High soil temperatures influence seedling emergence as well as the performance of plant organs and yields. Temperatures of above 40°C were recorded in the topsoil of the Ferralsols of the semi-arid areas of SE Kenya during the rainy season. Experiments were conducted in the climatological laboratory of the University of Trier, Germany, on two legumes (green grams and common beans var. kathika), grown by smallholder farmers in the study area under varying soil temperature conditions. The main objective was to examine the effect of soil temperature on various parameters: seedling emergence, crop water requirements, leaf area index and phenology of the two legumes. The simulated climatological laboratory conditions were similar to those at Kiboko, SE Kenya. This study confirmed that under high soil temperature conditions, green grams are well adapted to semi-arid and hot tropical lowlands as well as lower midlands due to low water requirements, high seedling emergence rates and good yield performance. However, kathika beans were very susceptible to the simulated extreme climatic environment. By means of crop simulation modelling, a temporal differentiation for potential growth of green grams is presented for the long and short rains according to different rainfall conditions (ENSO, antiENSO, normal) over a period of 31 years.