TABLE OF CONTENTS

List of Figures & Tables

1. Introduction

Following the first and second batch of soil samples collected (2002 and 2005) under potato based farming system from Bumthang, third batch of soil samples were collected from the same fields in August 2009. This is to generate information on the soil nutrient status as managed by farmers and a database is being built on the soils of the major crops in the country. Soil samples are collected along with the information on farmers' soil fertility management practices, cropping pattern and crop yields from the wetland farming system in Punakha-Wangdi valley, the dryland farming system in Bumthang and Eastern Dzongkhags.

Bumthang Dzongkhag is one of the major potato growing Dzongkhags in Bhutan. Potatoes are grown throughout the Dzongkhag in all the four geogs.

This report is on the soils of the major potato growing areas of Bumthang Dzongkhag. The National Soil Services Centre (NSSC) collected soil samples from 81 households spread over 4 geogs covering 27 villages under Bumthang Dzongkhag.

2. Method

The group collected soil samples from the farmers' fields based on the list from the First & Second Batch of samples collected in 2002 and 2005. A total of 81 households were selected from the initial samples (i.e. 342 households from First batch and 86 households from Second batch). The main criteria for downsizing the number of samples was based mainly on the clustered plots where a representative sample could be taken and also few scattered households were not included. Prior to sampling, 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 soil sample from a minimum of 8-10 sub samples was collected from one field though a composite sample was collected from 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 bags were labeled properly and the samples 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 16 for windows.

3. Results and discussions

This report presents the findings of soils under potato cultivation from Bumthang Dzongkhag. The general observations as recorded during the survey are presented in the first part of the report with the average soil analysis result of the whole Dzongkhag followed by soil analysis results of individual geogs under Bumthang Dzongkhag with fertilizer recommendations based on the findings for each geog/village.

3.1 Sample households

In Bumthang Dzongkhag, a total of 81 samples from all the 4 geogs covering 27 villages were sampled. The highest number of respondents was from Shingneer village under Ura geog (8.6% of

total respondents) followed by Jakar under Chokor geog (7.4% of total respondents). The various management practices and other site parameters in addition to the soil results are presented below**.**

3.2 Site description of fields under potato cultivation.

For potato to do well, an ideal situation is to have the fields with slopes less than 10% with either east or west facing aspects. However, it can also do moderately well on slopes ranging from 10-30% and with aspects facing either NNE-E or W to NNW. In Bumthang Dzongkhag, the majority of the plots are situated on sloping areas (33% of sampled plots) followed by gently sloping areas (31% of sampled plots) and level areas (24% of plots). About 35% of the plots are north-easterly and north-westerly (24% of plots) facing aspects. More than 75% of the sampled plots are located at medium altitude range (between 2000 and 3000 m.asl). The majority of the farmers (more than 63% of the sampled sites) have small plot sizes (< or =1 acre) while about 6% have large plots (>3 acres).

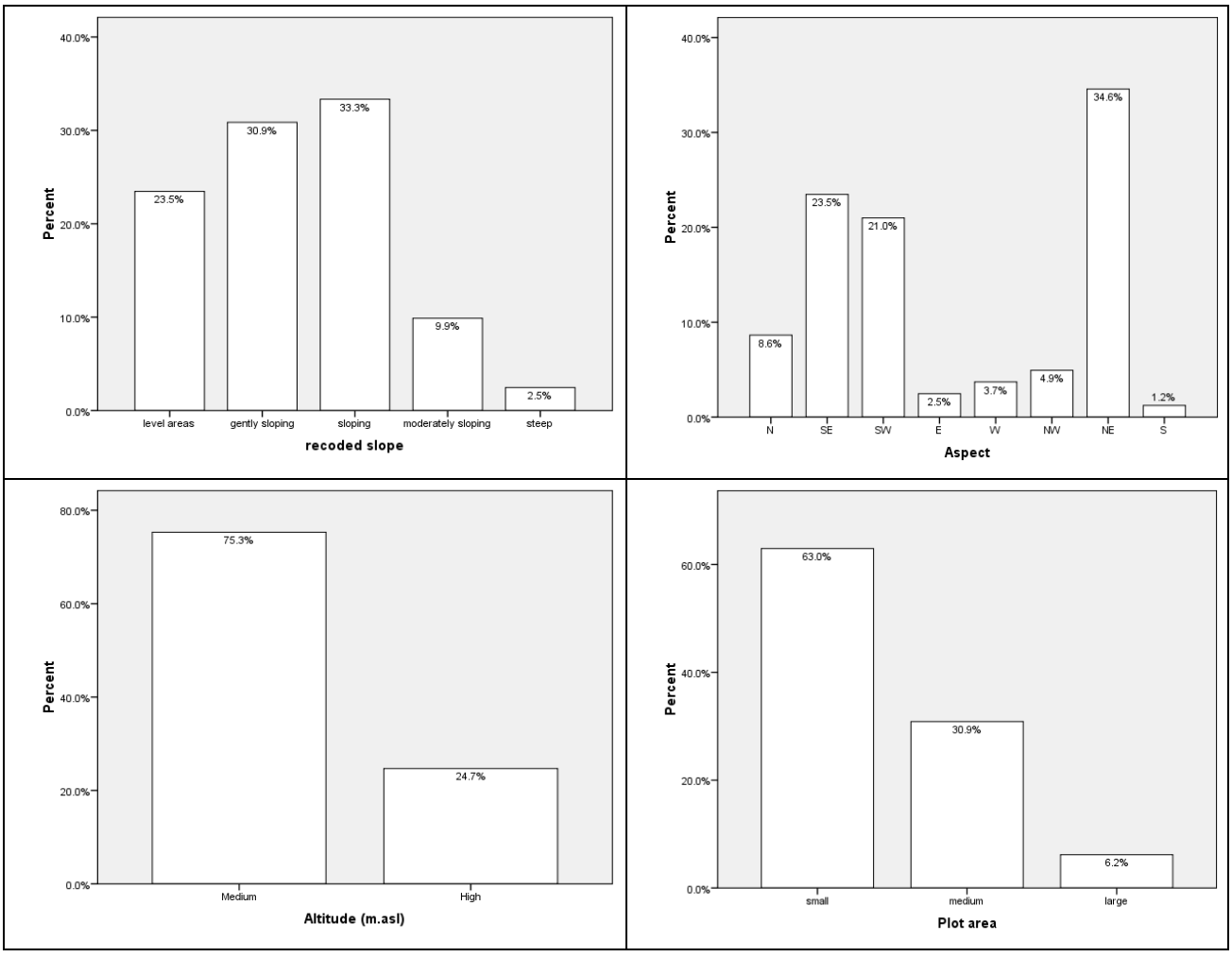

Figure 1 Slope, aspect, altitude and area of plots under potato cultivation

In Bumthang Dzongkhag, about 33% of the farmers grow only Desiree variety and about 18% of the farmers grow only Yusikap and the rest of the farmers grow both Desiree and Yusikap.

