In sugarcane breeding programs, improved genotypes are generally evaluated across several locations and/or years to determine their adaptation and stability over planting environments. Superior genotypes based on yield only may not always be adequate, when GE interaction is significant. The GE interaction in multi-environment yield trials refers to differential responses of genotypes across a range of environments. Therefore, a large amount of GE interaction reflects the need for testing genotypes in several environments to obtain reliable results. In this study, combined analyses of variance were performed across crop-cycles for each of three traits (cane yield, CCS value and sugar yield). The main effects (crop-cycle, location and genotype) and their interactions were highly significant in all traits. The location main effect was also highly significant with large variation, indicating the importance of tested locations. Choosing highly diverse geological conditions may be required for plant breeders in order to select a superior genotype for yield and adaptability.

The GGE biplot technique was used to explain the relationships among tested locations, genotypes and their inter-relationships. Some location was considered to be a representative location for selecting the best genotype for general adaptation based on cane yield, whereas some other locations were chosen to select superior genotypes for the adaptation to their locations. In CCS value, several locations were considered to be useful for selecting the generally adapted genotypes. Two tested locations were classified as non-representative locations, and useful for selecting the genotypes adapted to specific environment. Two genotypes were classified as stable genotypes with above average CCS in all the locations. In sugar yield, all twenty-two tested locations could be classified into four homogeneous groups. Locations within the same group were relatively similar in genotype discriminating ability, and also able to provide nearly similar information concerning genotype difference on sugar yield. The results of GT biplot analysis provided a very similar pattern to both newly planted and ratoon crops. Four major components for sugar yield, i.e. cane yield, the number of stalk, stalk diameter and single stalk weight, showed larger variation than the other traits. The large trait variation may provide a good opportunity for selecting tolerant genotypes to environmental stresses,
including water stress. The quality traits (CCS value, Pol, Brix value and fiber content) and the number of died-tillers had strong negative correlation with cane yield. Ideal genotypes are those with the highest cane yield and optimum juice qualities for maximum sugar yield per unit area. In trait covariate-effect biplot, it was confirmed that stalk height and the number of stalks at harvest had a large contribution to cane yield. Visualization by the biplot method clearly confirmed a know fact that selecting the genotypes with higher quality traits may reduce cane yield and major yield components, in many locations.

In sugarcane, flowering is a genetically determined trait and influenced by various environmental factors such as photoperiod, temperature, soil moisture and nutrition. Understanding effects of temperature on flowering time in sugarcane may enhance efficient selection of suitable locations for genotypic evaluation in the aim of breeding for nonflowering trait. At a tested site at TSCS in Thailand, the flowering date in each sugarcane genotype showed slight variations from year to year. The period between May and October, the period for flower bud initiation and development had the optimum daily maximum and minimum temperatures, leading to successful induction of flowering. The small diurnal difference of temperature in July and August may be also a promoting factor for flower initiation and development. Significance of air temperature at early, mid and late stages is considered to be related to acceleration of vegetative growth by relatively low minimum and relatively high maximum temperatures, inhibition of flower initiation by high maximum temperature, and inhibition of flower development by low minimum temperature and high maximum temperature, respectively.

Recently, crop modeling plays important roles to forecast growth and yield performance of crop genotypes in diverse environmental conditions. The simple biological models based on plant physiology can be applied for the genotypic evaluation in a wide range of environments. In this study, a simple model for prediction of the potential yield of sugarcane was developed. Potential yield shows the productivity under the assumption of non-limitation of water deficit, nutrient stress and damages caused by diseases, insects and weeds. The structure of the developed model was based on the estimation of LAI and conversion of captured solar energy into dry matter, using two popular varieties of Thai sugarcane. The developed model was validated by the results of the experiment conducted at the same experimental site with a different planting date. Although, the model requires relatively small number of input parameters, it showed high accuracy for the estimation of LAI and dry matter production.

The GIS technology has a great possibility to visualize complex relationships among various factors by two-dimensional images. In the present study, the patterns of monthly and annual averages of climatic factors at the central and western sugarcane planting area of Thailand were clearly shown and the long-term analysis
of the climatic trends was efficiently conducted by this technique. The results of the analysis together with the potential yield maps developed here not only provided the information of area with high productivity and its yearly variation, but also enabled to approximately classify the study area into 4 zones. Plant breeders can use this information to evaluate the sugarcane genotypes in 4 representative locations. In addition, the breeders can also increase the potential yield by selecting the genotypes showing high potential yield in a specific area. Therefore, by integrating crop modeling, geographical information systems and plant breeding, a better understanding of genotypic adaptation is realized and more efficient and targeted sugarcane improvement.