in this age classed more than other so it was shown the highest of bulk density because bulk density increased with clay content and is considered a measure of the compactness of the soil.

Soil chemical properties were investigated including reaction (pH), contents of organic matter, carbon, nitrogen, extractable minerals as soil cation exchange capacity (CEC) and base saturation.

Soil pH of total age classes samplings of pine plantations were strongly acid to very strongly acid. pH values tend to be increased over stand age. In the surface soil layer, the contents of organic matter, carbon and total nitrogen of total age classed had rather moderately high to very high as 27.8-115.1, 16.1-73.5 and 2.0-8.3 $g.kg^{-1}$; and phosphorus available, extractable calcium and magnesium tend to be high as 3.3-25.6, 73.4-1,714.6 and 82.0-259.5 $mg.kg^{-1}$. Cation exchange capacity had 17.4-36.6 $cmol.kg^{-1}$. These chemical properties tend to be higher over stand age except at 17 year-old and 33 year-old. The extractable potassium had very high (201.7-498.5 $mg.kg^{-1}$), whereas the extractable sodium had low to very low (15.0-67.2 $mg.kg^{-1}$) in soil profiles of total age classed. The percent base saturations in the top soil depth (0-10 cm) of total age classed samplings tend to be higher over stand age. Fertile assessments in the top soil depth (0-10 cm) of total age classed samplings of *Pinus kesiya* plantations tend to be medium and higher over stand age except at 17 year-old was high, and they were decreased with soil depth.

Soil properties in 17 and 29 year-old pine plantation were quite well so the average growth increment in 17 year-old had the highest (0.93 m/yr height and 1.56 cm/yr diameter), contrast with 29 year-old had the lowest (0.52 m/yr height and 0.98 cm/yr diameter). This may caused of too high elevation (1,606 m msl) at 29 year-old in cool condition would delay the mechanism growth process.

(2) Soil Properties in Fragmented Forests and Opened Area

The soils in fragmented forests were classified in Order Ultisols, Suborder Humults. Soil depths were more than 200 cm with 10-15 cm thickness of organic layers. The soil profiles were developed as A-AB-Bt with high clay mineral in subsoil.

Total fragmented forests had low to very low bulk densities in the top soils and increased with soil depth. The top soils (A horizon) of total fragmented forests had very low densities of 0.70-0.97 $Mg.m^{-3}$. The 2nd fragmented forest had the highest amounts of gravel on the top soils because of lower soil horizon development process than other fragmented forests.

The percentages of sand in soil profiles varied from 26.5-75.0%. Silt particles in soil profiles varied from 7.7-37.7%, whereas the clay varied from 9.7-56.1%. The 3rd and 4th fragmented forest had the highest sand particles, whereas the 2nd fragmented forest had the highest clay particles. The top soils of almost fragmented forests were sandy loam whereas subsoils were sandy clay loam, loam and clay loam. The 2nd fragmented forest had sandy clay loam in top soil and clay to clay loam in subsoil.

Soil pH of most fragmented forests were strongly acid (5.25-5.55) except the 1st fragmented forest was slightly acid (6.13) in top soil and moderately acid to very strongly acid in subsoil. The contents of organic matter, carbon and nitrogen in the

top soil depth of total fragmented forests had rather high as 60.9-129.6, 35.3-75.2 and 2.5-6.9 $g.kg^{-1}$. There were decreased with soil depth. The phosphorus available contents, the extractable potassium, calcium, magnesium and sodium were 12.2-22.0; 298.4-745.5; 425.9-1,572.7; 89.9-357.5 and 19.9-26.0 $mg.kg^{-1}$. Cation exchange capacity (CEC) had range from 7.7-29.6 $cmol.kg^{-1}$. The percents base saturation in the top soil depth of total fragmented forests varied range from 12.69-84.45%. Fertile assessments in the top soil depth of total fragmented forests tend to be medium to high and they were decreased with soil depth. The 5th fragmented forest had the highest of the base saturation percentage. The 2nd fragmented forest had poorer soil properties than other fragmented forests so species diversity (SWI) was quite low (3.65). They were found the dominated tree species in fragmented forests by *P. kesiya*, *C. acuminatissima*, *S. wallichii*, *C. diversifolia*, *C. purpurea*, *Helicia nilagirica* and *T. gymnanthera*. However, *Q. brandisiana* only distributed in the 2nd fragmented forest.

Bulk density in opened area was very low in the top soils and increased with soil depth as 0.80-1.38 $Mg.m^{-3}$. The amounts of gravel were range from 10.52-23.08%. The percentages of sand in soil profiles varied from 57.0-72.2%. Silt particles in soil profiles varied from 18.5-30.0%, whereas the clay varied from 7.2-20.7%. The top soils of opened area was sandy loam and sandy loam to sandy clay loam in subsoil

Soil pH of opened area was mainly strongly acid. The contents of organic matter, carbon and nitrogen in the top soil depth had quite high as 105.6-118.7, 61.3-68.9 and 5.2-5.3 $g.kg^{-1}$; phosphorus available, extractable potassium, calcium, magnesium and sodium as 8.8-12.8, 352.6-468.3, 1,019.2-1,690.7, 97.2-228.5 and 18.2-19.4 $mg.kg^{-1}$, cation exchange capacity as 30.4-33.5 $cmol.kg^{-1}$.

It was found the highest density of herb species in opened areas including, *Hypolepis punctata* and *Ageratina adenophora*. Other herb species were *Imperata cylindrical, Catimbium speciosum*. There were some seedlings of *Eurya nitida*, and few of *Melastoma sanguineum, Camellia pleurocarpa, Litsea cubeba, Blumea balsamifera* and *Tephrosia purpurea* in opened areas.

Recommendations

The recommendations for successions of reforestation on highland watershed should be following below.

When the forest areas on highland watershed are clear felling, plantations play the firstly key role to reforestations. Pioneer local species including *P kesiya* should be select for plantation on highland watershed because it can establish and grow well on dry site conditions and poor soils. Fertilization and particularly weeding to ensure rapid early tree growth are frequently fundamental to the success of the plantations. Furthermore, damage from forest fires is efficiently prevented. Growth rate and microclimate at establishment are influenced by soil properties and ground vegetation. The forest microclimate can change as the plantations develop.

After establishment *P kesiya* plantations were succeed, increasing size and biomass, a distinctive microclimate and soil environment develop which in turn strongly influence the growth process itself. Other local broad-leaved tree species need ever be planted in mixed stand with *P kesiya* plantations. Certain tree species in

suitable site including altitude should be recommend such as *C. acuminatissima* as 1,200-1,500 m msl; *Q. brandisiana* and *A. fragrans* as 1,200-1,300 m; *L. elegans, T. gymnanthera* and *C. purpurea*, 1,300-1,400 m; and *C. diversifolia, T. gymnanthera, H. nilagirica, S. wallichii, Q. vestita* and *E. nitida*; 1,400-1,500 m. Changes in plant diversities will become more apparent and rapid restoration of a forest community as well as forest succession progress.

Trees retain large reserve of nutrients within them, especially in the foliage and stem, and have a remarkable ability to mobilize and re-use the nutrients to support sustained growth in the long term.

Adjacent fragmented forests are urgently to facilitate their conservation and management especially prevent clear felling and forest fires in order to play a key role as the mother trees which are a source of seed dispersal into plantations and opened areas to increase plant diversities. The roles of plant resources are still very important for naturally succession.

Finally, the local communities could also have a role in forest management.