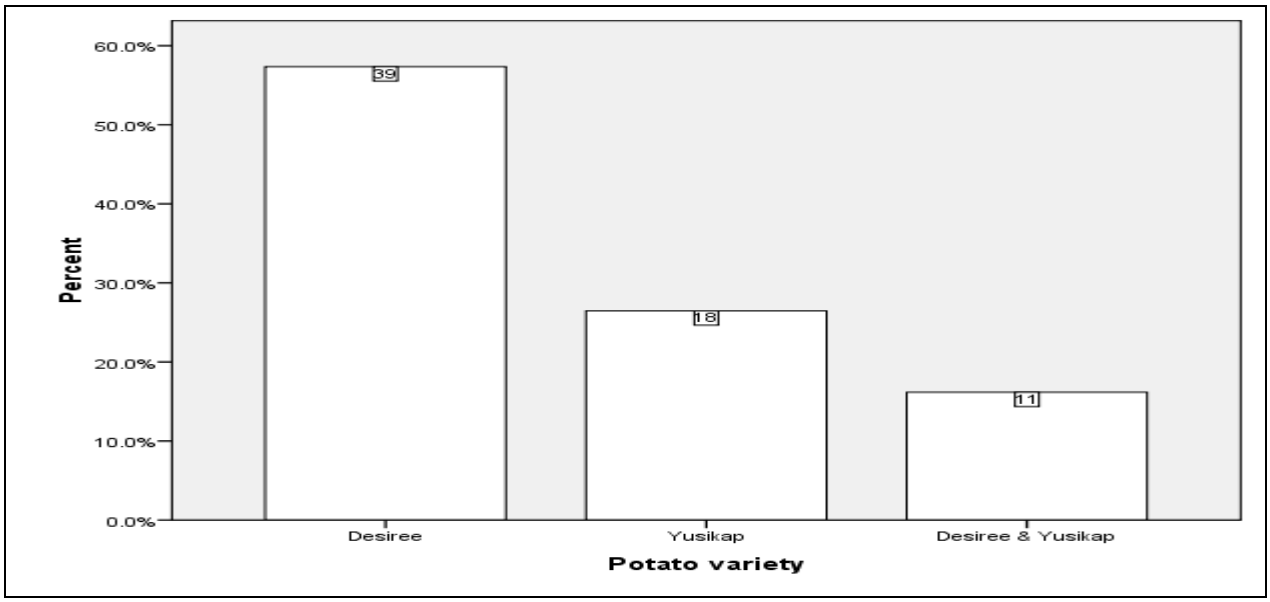

Figure 2 Potato variety grown by the farmers of Bumthang Dzongkhag

3.3 Crop yield and other management practices.

In this Dzongkhag, potato is not intercropped with any other crops but is followed by buckwheat which is sown about a month after potato harvest. Under favorable growing seasons, crop management and variety, potato yield can vary from 16-20 tac^{-1}[a] though on an average, the yield is about 7-8 tac^{-1}.

The average potato yield of Bumthang is 4.28 tac^{-1}. From Figure 3 it can be observed that the maximum potato yield of 6.9 tac^{-1} is observed from Tang geog and the lowest potato yield of 3.26 tac^{-1} is reported from Chokor geog. These figures suggest that the potential yield level in some of the villages has not been attained yet and there is the possibility of increasing returns with proper management practices.

[a] According to FAO reports

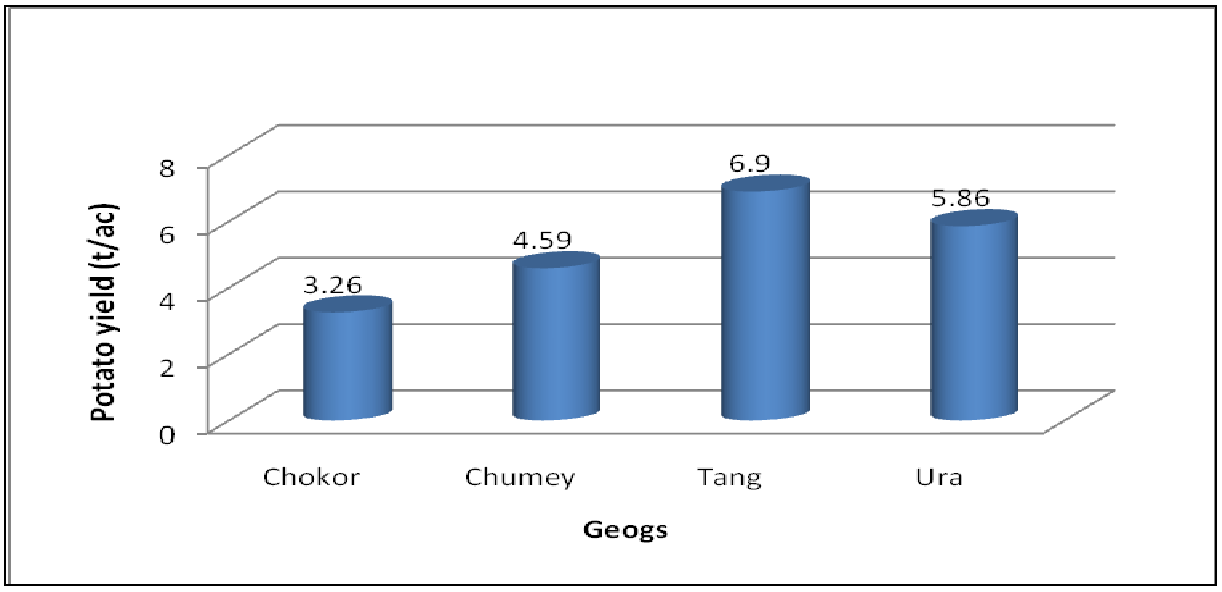

Figure 3 Average potato yield (tac^{-1}) under each geog

In this geog, majority (81%) of the farmers reported that they have changed the potato seeds. About 58% of them have changed the potato seeds during the last 5 years while about 40% of them have changed seeds during the last 5-15 years.

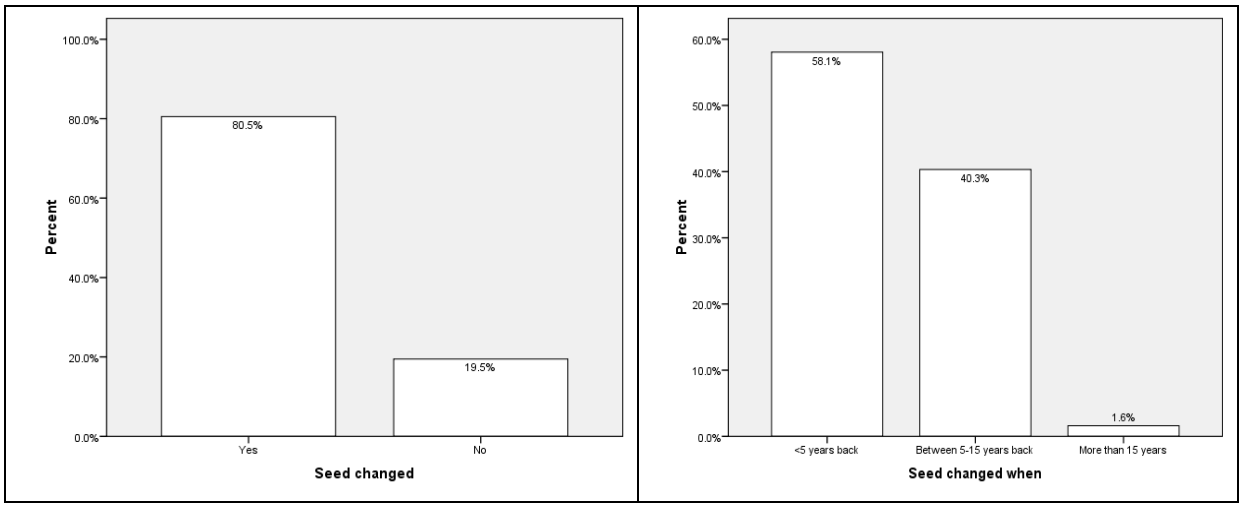

Figure 4 Potato seeds changed?

3.4 Soil fertility management practices

3.4.1 Farm Yard Manure (FYM)

In Bumthang Dzongkhag, almost all the farmers apply FYM to their fields. The average FYM application rate of the geog is 2.55 tac^{-1}. Tang geog applies the highest amount of FYM to potato fields (3.33 tac^{-1}) followed by Ura geog (3.2 tac^{-1}). Chumey geog applies the lowest amount of FYM (1.84 tac^{-1}).

