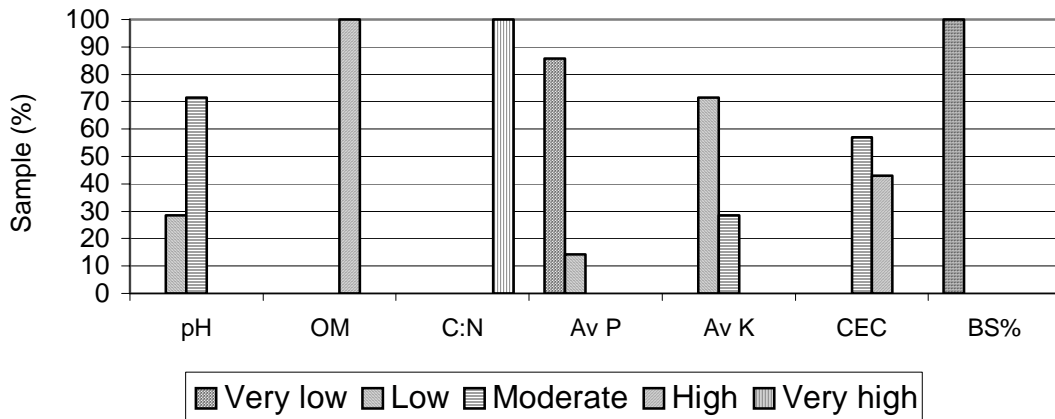


Figure 16 Soil parameters of potato fields in Dhopung village.

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

The pH of the soils of this village is of medium (pH 5.5-6.5) range. The available K is mostly within the low to medium (100-199mg/kg) range. More than 37% of these soils have low available K (40-100mg/kg). The available P content of these soils is distributed within the very low to high range with more than 38% in the low range. These 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 high and these soils have very high C:N ratio (>12).

The CEC of these soils is of medium (15-25 meq/100g) range while the BS% range of these soils is evenly distributed from very low to very high range with

more than 60% in the low range. 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, clay loam and clay (figure 26). Clay loam soils are of medium textured soils containing less than 40% clay content and in such lighter textured soils, a split application of inorganic fertilizers especially urea is advisable while silty clay and clay soils contain more than 40% clay contents and considered more heavy than loams and silty clay loams.

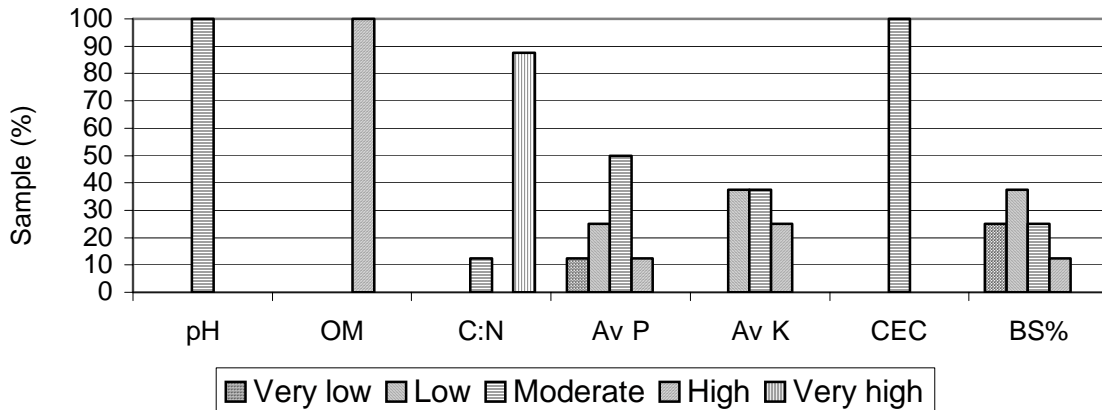


Figure 17 Soil parameters of potato fields in Mertsham village.

xi. Soil result of Asham Drelo village (see figure 18).

The pH of the soils of this village is of medium (pH 5.5-6.5) range. The available K is in the medium range. More than 70% of these soils have low available P (5-15mg/kg). This figure suggests that there is a **need to apply P containing fertilizers such as SSP** to improve the nutrient status of these soils though the K levels are fairly adequate there is also the need to **apply K containing fertilizers** since potatoes are efficient removers of K and therefore the need to replenish it. The organic matter content of these soils is mostly within the medium to high range with more than 70% in the high range and all the soils have very high C:N ratio (>12).

