CHAPTER I
INTRODUCTION

Paddy fields occupy approximately 65% of the arable land in Northeast Thailand, with nearly 90% under rainfed conditions and 10% in irrigated (OAE, 2009).Within the region, transplanting is the main method of rice cultivation which mostly starts during peak rainfall from late-July to early- August. In rainfed paddy fields, with late rainfall, rice transplanting is delayed until mid August. Thus, these arable lands are mostly left fallow for several months during the dry-wet transition period. In irrigated lowland areas, farmers usually adopt a double cropping system by growing second rice and field crops after the major rice crop. Crops are usually grown in December and January, with harvested in April. As a result, large areas of land lie fallow before the new crop season between April and August. In addition, even though there are irrigation systems, crops grown in these irrigated areas frequently suffer from drought during their late growth stage due to limited water reserves in shallow-wells and farm ponds or to limited areas covered by state irrigation systems. Introduction of sweet sorghum (*Sorghum bicolor* L. Moench), a drought tolerant, rapid growth (3-5 months), C4 sweet-stemmed annual crop and a promising ethanol feedstock, as a double cropping system in both areas or a triple cropping system in irrigated lowland paddy fields. This may reduce the risk of existing cropping systems in irrigated areas and allow small-holder farmers to access markets in the huge agro-bioethanol industry. This could ultimately improve the income of farmers in the region.

At present, cassava and sugarcane are the main feedstocks for ethanol production in Thailand. But the ethanol industry faces high competition for raw material from other well-established industries such as sugar, animal feed and cassava flour. This shortage of raw material causes inefficiency in the ethanol industry because the factories can only be operated for four to six months a year. It is for this reason that the production of sweet sorghum as a pre-rice crop could not only increase farmers' incomes but also fill supply gaps during the shortage of feedstock. The result would be an increase in the efficiency of the ethanol industry.

However, with intensity of rainfall, rising water table, low evapotranspiration (Polthanee, 1997), limited external drainage because of insufficient paddy to paddy slope gradient and slow infiltration due to the typically fine textured soil (Herrera and Zandstra, 1979), waterlogging and prolonged surface flooding occurs toward the peak

rainfall of the mid- rainy season. Growth, yield and sugar content of sweet sorghum grown as a pre-rice crop can be affected by flooding at any growth stages and the duration of flooding may vary greatly. Understanding sweet sorghum's response to waterlogging and its acclimation traits at different growth stages and flooding intensity of diverse genotypes will prove valuable in the management of pre-rice sorghum.

Therefore, the objectives of this research were: i) to investigate and compare the waterlogging tolerance of four sorghum cultivars, ii) to investigate the effect of flooding at different growth stages on plant growth and yield of sorghum cultivars, focusing on the evaluation of the sensitivity of plants and on the identification of characteristics which may result in resistance to flooding stresses, iii) to investigate the effect of flooding of different durations on the growth of root, shoot, yield and sugar content and to identify characteristics associated with flooding tolerance in sweet sorghum and iv) to indentify optimum sowing time and ideal sweet sorghum cultivar(s) for high stalk yield as well as estimated ethanol production when grown as a pre-rice crop under rainfed and irrigated rice fields.

This research was comprised of three experiments conducted in Khon Kaen province, Thailand, between 2005-2007 and one experiment in Newcastle University, Newcastle upon Tyne, United Kingdom conducted from February to April, 2008. The results from one experiment conducted in UK are presented in chapter 3. The experiments conducted in Thailand are presented in chapter 5-6. Therefore, this thesis consists of 7 chapters. Chapter 1 is the introduction, followed by Chapter 2, literature review. Chapter 3 presents morphological and physiological responses of sorghum to waterlogging. Chapter 4 presents growth, yield and aerenchyma formation of two sorghum cultivars subjected to flooding at different growth stages. Chapter 5 presents a flood-free period combined with early planting is required to sustain yield of pre-rice sweet sorghum. Chapter 6 presents effects of planting date and cultivar on growth, stalk yield and ethanol production potential of sweet sorghum grown as a pre-rice crop under rainfed and irrigated conditions. And finally, chapter 7 presents overall conclusion and discussion, emphasizing growth, yield, and plant acclimation to flooding at different growth stages and duration, including information on growth and yield as well as the ethanol production potential of different sweet sorghum cultivars grown at different planting dates in rainfed and irrigated paddy fields.