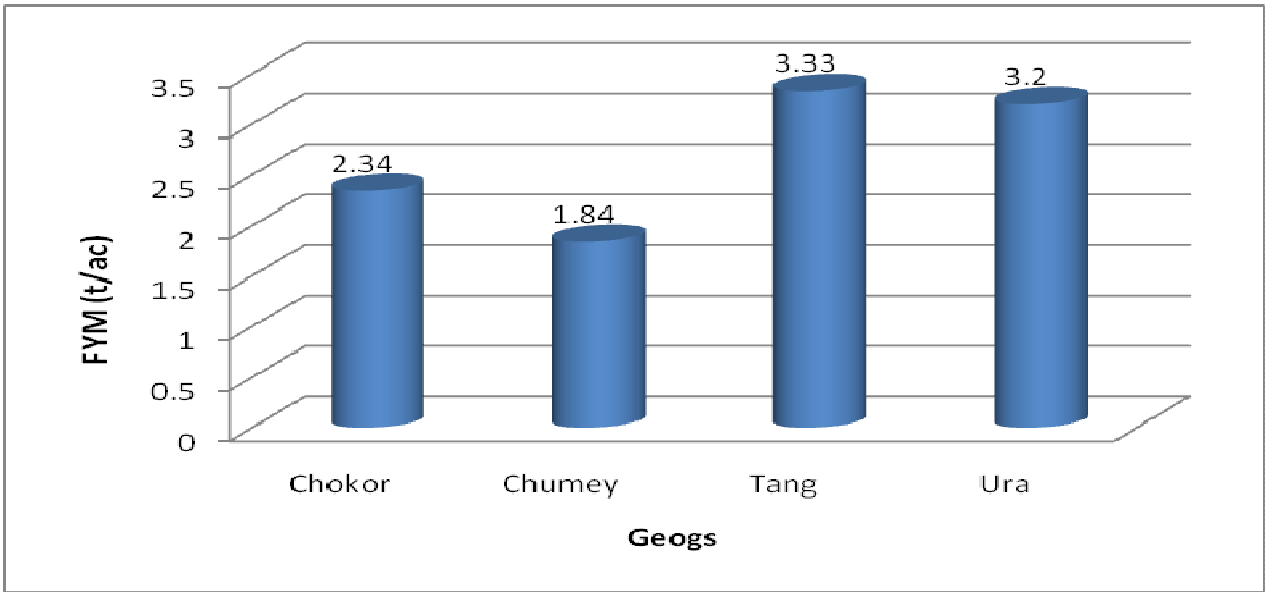

Figure 5 Amount of FYM applied (tac^{-1}) under each geog.

3.4.2 Inorganic fertilizers

The survey findings indicate that all the farmers (100%) of this Dzongkhag apply inorganic fertilizers to potato. Few farmers of Chokor and Chumey geogs apply only Suphala to potato and neither urea nor SSP is applied. The rest of the farmers of Bumthang apply urea and SSP to potato and these farmers do not apply Suphala. The average rates of fertilizers applied in this geog are about 121 kgac^{-1} urea, 271 kgac^{-1} SSP (which is equivalent to 55.75 kgac^{-1} N from urea and about 43.4 kgac^{-1} P from SSP) and about 167 kgac^{-1} of Suphala (which is about 25 kgac^{-1} each of N, P and K).

Potash containing fertilizers other than suphala is not applied in this geog and there could be a possibility of exploring fertilizer training program for the farmers of this village on balance nutrient application and also encourage farmers to apply potash containing fertilizers to potato. If this trend is continued there could be a possible nutrient mining due to application of more N and less K nutrients.

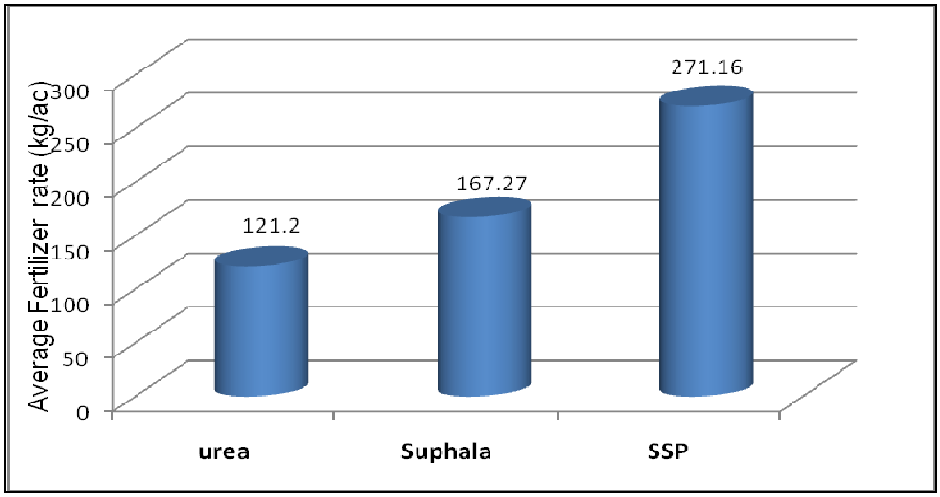

Figure 6 Average rates of fertilizer applied (kgac^{-1}) in Bumthang Dzongkhag.

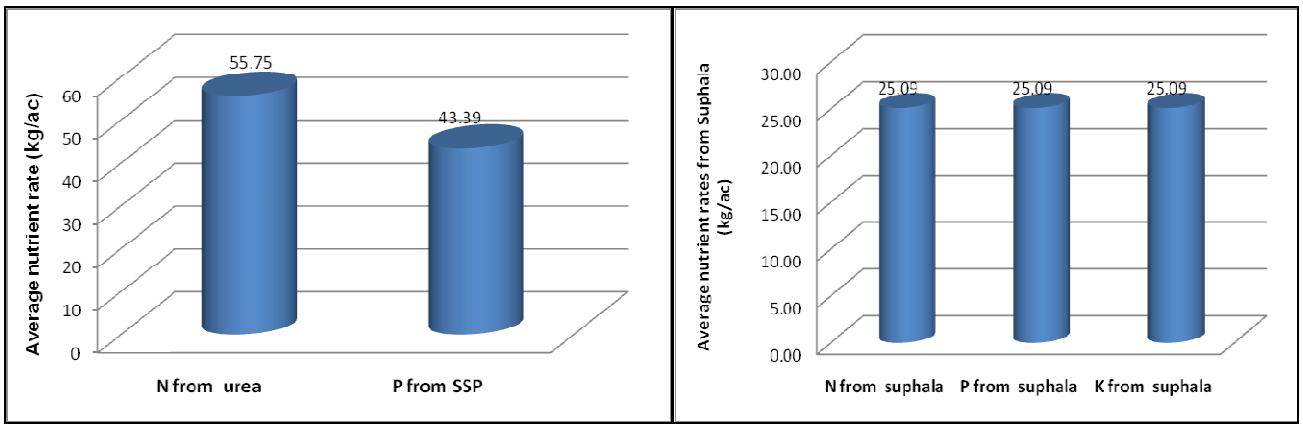

Figure 7 Average rates of nutrients applied (kgac^{-1}) in Bumthang Dzongkhag.

The highest application of suphala is reported from Chokor geog (230 kgac^{-1}) while the highest rate of SSP application is from Ura geog (387 kgac^{-1}) though urea application rates doesn't differ much between these geogs.