The CEC of these soils is mostly within the medium (15-25 meq/100g) range. About 42% of these souls have very low BS% and about 30% in the low range. Coarse-textured soils lack both nutrient and water holding capacities while fine-textured soils often have structural and infiltration problems. The major soil type in this village is clay (figure 26). This soil type is a heavy textured soil containing more than 60% clay content and in such heavy soil the workability, infiltration and structural problems arises.

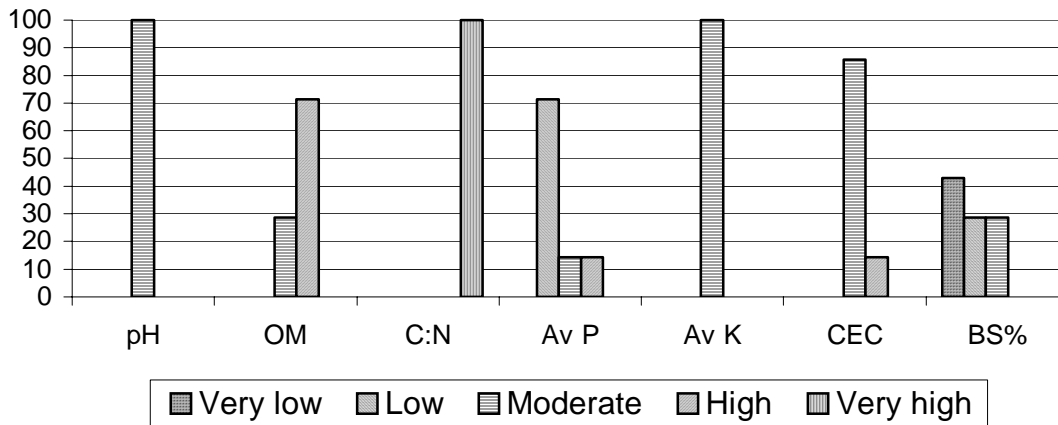


Figure 18 Soil parameters of potato fields in Asham Drelo village.

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

The soil pH of this village is of medium (pH 5.5-6.5) range. The available K is in the medium (100-199mg/kg) to high (200-299mg/kg) range) with 50% in the low range. The available P content of these soils is low with more than 70% in the very low range and 30% in the low range. **These low P and K figures suggest 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 are high with very high C:N ratio (>12).

The CEC of these soils is of medium (15-25 meq/100g) range while the BS% range of these soils is ranges from very low to medium range with 50% in the low range and another 25% in the very low range. 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, which contains more than 40% clay content.

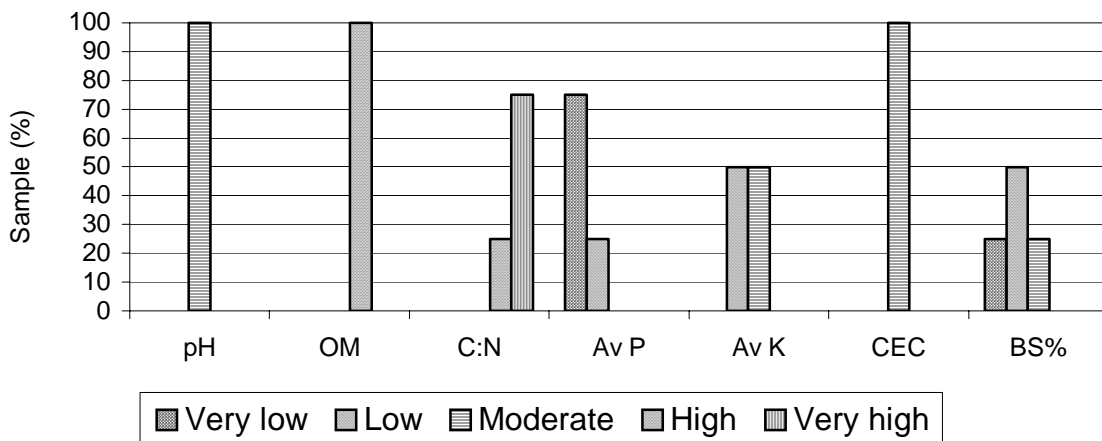


Figure 19 Soil parameters of potato fields in Dhurung village.

xiii. Soil result of Naktsang rou village (see figure 20).

The pH of the soils of this village is of medium (pH 5.5-6.5) range. The available K is low in this village and that of the available P is also low to very low. These low P and K values suggest 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 high and the C:N ratio is also very high.

