CHAPTER 6
CONCLUSIONS

1. Experimental conclusion

1.1 Appropriate amendment application method

The method of application of organic and clay material amendment to improve sugarcane production in degraded sandy soil was considered from soil properties, sugarcane germination, growth and yield. Broadcasting method was found to be suited for amendment which improved bulk density, increased clay content, soil organic matter, available phosphorus, improved sugarcane germination, growth and yield. The materials incorporated can attach and react with soil particle fully with higher efficiency than banding in the furrow method without incorporation.

1.2 Appropriate type of amendment material

The most suitable material to improve sugarcane production in degraded sandy soil was clay soil @ 75 t ha^{-1} for both broadcast and banding application methods. This was shown by suitability classification method.

The best material was explained by ranking soil properties and plant characteristics as presented in Tables 13 to 19 that cattle manure @ 25 t ha^{-1}, filter cake @ 50 t ha^{-1} and clay soil @ 75 t ha^{-1} were best for broadcasting method. The appropriate materials in banding trial were filter cake 50 t ha^{-1} followed by clay soil 75 t ha^{-1} and cattle manure 25 t ha^{-1} respectively.

In addition, types of amendment should be considered from cost of material, transportation cost, and source of material, management after amendment, cost benefit ratio and return on investment. The best material was filter cake application because of lowest transportation and material cost but the field should not be far from the mill (< 30 kilometers). Cattle manure application had the best yield but problem of weeds which comes along with manure and material cost which is higher than other treatments. In late rainy season where pre-emergence herbicide application cannot be done, maintenance cost on manual weeding becomes quite high. However, the cost

benefit ratio showed best treatment in broadcast application was filter cake @ 50 t ha^{-1} (32,000 Baht ha^{-1}) followed by conventional fertilizer @ 50-50-25 KgN-P_2O_5-K_2O ha^{-1} (32,021 Baht ha^{-1}) and cattle manure @ 25 t ha^{-1} (27,069 Baht ha^{-1}). In addition, banding application with filter cake @ 50 t ha^{-1} received highest net profit with 27,747 Baht ha^{-1} followed by conventional fertilizer @ 25-25-12.5 KgN-P_2O_5-K_2O ha^{-1} (24,939 Baht ha^{-1}) and clay soil at the rate of 25 t ha^{-1} (23,059 Baht ha^{-1}). We have made an attempt to evaluate the present study from the cost benefit ratio and the data is presented in Table 20-21.

The appropriate clay soil application rate for improving sugarcane production in degraded sandy soil was incorporated with 75 t ha^{-1} of clay soil. This resulted in maximum yield, increased aggregate stability of soil and maintained exchangeable calcium after planting. However, after considering the cost benefit analysis that clay soil @ 25 t ha^{-1} recorded highest profit in both broadcasting and banding application mehods as shown in Table 20 and 21. The higher transportation and material cost of clay soil necessitates lower application rate.

2. General conclusion

The conventional practice in sugarcane production without organic or clay material amendment reduces crop productivity through (1) increased bulk density (2) decreased aggregate stability (3) decreased soil pH (4) decreased soil organic matter (5) decreased available phosphorus (6) decreased potassium (7) decreased calcium (8) decreased magnesium and (9) decreased CEC. The limitation to sugarcane production in Oxic Paleustults found were soil texture, exchangeable potassium, organic matter and cation exchange capacity (soil fertility factor). First limiting factor in this area was potassium deficiency. The amendment of organic and clay material can fix potassium ion due to greater CEC with a high negative charge in slowly available form (Brady, 1984). This was indicated by luxury consumption with more potassium concentration in third visible dewlap leaf of control and conventional chemical fertilizer. Also in organic and clay material amendment excess potassium concentration in tissue was found. Potassium removal by sugarcane is high so the amendment of organic and clay materials can sustain potassium in soil. Otherwise, influence of calcium in clay soil can greatly reduce the level of potassium in soil

solution. Furthermore, high calcium levels in the soil solution may reduce potassium uptake by the plant. That means clay soil application can reduce luxury consumption of potassium from soil.