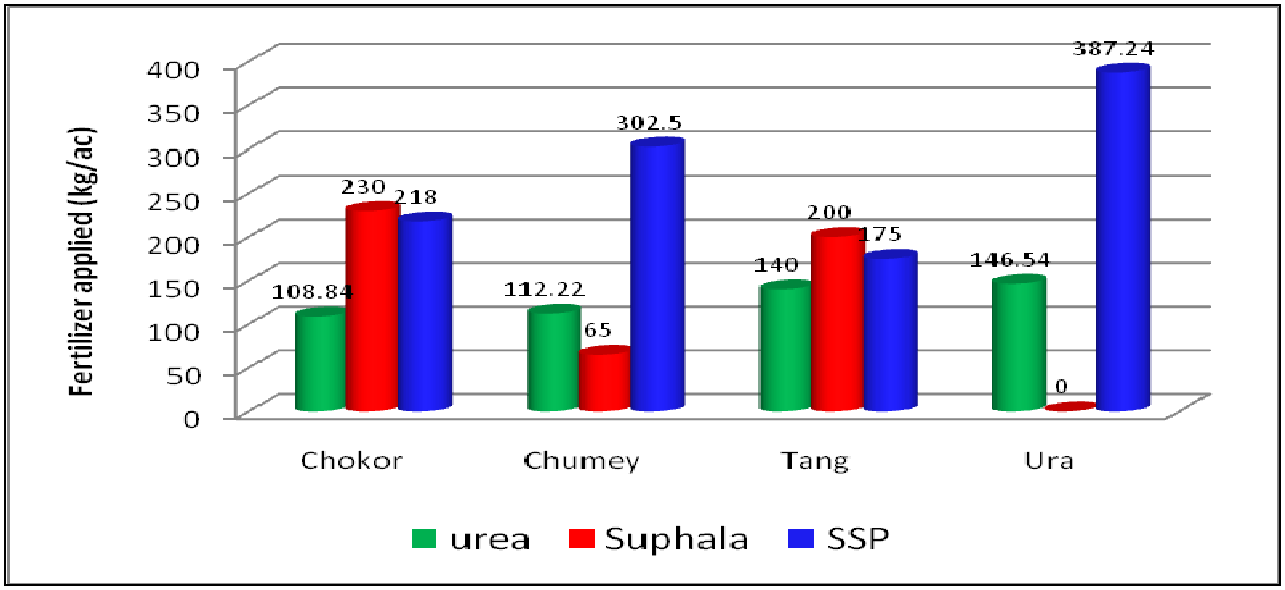

Figure 8 Amount of Suphala & urea (kgac^{-1}) applied to potato under each geog.

It is reported from literature that potatoes respond well to moisture, however, irrigation at tuber initiation can affect the skin quality of daughter tubers by influencing phytopathogens, either favorably or adversely according to conditions**,** and amount of moisture present. However, in all the geogs, no irrigation is done and is completely rain fed.

3.5 Soil analytical results of Bumthang Dzongkhag.

In the soil analysis result, with the exception of soil pH, the classifications are categorized as very low, low, moderate, high, and very high. For fertility factors (N, P, K and micronutrients) very low and low classifications indicate a high probability of obtaining a good fertilizer response; moderate classifications indicate a fertilizer response may or may not occur while a high to a very high classifications indicate that 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 applying only urea leads to rapid depletion of soil reserves of other nutrients such as P and K etc.

3.5.1 Soil pH

The following figure 9 shows the soil parameters of the Dzongkhag. The soil pH is generally categorized into five categories viz. very low (<5.0), low (5.0 to 5.5), medium (5.5 to 6.5), high (6.5 to 7.5) and very high (>7.5).

The pH of these soils is distributed from very low - low - medium ranges. Anout one third of the sampled plots very low pH (sometimes as low as 4.23) and therefore for these soils, there is the need to recollect soil samples[b] and submit to NSSC for further confirmation before trying to amend it. Potatoes are grown on organic as well as mineral soils. For potatoes, the minimum soil pH requirement is 5.5 and below about pH 4.8 growth is impaired. Alkaline conditions (pH above 7.0) can adversely affect skin quality and highly alkaline conditions can induce micronutrient deficiencies.

3.5.2 Organic Matter content (OM%)

Organic matter serves as a reservoir of nutrients and water in the soil, aids in reducing compaction and surface crusting, and increases water infiltration into the soil. The organic matter content of the soils in this Dzongkhag is within the moderate to high range. Usually the organic matter content of the soils can be increased by incorporating farm yard manure and other organic materials into the soil.

3.5.3 Available phosphorus (P)

As in all plants, potatoes also need phosphorus for good growth and yield and do respond well to P fertilizer application if the soil test results show low P values.

The available P has been categorized into five ranges, viz. very low (<5 $mgkg^{-1}$), low (5-15 $mgkg^{-1}$), medium (15-30 $mgkg^{-1}$), high (30-35 $mgkg^{-1}$) and very high (>35 $mgkg^{-1}$).

More than ***50% of the samples have high to very high available P*** while about ***35% of the samples have low to very low P*** values (name list under Table 1). Usually for available P values with low to medium range, there is a possibility of a good yield response with P application while for those farmers with high to very high P values; there is no need to apply P containing fertilizers (details under individual geog report).

[b] Soils from Chokor geog and few samples from Ura, Tang and Chumey geogs. Dzongkhag Agriculture Office to collect soil samples and submit to NSSC for further confirmation. Name list under Table 1.

3.5.4 Available potassium (K)

As in any other crop, potatoes also require adequate amounts of N, P, K for optimum crop yield. Potatoes require large amounts of K as it plays an important role in photosynthesis and starch production. Potatoes are efficient extractors of K and therefore the need to apply more K to the soil especially more so if the soil test results show low values.

Available K is also categorized into five ranges viz. very low (<40 $mgkg^{-1}$), low (40- 100 $mgkg^{-1}$), medium (100-200 $mgkg^{-1}$), high (200-300 $mgkg^{-1}$) and very high (>300 $mgkg^{-1}$).

About ***46% of the samples have low to very low available K*** while about ***42%*** of the samples are within the ***medium range*** and only about 11% within the high range. In general, the K content of these soils is poor and only few farmers of Chokor geog and Tang geogs have high available K (details under individual geog report and refer Table 2 for name list).

3.5.5 Nitrogen (N)

Potatoes require high amounts of nitrogen during a short period of time and potatoes also use large amounts of N, frequently more than the total applied as fertilizer (Anderson & Hewgill, 1978). Nitrogen is important for potato and its deficiency induces poor plant growth and crop yield besides accentuating certain diseases such as early blight and *Verticillium* wilt. On the other hand, excess N can delay the onset of tuber growth, increase knobby potatoes and promote excess vine growth.

On an average, the nitrogen content of the soils in this Dzongkhag is low. This could probably indicate the loss of nitrogen from the soil through leaching, volatilization due to improper application method and/or timing or inadequate application of nitrogen containing fertilizers.

3.5.6 Cation Exchange Capacity (CEC)

The CEC is the measure of the capacity of the soil to hold exchangeable cations (nutrients) and is used to assess the overall fertility potential of the soil. The CEC has been categorized into five ranges, viz. very low (<5 $meq100g^{-1}$), low (5-15 $meq100g^{-1}$), medium (15-25 $meq100g^{-1}$), high (25-40 $meq100g^{-1}$), very high (>40 $meq100g^{-1}$). Usually, a soil with a high CEC value (>25 meq/100g) is a good indicator that a soil has high clay and/organic matter content and can hold lots of cations while a soil with a low CEC value (<5meq/100g) is a good indication that a soil is sandy with little or no organic matter that cannot hold many cations. Normally a soil with high CEC values is considered more fertile than the ones with low values.

On an average, the CEC of this Dzongkhag falls within the low range indicating a fairly poor soil fertility status.