The CEC of these soils is of medium (15-25 meq/100g) range while the BS% is low to very low. Coarse-textured soils lack both nutrient and water holding capacities while fine-textured soils often have structural and infiltration problems. Silty clay and silty clay loam are the two soil types found in this village (figure 26). Silty clay loam is a medium-textured soils containing less than 40% clay content while silty clay contains more than 40% clay content.

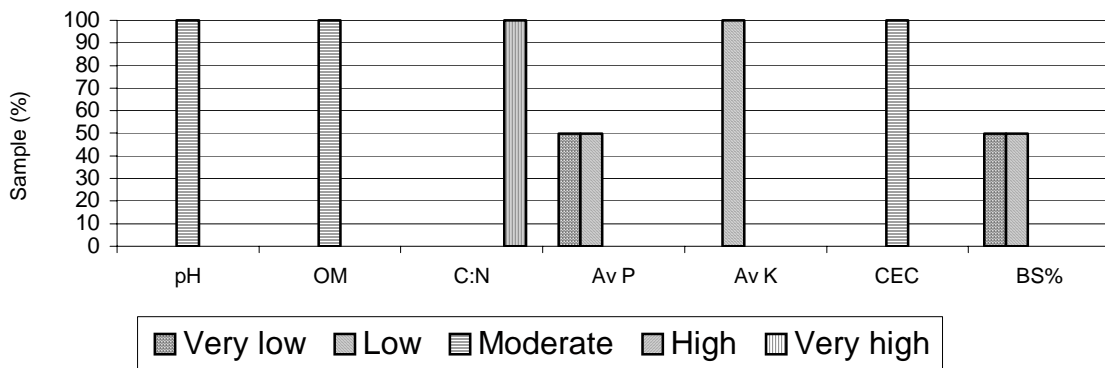


Figure 20 Soil parameters of potato fields in Naktsang rou village.

xiv. Soil result of Tok phay wok village (see figure 21).

The pH of the soils of this village is of low range (pH <5.5). The available K is in the low to medium range with more than 65% in the low range. The available P of these soils is low with more than 30% in the very low range. **These low P and K values suggest 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 high with very high C:N ratio. The CEC of these soils is of medium range while the BS% range of these soils is very low. The major soil type is silty clay (figure 26) containing more than 40% clay content.

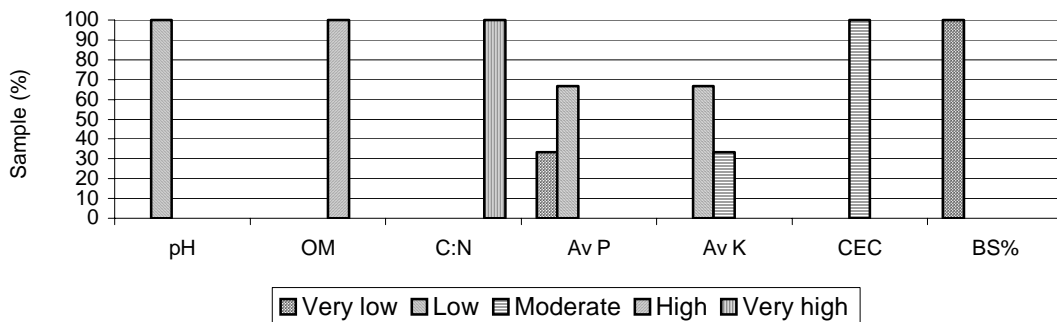


Figure 21 Soil parameters of potato fields in Tok phay wok village.

xv. Soil result of Bramtsang gonpa and Sadamani (see figure 22).

The pH of the soils of this village is mostly within the medium (pH 5.5-6.5) to high (pH 6.5-7.5) range. The available K content of these soils is mostly tithing the very low to medium range with more than 80% in the low range. The available P ranges from very low to high values with more than 80% in the low range. **These very 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.** More than 90% of these soils have high organic matter content and more than 70% these soils have very high C:N ratio. The CEC of these soils is mostly within the medium to high range while the BS% range of these soils is very low. Coarse-textured soils lack both nutrient and water holding capacities while fine-textured soils often have structural and infiltration problems. Clay loam and silty clay are the major soil types of Bramtsang gonpa village while silty clay loam is the soil type of Sadamani.