The supplementary properties are organic matter and CEC wherever found maximum organic matter after amendment in cattle manure and filter cake application. Cation exchange capacity (CEC) increased in clay and organic materials amendments. Negative charge in clay comes from ionizable hydrogen ions and from isomorphous substitution. Ionizable hydrogen ions are hydrogens from hydroxyl ions on clay surfaces. The –Al-OH or –Si-OH portion of the clay ionizes the H and leaves an unneutralized negative charge on the oxygen (-Al-O^- or –Si-O^-). The second source of charge on clay particles is the substitution of one ion for another of similar size and often with lower positive valence (Miller and Roy, 1990). In addition, organic and clay material can improve soil aggregate stability by increasing mean weight diameter and degree of aggregation due to more cation adsorption and humic acid binding.

Calcium management should be considered in moderately acid soil as calcium can increase soil pH and CEC. Liming can enhance pH and CEC by adsorb more to available nutrients e.g. nitrogen, magnesium, phosphorus, potassium, sulphur and molybdenum.

Soil fertility rehabilitation for sugarcane production in Oxic Paleustults should take into consideration the following issues:

(1) Improve and retain CEC and organic matter by organic materials supplement (especially with local organic waste and industrial by-product) combined with clay soil amendment. It could retain nutrients availability especially in high consumption nutrients e.g. potassium and calcium.

(2) Provide sufficient nutrients in a balanced level with plant removal using split fertilizer application depending on stage of growth and crop nutrient demand.

(3) Liming with dolomite can increase soil pH, calcium and magnesium and encourage aggregate stability and CEC.

(4) Green cane trash blanket after harvest can return carbon, nitrogen and other nutrients (e.g. P, K, Ca, Mg) to soil.

(5) Increase biodiversity by organic matter supplement, avoid herbicide and insecticide (using integrated pest management).

(6) Control tillage system in land preparation and weeding should be done at the right time with minimum tillage.

(7) Control traffic in heavy machinery usage one should layout transportation path to reduce soil compaction in field.

(8) Soil erosion control by reducing unnecessary cultivation practices, green-cane trash blanketing and contour planting on steep slope. Management on time following sequence of sugarcane cropping system should done avoiding cultivation or growing during storm events (prevalent between September and October).

(9) The cropping system management using fallow or crop rotation with green manuring between crop cycles provides the soil with a break from pest, weed and diseases cycles and allows mineralization of nitrogen and other nutrients stored in soil microbes.

In other crops, the limiting factors which influence on growth, plant nutrient concentration and soil properties should be considered. However, cash crop *viz.*, cassava and kenaf also remove potassium at higher level and require more potassium supplement in soil can be managed similarly to sugarcane management.

3. Suggestion for further study

3.1 The effect of organic and clay material amendments should be studied further in utilization of recommendation rate of cattle manure @ 25 t ha^{-1}, filter cake @ 50 t ha^{-1} and clay soil @ 75 t ha^{-1} for sugarcane production should reconsider for other crops production.

3.2 Organic and clay material combination should be tested for application method and appropriate rate for degraded soil improvement in sugarcane cropping system. The combination material can increase and maintain organic matter for organic sugar production in future.

3.3 The effect of organic and clay material amendment on subsequent ratoons according to trash management in long-term sugarcane production should be studied. Then one can understand nutrient cycling in continuous sugarcane monoculture and use of nutrient management in sugarcane cropping system with sufficient level according to growth stage.

3.4 The improvement of soil pH in acid sandy soil using lime can support organic and clay material amendments efficiency. The calcium increment with liming can enhance soil granulation and cation exchange capacity.

3.5 Clay illuviation should be studied to determine rehabilitation capability of clay material

3.6 Local sites of high activity clay should be explored to reduce transportation cost and should be recommended to enhance crop production for sustainable agricultural system.