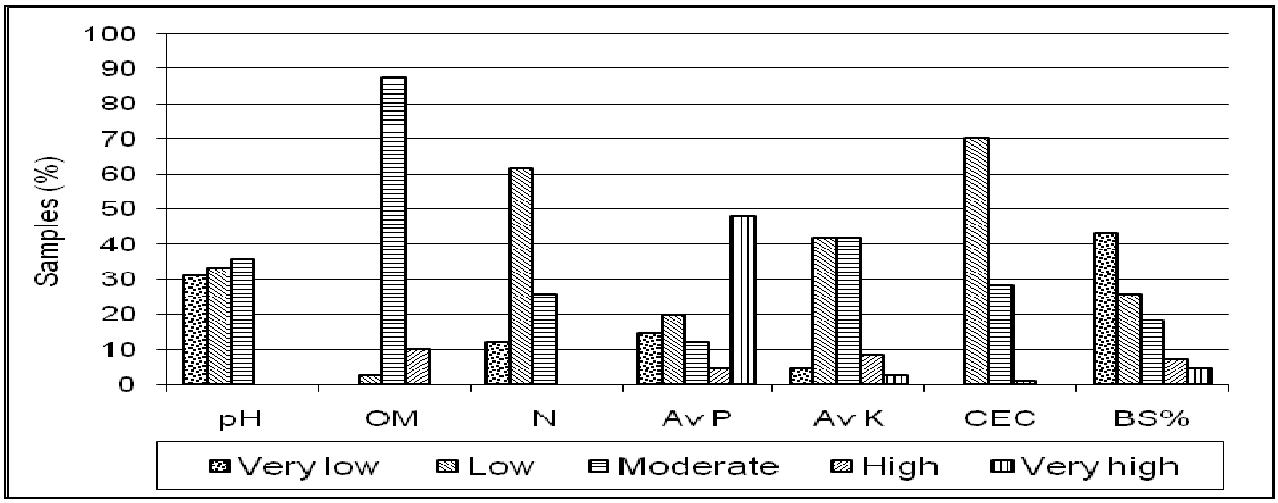

Figure 9 Soil parameters of potato fields under Bumthang Dzongkhag.

3.5.7 Soil Texture

Potatoes can be grown in most soil types though the greatest productivity is from a deep, loose, crumbly and well-aerated soil. Potatoes have low tolerance to water logging and do not do well in heavy clayey soils. Coarse-textured soils lack both nutrient and water holding capacities while fine-textured soils often have structural and infiltration problems.

The dominant soil types of this Dzongkhag are sandy clay loam (SCL) which is a moderately fine textured soil (containing more than 45% sand and about 35% clay particles); loamy sand (LS) which is a light/coarse textured soil (containing more than 70% sand and about 15% clay particles) and sandy loam (SL) which is a moderately coarse textured soil (containing more than 45% sand and 20% clay separates).

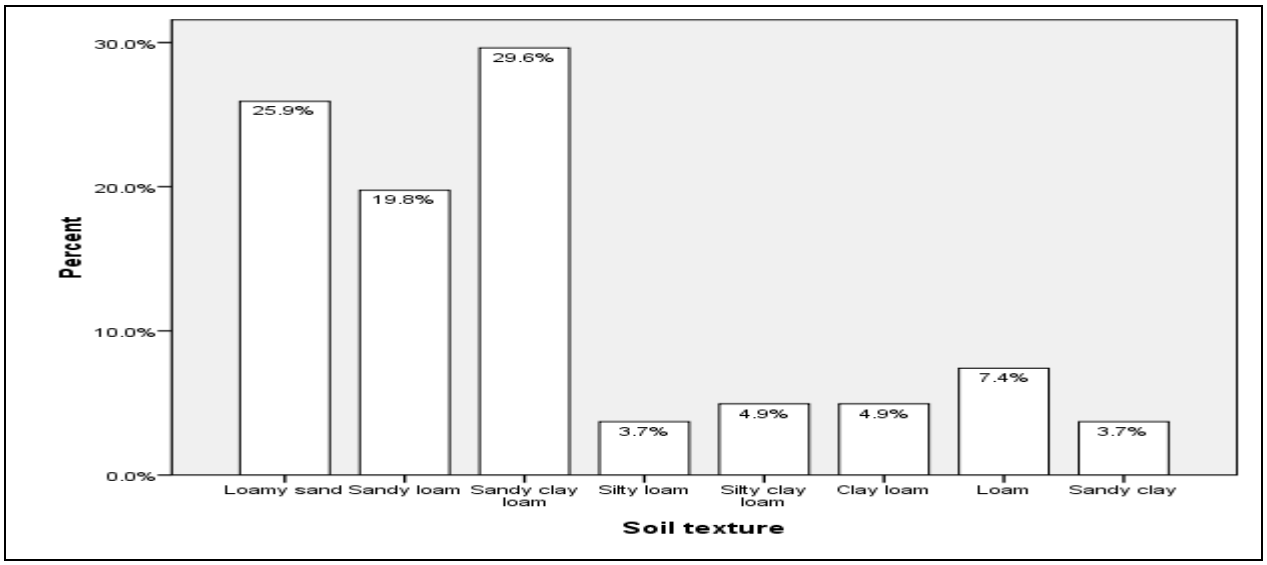

Figure 10 Soil texture of potato fields under Bumthang Dzongkhag (average of all geogs)

The soil results of individual geog under Bumthang Dzongkhag are summarized as follows.

3.6 Soil analytical result of individual geog under Bumthang Dzongkhag

3.6.1 Soil result of Chokor geog

The pH of the soils of this village is mostly within the low range. The organic matter content of this geog is mostly within the medium range. The nitrogen content is mostly within the very low to low ranges. More than ***75% of these soils have high P values*** and for these soils there is ***no need to apply P containing fertilizers such as SSP.*** While about 11% of the samples have low available P contents (refer Table 2 for name list).

More than ***79% of the samples have low available K*** values and only about 15% in the **high** range and the rest of the samples in medium range (about 36% of the samples). For those samples with low to medium K ranges, there is the need to apply ***K containing fertilizers such as MoP*** (refer Table 3 for name list). The CEC values are mostly within the low to medium ranges though the BS% range of these soils is mostly in the very low to low ranges.

The major soil type of this village is loamy sand (LS) which is a light/coarse textured soil (containing more than 70% sand and about 15% clay particles) followed by sandy clay loam (SCL) which is a moderately fine textured soil (containing more than 45% sand and about 35% clay particles), and sandy loam (SL) which is a moderately coarse textured soil containing more than 45% sand and 20% clay separates (Figure 15).

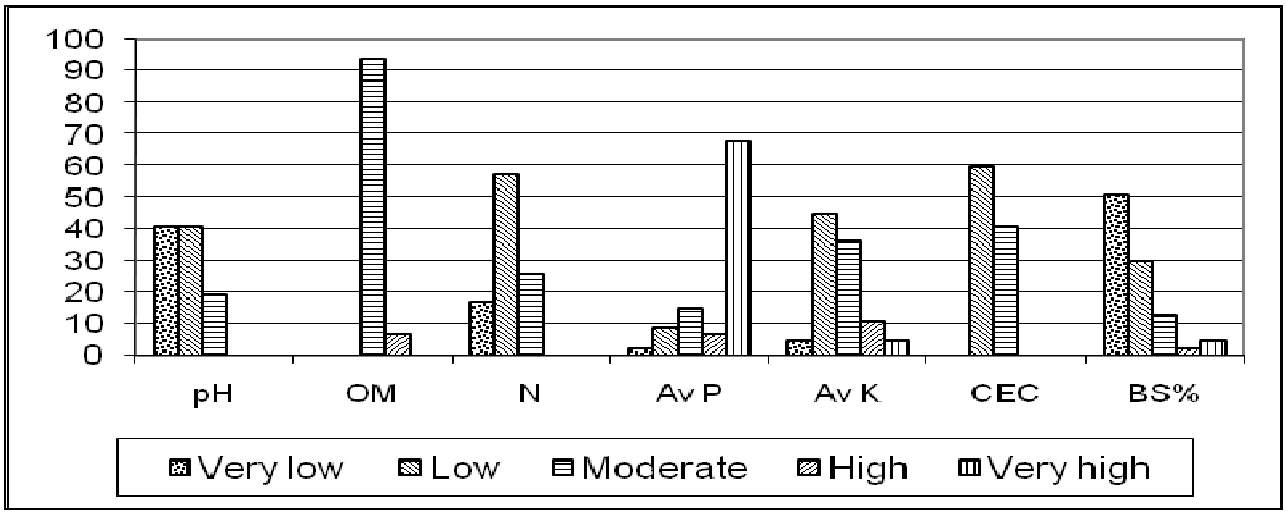

Figure 11 Soil parameters of potato fields in Chokor geog.