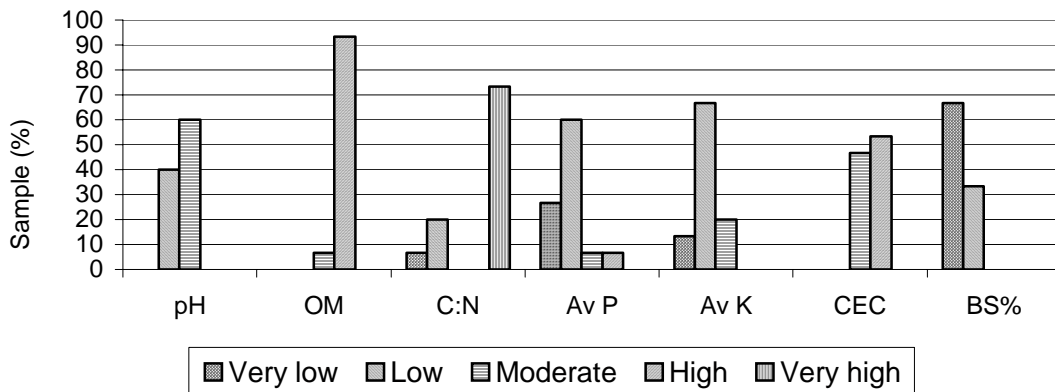


Figure 22 Soil parameters of potato fields in Bramtsang gonpa & Sadamani villages.

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

The pH of the soils of this village is of medium range. The available K is low while that of the P is also 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 of medium range while the C:N ratio is high.

The CEC and the BS% of these soils are of medium range. The major soil type is silty clay loam (figure 26). This soil type is 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.

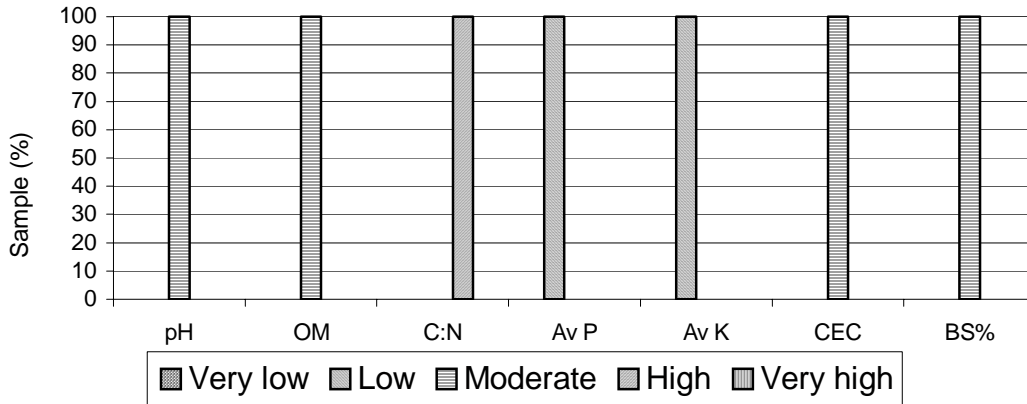


Figure 23 Soil parameters of potato fields in Thragom village.

xvii. Soil result of Shinangkhar village (see figure 24).

The pH of the soils of this village is of medium range. The available K is in the medium range while that of P is low. This figure suggests that there is a need to apply P containing **fertilizers such as SSP** to improve the nutrient status of the soil. Though the K levels are fairly adequate it is advisable to apply K containing **fertilizer such as MoP** as potatoes are efficient K removers and therefore the need to replenish. The organic matter content is high with very high C:N ratio.

The CEC of these soils is within the medium range while the BS% is very low. 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 clay loam (figure 26). This soil type is 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.

