1 Prologue

This dissertation focuses on the competitiveness of the sugar beet (*Beta vulgaris* L.) crop in the Netherlands. Basically the income of the farmer is the product of yield and product price (revenues) minus total costs, as a sum for all crops. For a number of crops but especially sugar beet the product price is dependent on product quality. For many years, the sugar beet crop had a relatively high share in farmers income (Berkhout and Berkum, 2005). Due to the sugar regime of the European Union (EU), minimum sugar beet prices for quota beet were guaranteed for the growers and thus causing a more or less stable income compared to other crops like onions, potatoes and carrots, whose prices are fluctuating within and between years (Berkhout and Bruchem, 2005; Vrolijk et al., 2009; Berkhout and Bruchem, 2010). As a result of the World Trade Organisation (WTO) negotiations the EU had to open their market for sugar outside the EU. Consequently the EU sugar market regime had to be adapted, with a lower guaranteed price for farmers. The guaranteed price for quota beet fell from € 43.63 t sugar beet^{-1} (EC, 2001; Zeddies, 2006) to € 26.29 t^{-1} from 2009 onwards (EC, 2006), implying a 39.7% decrease. With the costs on a similar level this causes a dramatic drop in farmers' income. At present it is not known if and how the EU sugar market regime will continue when it ends after the harvest and the processing of the 2014 cultivated sugar beet (EC, 2006).

The study LISSY (Low Input Sustainable Sugar Yield) identified possibilities to save up to 20% of the total variable costs in Dutch sugar beet production (Pauwels, 2006). However, this could not compensate for the price drop of quota sugar beet (figure 1.1). In order to keep the profitability of the sugar beet crop on the same level as before 2006, a raise in yield is needed. The potential sugar yield in the Netherlands was previously estimated at 23 t sugar ha^{-1} (De Wit, 1953). The average sugar yield realised by growers in the period 2002-2006 was 10.6 t ha^{-1} (Swaaij, 2007), only 46% of the theoretical potential. In the meanwhile, large differences between growers in the same region, encountering almost the same production circumstances like soil and climate, are reported (Agrarische Dienst, 2007). This phenomenon is not restricted to sugar beet production in the Netherlands, its found in Sweden, Germany and the United Kingdom (Blomquist et al., 2003; Fuchs et al., 2008; Limb and Atkin, 2010) and for other crops, as well (Lobell et al., 2009). However, it seems that in many cases the other crops' average yield is more close to 80% of the crops potential in that region, although large differences exist (Lobell et al., 2009). Therefore, there is an unexploited yield gap in sugar beet cultivation.

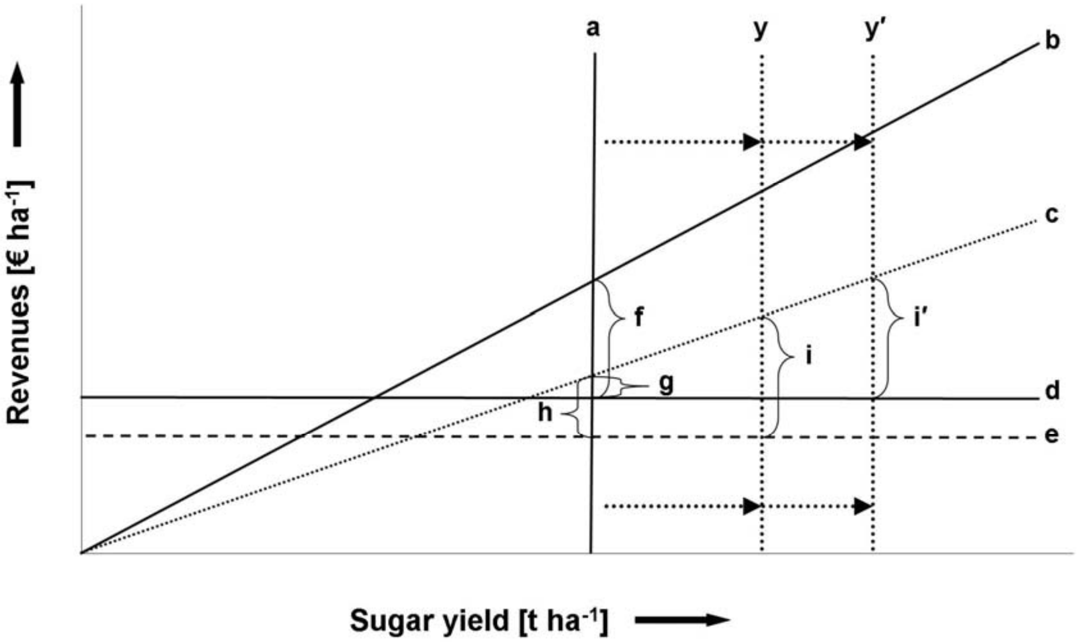

Figure 1.1. Graphical impression to the effect, for an average sugar yield (a), of the quota sugar beet guarantee price before 2006 (b) and after 2009 (c) on farmers gross margin (f, g and h) when the total variable costs are on average (d) or on a 20% reduced level (e). In response to the lower quota sugar beet guarantee price, growers have to raise yield (y/y′) to an level were the margin i/i′ equals f to keep profitability on the level before the reform of the EU sugar regime.