3.6.2 Soil result of Chumey geog

Most of the sampled plots of this geog have low pH values and about 40% of the sampled plots have ***very low pH values*** (refer Table 1) while only about 22% of the samples plots have medium pH values. The soil organic matter content is mostly in the medium range. The N content is mostly low. About ***77%*** of the sampled plots in this geog have ***low to very low available P*** and the rest of the samples are in the medium range. About 44% of the plots have ***low available K*** and the rest of the samples are in the medium range (refer Table 2 and 3 for name list). Therefore, to get a good yield,

there is a need to apply P and K containing fertilizers such as SSP and MoP respectively to improve the soil P and K status, thereby increasing the yields. The CEC and the BS% of these soils are also within the low to very low ranges for the majority of the plots. This low value indicates a fairly poor soil fertility status.

In Chumey geog, the major soil types are loamy sand (LS), a fairly coarse textured soil (containing more than 70% sand and less than 15% clay) and clay loam (CL), a moderately fine textured soil (containing about 40% of sand and clay separates). The other soil types are sandy loam, loam and silty loam (Figure 15).

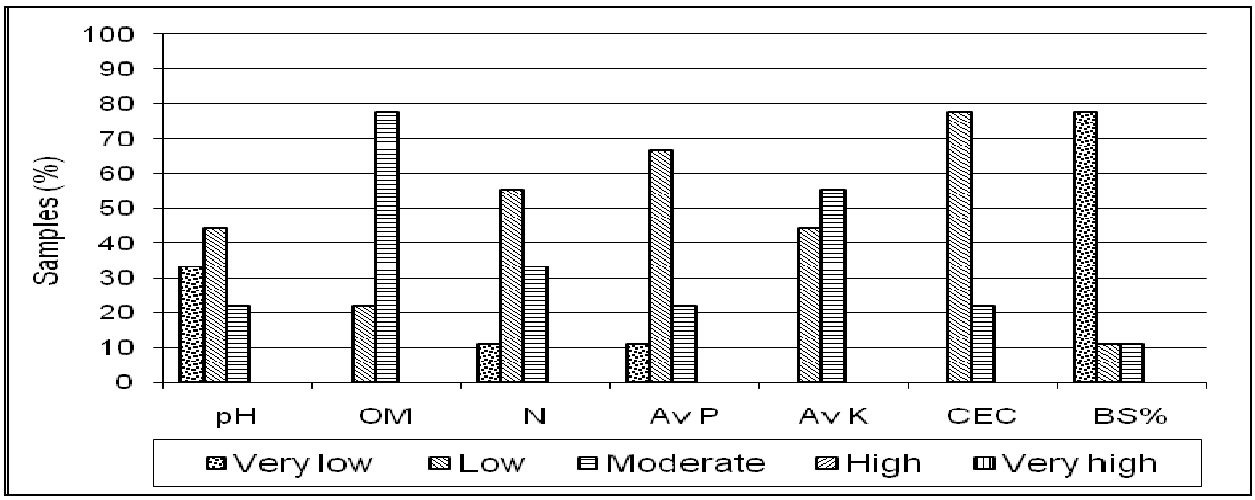

Figure 12 Soil parameters of potato fields in Chumey geog.

3.6.3 Soil result of Tang geog

The pH and the OM% of this geog are in the medium ranges. The N content is low. ***About 60% of these samples have low to very low available P,*** indicating the need to apply P containing fertilizers such as ***SSP or TSP*** while about ***40% of the sampled plots have very high P*** and therefore for these plots there is no need to apply any P (refer Table 2 for the name list of farmers with low and high P values). About ***60% of the samples have medium K values*** and about ***20% each of the samples plots have low and high K values.*** These low to medium K values indicate the need to ***apply K containing fertilizers such as MoP*** to improve the nutrient status of these soils (refer Table 3 for name list). The CEC of these soils is low while the BS% range of these soils is distributed from very low to medium ranges.

Silty loam (ZL), which is moderately coarse textured soils containing about 25% clay and about 45% sand is the major soil type of this geog. The other soil types found are sandy clay loam, sandy loam and loamy sand (Figure 15). In such coarse soils, usually a split application of N is advisable.

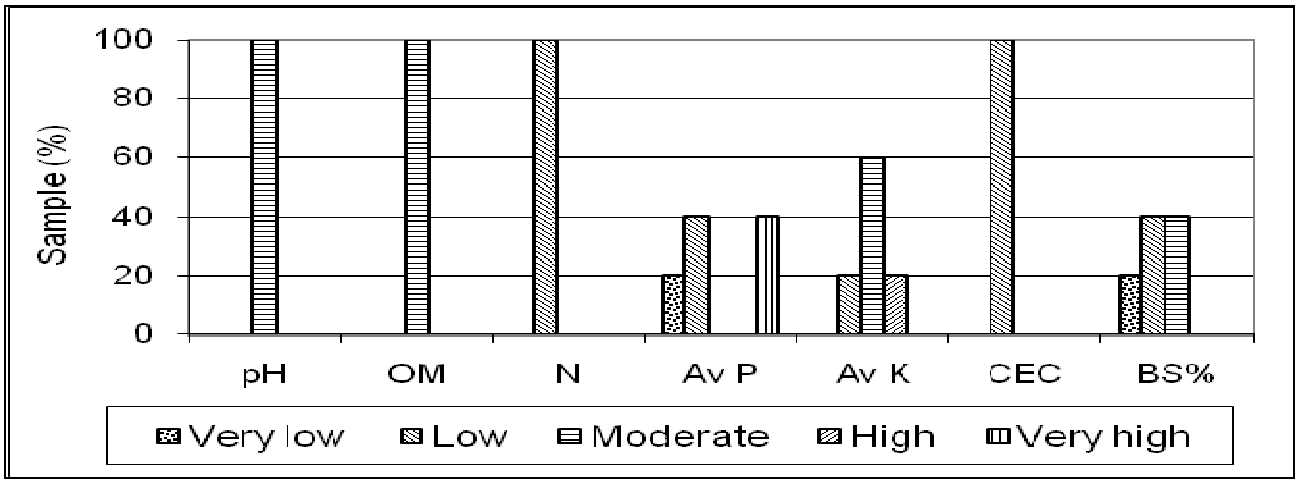

Figure 13 Soil parameters of potato fields in Tang geog.

3.6.4 Soil result of Ura geog

The pH of these soils is mostly within the medium range. The N content of these soils is within the low to medium range. About ***65% of the sampled plots have low to very low available P*** values while about 15% are in the medium range and about ***20% of the sampled plots have high to very high P*** values (refer Table 2 for name list of farmers with low and high P values). Therefore, for those with low P values there is the need to ***apply P containing fertilizers such as SSP and TSP*** to increase the P content of the soils for better crop yield. About ***50% of the samples plots have low to very low available K*** contents and about ***50% have medium K*** values and only about ***5% have high K values*** (refer Table 2 for farmer name list). Therefore, for those plots with low to medium K values, there is the need to apply ***K containing fertilizers such as MoP*** (refer Table 3 for name list). The CEC of these soils is mostly in the low range while the BS% of these soils is distributed from very low to high ranges.

Sandy clay loam (SCL), moderately fine textured soil containing more than 50% sand and more than 35% clay) is the predominant soil type of this geog, followed by silty clay loam (ZCL), which is also moderately fine textured soil containing about 20% sand with 40% clay with more than 40% silt separates (Figure 15).