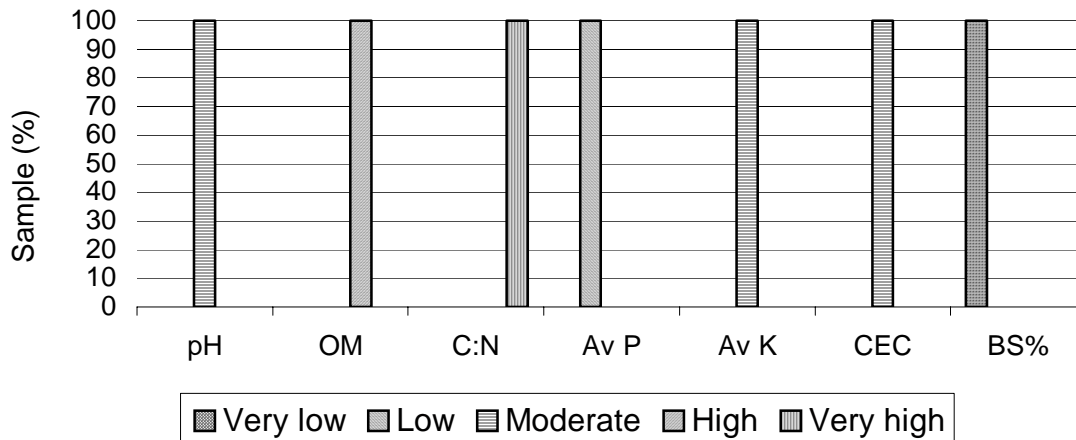


Figure 24 Soil parameters of potato fields in Shinangkhar village.

xviii. Soil result of Chamberi village (see figure 25).

The pH of the soils of this village is mostly of medium range. The available K is in the medium range while the available P is within the low and medium range (50% each). This low P values suggests that there is a need to apply P containing fertilizers such as SSP to improve the nutrient status of these soils. Though the K levels are fairly adequate, it is advisable to apply K containing fertilizer such as MoP, as the crop would remove most K in the soil. The organic matter content and the C:N ratio of these soils are within the medium to high ranges.

The CEC of these soils is of medium range while the BS% of these soils is within the medium to high ranges. The major soil type is clay loam and clay loam (figure18). This soil type is 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.

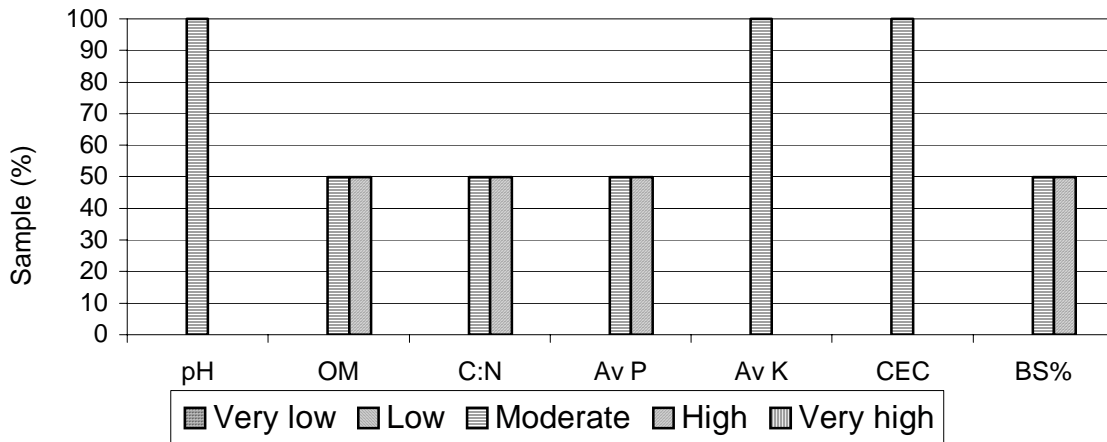


Figure 25 Soil parameters of potato fields in Chamberi village.

xix. Soil texture of different villages under Kanglung geog (see figure 26)