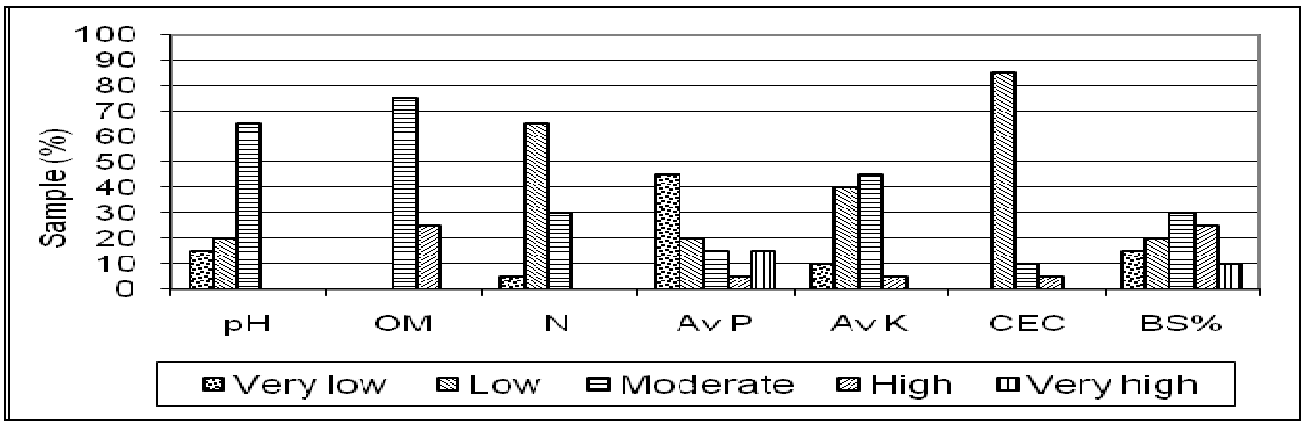

Figure 14 Soil parameters of potato fields in Ura geog.

3.6.5 Soil texture of different geogs under Bumthang Dzongkhag

The different soil textures found in each geog under Bumthang Dzongkhag is presented in the following figure.

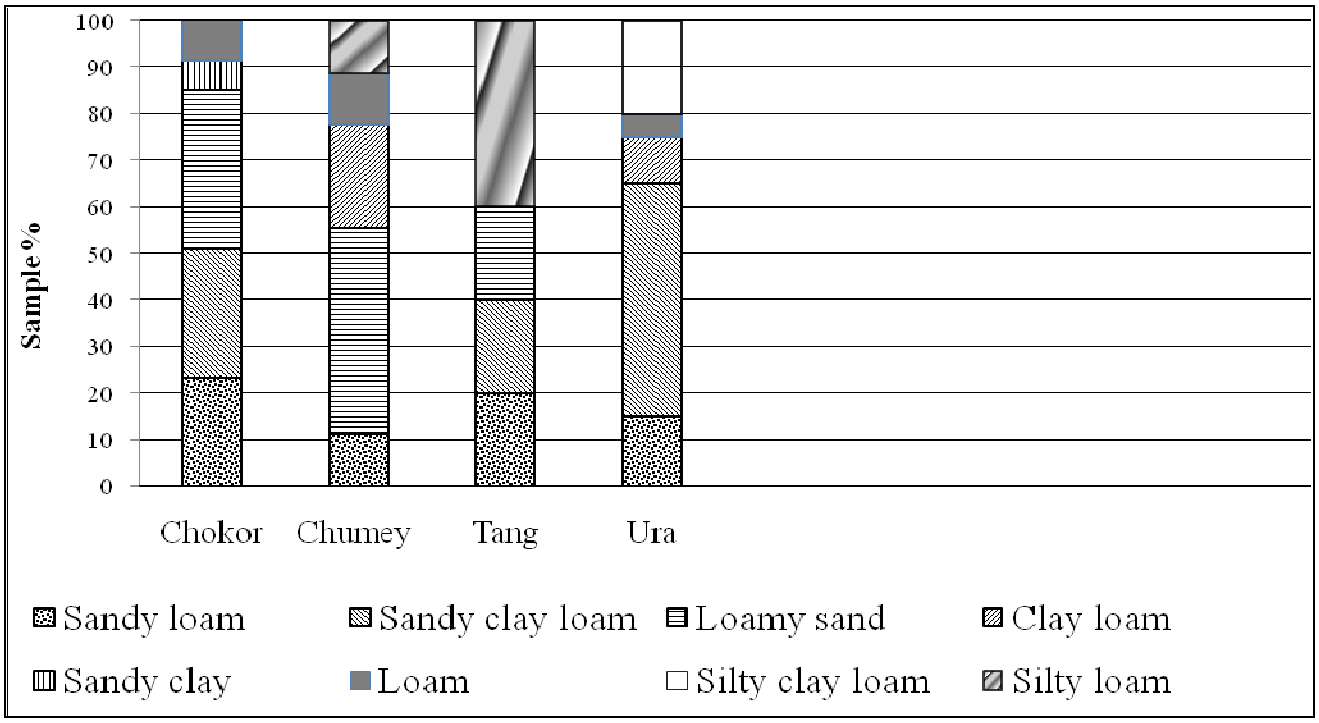

Figure 15 Soil textures of potato fields in different geogs under Bumthang Dzongkhag.

4. Conclusions

In Bumthang Dzongkhag, the survey findings indicate that majority of the sampled plots are located at medium altitude range of (2000 -3000 m.asl) and the majority of the plots are situated on sloping areas. Most of the sampled plots are north-easterly and north westerly facing aspects. The average field size for potato plantation is less than 1 acre. Desiree followed by Yusikap is the most preferred potato variety grown by the farmers.

The majority of the farmers of this Dzongkhag apply FYM and some chemical fertilizers as part of the soil fertility management practices. On an average, the farmers apply about 2.55 tac^{-1} of FYM, 121 $kgac^{-1}$ urea, 167 $kgac^{-1}$ Suphala and 271 $kgac^{-1}$ SSP to potato. The majority of the farmers of this Dzongkhag apply urea and SSP to potato and these farmers do not apply suphala. Those farmers applying suphala do not apply either urea or SSP and vice-versa. Other fertilizer such as MoP is not applied at all.

The average potato yield of Bumthang Dzongkhag is 4.28 tac^{-1}[c]. Tang geog reported the highest yield of potato (6.9 tac^{-1}). The average potato yield figure is lesser than the FAO yield estimate for Bhutan (FAO yield estimate for farmer field is about 6.5 tac^{-1}) indicating the potential for increasing yield with better inputs and management practices. About 58% of the farmers reported that they have changed the potato seeds during the last 5 years.

On an average the pH of the soils is mostly within the low to medium range with some plots in the very low range. About 50% of the sampled plots have high available P values though few villages have low P values. The organic matter content of these soils is also within the medium to high range. The available K content of most of these soils is within low to medium ranges and very few plots in the high range. The CEC of these soils is low range indicating a fairly low soil fertility status. Sandy clay loam, loamy sand and sandy loam, are the major soil types found in this Dzongkhag.

5. Recommendations

- In Bumthang Dzongkhag, there are two rates of fertilizer applications. Viz.
  - The average nutrient input through use of inorganic fertilizers (urea and SSP) to potato is 55.75 $kgac^{-1}$ N from urea and 43 $kgac^{-1}$ P from SSP (i.e 121 $kgac^{-1}$ of urea and 271 $kgac^{-1}$ SSP). With the limited use of balanced mineral fertilizer, especially K, the soil K status could deteriorate with time. The farmers of this geog should decrease the P applicaition for time being and increase K fertilization to get a good yield and also to prevent P build up in the soils. (Please refer Table 1 for the farmer list with low P and K values).

  - The other through the use of suphala alone (167 $kgac^{-1}$ suphala) which supplies only about 25 $kgac^{-1}$ of N,P,K. This rate is quite low compared to the NSSC recommendations.