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

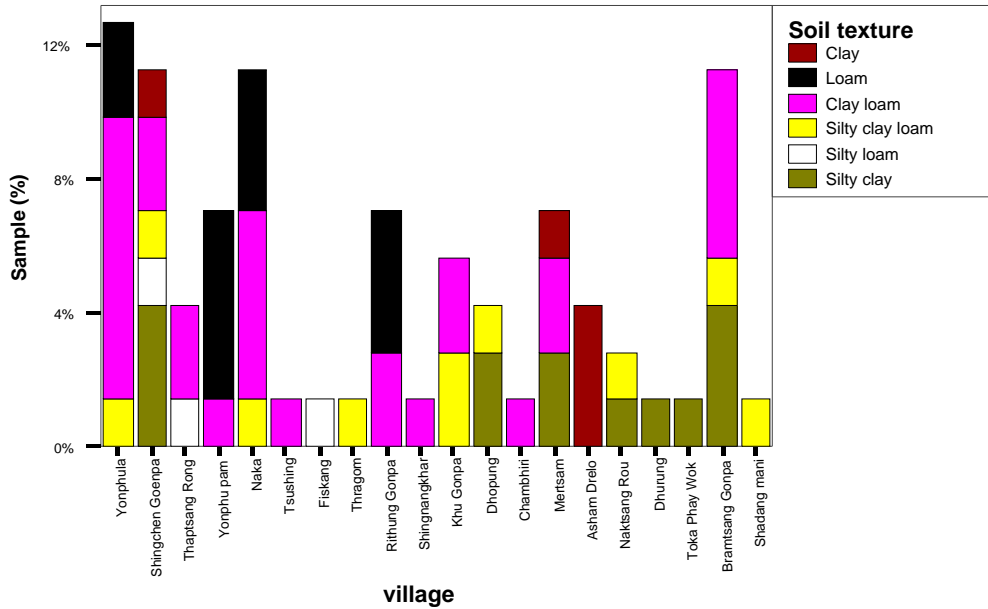


Figure 26 Soil textures of potato fields in different villages (Kanglung geog).

The following figure shows the local soil types as classified by the farmers of Kanglung geog. The most common local soil type is “Munangsa” which as described by the farmers is of medium textured, black humic soil.

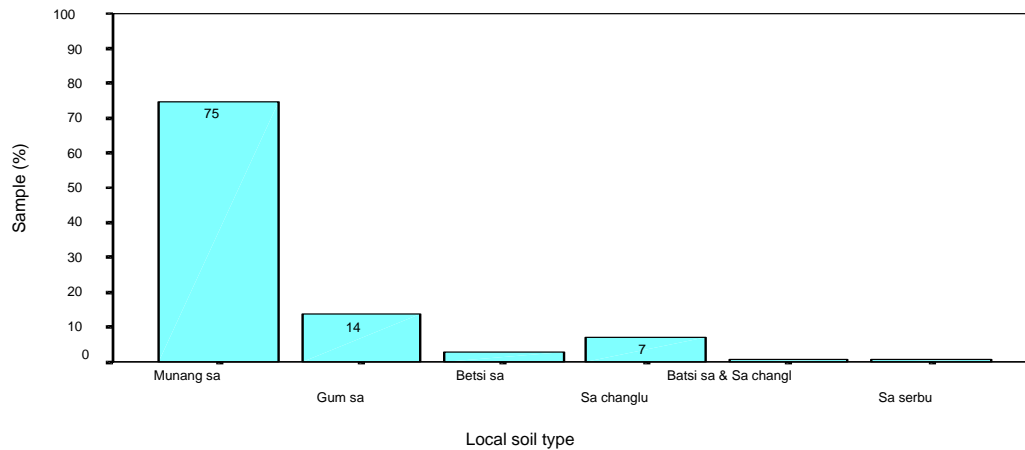


Figure 27 Local soil types found in Kanglung geog.

4. Conclusions

In Kanglung 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 north easterly and westerl 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. 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 4.6t/acre. Other inorganic fertilizers like SSP in addition to urea and sulphala are 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 6.4t/ac and 0.8t/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 and K content of these soils are mostly within the low range. Therefore, the need to improve the soil nutrient status and hence the yield by applying P and K containing fertilizer. The organic matter content is within the moderate range. Most of the soils have low BS% and CEC content and incorporating more FYM could increase the CEC values. Clay loam and loam are the dominant soil types in this geog.

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 low and 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. (i.e. the rate of 100:80:80 kg/ha or 40:32:32 kg/acre of N,P,K is recommended based on the soil result with modifications from the previously recommended rate of 100:80:60 kg/ha of N,P,K or 40:32:24 kg/acre of N,P,K). The P and K values are slightly increased from the FAO recommended rate, as these values from the soil analysis report are low in this geog. 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.

▪ **Thus the recommended rate of 100:80:80 kg/ha of N,P,K:**

1. Using Suphala is as follows:

- Apply about 216 kg/acre of Suphala as basal dose during land preparation (i.e. about 4 bags of Suphala @50 kg per bag per acre).
- Followed by two split applications of 9 kg each of urea once when the plants are of 15-20 cm high (i.e. 30-45 days after planting) and the second dose at the time of flowering of potato (or when the maize plants are of knee high stage if intercropped with maize).

2. Using SSP, MoP and Urea² 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 202kg/acre of SSP as basal dose during land preparation (i.e. 4 bags of SSP @ 50 kg per bag per acre).
- 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 two split applications of 9kg urea as top dress once when the plants are of 15-20 cm high (after 30-45 days of planting) and the second application 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.

² 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.