- For this Dzongkhag, the soil analytical result indicate a ***fairly low K*** but ***very high P*** **status** and therefore, the NSSC recommendation of 40:32:32 kg NPK ac^{-1} could be followed.

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 3.5 and 3.6) the following recommendations are suggested to improve the soil nutrient status in the Dzongkhag.

- The available P content of these soils in most of the villages is high and this could be checked by not applying P containing fertilizer such as SSP (refer Table 2 for name list) for this cropping season.

- The available K content of these soils is mostly within the low to medium range and there is 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 (refer Table 3 for name list).

The CEC of these soils is within the low to medium range and therefore there is also the need to improve its nutrient content as all the major macronutrients are required to obtain an adequate yield

[c] This average potato yield figure is comparable to the RNR data of 2009 (potato yield of 4.05 tac^{-1})

and hence an application of balanced nutrients with proper recommended rate needs to be encouraged (i.e. the rate of 40:32:32 kgac^{-1} of NPK is recommended based on the soil results.

The K values need to be increased for these soils based on the NSSC and FAO recommended rate, as these values from the soil analysis report are low while the rate of P is to be decreased or not applied for time being as the soil results show fairly high P values. 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 40:32:32 kgac^{-1} of NPK (for those farmers with low P & K values only):

5.1 Using Suphala and urea (in one acre) for those farmers with low P and K values**:**

- In order to supply the nutrients at the recommended rates, apply about 213 kgac^{-1} of Suphala as basal dose during land preparation (i.e. about 4 bags of Suphala @50 kg bag $^{-1}$ ac^{-1}).

- Followed by one application of 17 kgac^{-1} of urea after 30 days of planting (or when the plant is about 45 cm in height) OR two split applications of urea @ 8.5 kg each when the plants are 45 cm high and the other at the time of flowering.

5.2 Using SSP, MoP and Urea (in one acre) [d] for those farmers with low P and K values**:**

- Apply 44 kgac^{-1} of Urea as basal dose during land preparation (i.e. about 1 bag of urea @50 kg bag $^{-1}$ ac^{-1}).

- Apply 200 kgac^{-1} of SSP as basal dose during land preparation (i.e. 4 bags of SSP @ 50 kg bag $^{-1}$ ac^{-1}).

- Apply about 54 kgac^{-1} of MoP as basal dose during land preparation (i.e. about 1 bag of MoP @ 50 kg bag $^{-1}$ ac^{-1}).

- Followed by urea application as two split top dressings, i.e about 22kg ac^{-1} of urea top dressed when the plants are 45 cm high and another 22 kg ac^{-1}of urea at the time of flowering.

- In addition to this, where ever there is a moderately coarse to medium textured soil type, 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 a completely dry soil is not encouraged.

- The above recommended rate would be applicable for those farmers' soils with low P and K values as suggested in Table 2 & 3 for easy reference.

[d] If the farmers are willing, this second type (5.2) of application is more advisable than the first type as the SSP contains additional nutrient (sulphur), which helps in better production of yield.

B. The recommended rate of 40:00:32 kgac^{-1} of NPK (for those farmers with *high P* & low K values):

5.3 Using MoP and Urea (in one acre) for those farmers **with low K but high P values:**

- Apply 44 kgac^{-1} of Urea as basal dose during land preparation (i.e. about 1 bag of urea @50 kg bag $^{-1}$ ac^{-1}).
- Do not apply any SSP at all for time being (at least for this year)
- Apply about 54 kgac^{-1} of MoP as basal dose during land preparation (i.e. about 1 bag of MoP @ 50 kg bag $^{-1}$ ac^{-1}).
- Followed by urea application as two split top dressings, i.e about 22kg ac^{-1} of urea top dressed when the plants are about 45 cm in height 9or3o days after planting) and another 22 kg ac^{-1}of urea at flowering time.

Table 1 Name list of farmers with low pH values under Bumthang Dzongkhag

VERY LOW pH VALUES (i.e. pH < 5.0)	
1. SANGAY DEMA, DEKILING, CHOKOR GEOG 2. KARMA, DEKILING, CHOKOR GEOG 3. PHURBA, DEKILING, CHOKOR GEOG	1. DECHENMO, PANGKHAR, URA GEOG 2. DORJI CHODEN, SHINGNEER, URA GEOG
1. NAKPHEL, JAKAR, CHOKOR GEOG 2. UGYEN WANGMO, JAKAR, CHOKOR GEOG	1. KARMA EDEN, DOMKHAR, CHUMEY GEOG 2. AP TAWLA, DOMKHAR, CHUMEY GEOG
• KARDUNG, CHANGWA, CHOKOR GEOG	
1. TAULA, NORGANG, CHOKOR GEOG 2. DORJI, NORGANG, CHOKOR GEOG 3. JAMBAY LHAMO, NORGANG, CHOKOR GEOG 4. PEM DEMA, NORGANG, CHOKOR GEOG	
• PHOMO, JAMBAY LHAKHANG, CHOKOR GEOG	
• TSHEWANGMO, DAWATHANG, CHOKOR GEOG	
• TSHERING DOLKAR, TAMSHING, CHOKOR GEOG	
1. WANGMOLA, NORGANG, CHOKOR GEOG	
2. TASHIMO, NORGANG, CHOKOR GEOG	
3. DEMA, NORGANG, CHOKOR GEOG	
4. TSHOMO, NORGANG, CHOKOR GEOG	
• KARMA DEMA, DORJIBI, CHOKOR GEOG	
• PEMA YUDEN, ZUNGNEY, CHOKOR GEOG	
DZONGKHAG AGRICULTURE OFFICE (EAs OF RESPECTIVE GEOGS) COULD COLLECT SOIL SAMPLES FROM THESE PLOTS AND SEND TO SFU, NSSC FOR FURTHER ANALYSIS AND CONFIRMATION.	

Table 2 Name list of farmers with extremes of P values under Bumthang Dzongkhag

VERY LOW – LOW AVAILABLE P	HIGH - VERY HIGH AVAILABLE P
TSHERING DEKI (PANGSHING, TANG)	KARMA RINZIN (PHOMRANG, TANG)
AP KHANDU (PRALANG, TANG)	SONAM DEMA (PHOMRANG, TANG)
LEKI CHODEN, JAMSHONG, TANG GEOG)	PHUNTSHO NAMGYAL (URA, URA GEOG)
CHINGMO (PANGKHAR, URA GEOG)	NADOLA (SHINGNEER, URA GEOG)
ALL THE FARMERS OF SAMRONG, SHINGNEER AND TANGSIBI (URA GEOG)	ALL THE FARMERS OF PANGKHAR (URA GEOG)
ALL THE FARMERS OF CHUMEY EXCEPT • PEMA YUDEN (ZUNGNEY) • AP TAWLA (DOMKHAR)	ALL THE FARMERS OF CHOKOR GEOG EXCEPT • NAKPHEL (JAKAR • UGYEN WANGMO, (JAKAR) • CHOKI (NASFIL) • UGYEN WANGMO (CHANGWA) • TSHEWANGMO (DAWATHANG)

Table 3 Name list of farmers with low K values under Bumthang Dzongkhag

VERY LOW – LOW K
ALL THE FARMERS OF CHUMEY
ALL THE FARMERS OF TANG GEOG EXCEPT KARMA RINZIN (PHOMRANG)
ALL THE FARMERS OF CHOKOR GEOG EXCEPT • TSHERING WANGMO (DEKILING) • DORJI (JAKAR) • RINCHEN WANGMO (NASFIL) • TSHERING CHOKI (KENCHOSUM) NAZOM & SONAM PELDON (JALKHAR)
ALL THE FARMERS OF URA GEOG • URA VILLAGE • PANGKHAR VILLAGE • SHINGNEER VILLAGE • TANGSIBI VILLAGE