Considering the above mentioned, the IRS (Institute of Sugar Beet Research, The Netherlands) formulated the 3 x 15 target. In 2015 the present EU sugar market regime ends and then the target for sugar beet cultivation is a national average sugar yield of 15 t ha^{-1} (equivalent to 60% of the sugar beet potential) and 15 Euro t^{-1} sugar beet of total variable costs. This implies that, next to the savings on total variable costs, a steep raise in sugar yield is needed (figure 1.2).

The study SUSY (Speeding Up Sugar Yield) was aimed to identify possibilities to raise sugar yield by comparing 26 pairs of growers, the idea adapted from a pair study in Sweden (Berglund et al., 2002). Each pair consisted of a high yielding 'type top' and average yielding 'type average' grower in the same region, based on the 2000-2004 sugar yields. More details about the selection are given by Hanse et al. (2010a).

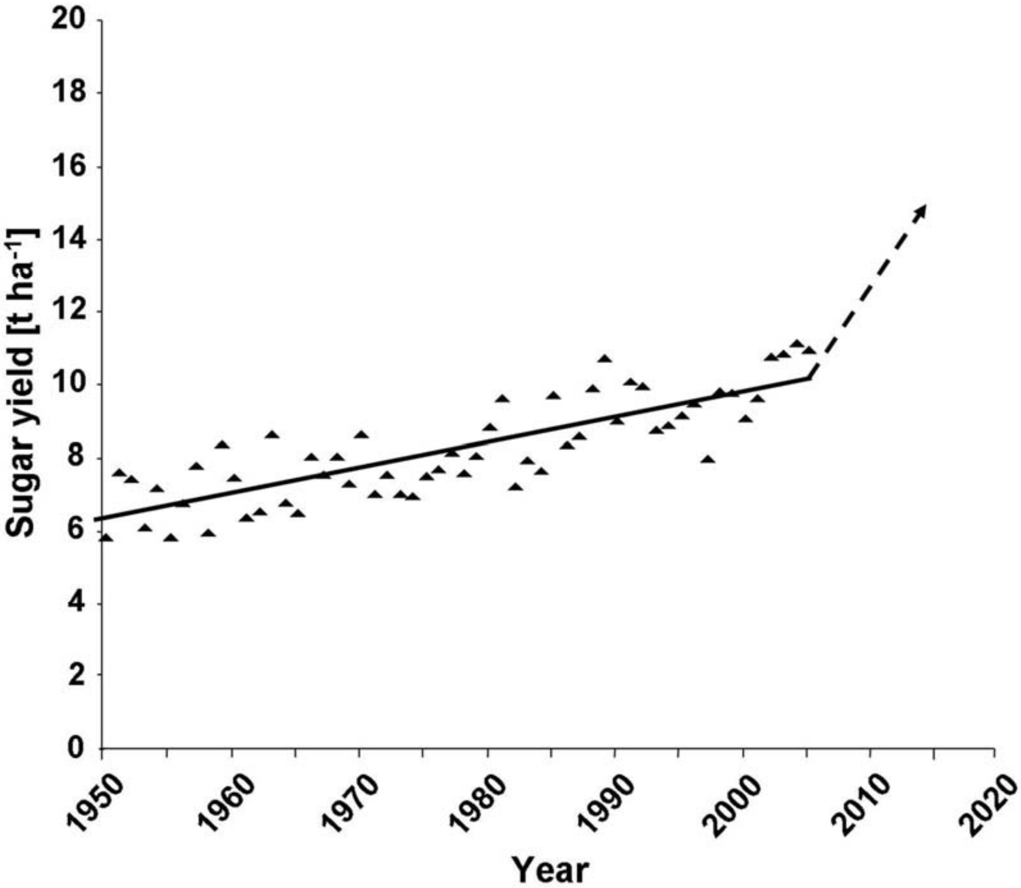

Figure 1.2. Average sugar yield (t ha^{-1}) in the Netherlands from 1950 to 2006. Sugar yield is raised on average by 1.7% a year. To reach the 15 t sugar hectare^{-1} target, sugar yield raise has to break this trend and should increase steeply (dashed arrow).

A large part of the data obtained from the SUSY-project is analysed and published in four publications, compiled in this dissertation.

The first publication analyses the data concerning the differences in costs and sugar yields between the type top and type average growers and is published in the journal Sugar

Industry (Hanse et al., 2010a). A German translation is published in the Special Edition of Sugar Industry for the purpose of the 9th Göttinger Zuckerrübentagung on September 2nd, 2010 (Hanse et al., 2010b). In this publication it is shown that the type top growers did not have higher total variable costs, although their yields were significantly higher compared to the type average growers. It was concluded that the differences in sugar yield were not caused by economical constraints. Sugar yield proved independent of total variable costs.

In the second publication the influence of pests and diseases on sugar yield is published (Hanse et al., 2011a). The occurrence of pathogens differed for the soil types clay and sand. The type top growers on clay soil had significantly lower infestation levels of *Heterodera schachtii*, *Beet necrotic yellow vein virus* (BNYVV) and other foliar diseases (*Pseudomonas, Phoma betae* and *Verticillium* spp. combined). On sandy soils, infestation levels of *Meloidogyne* spp., *Cercospora beticola* and *Erysiphe betae* were significantly lower for type top growers. The insecticides on seed pellets provided sufficient control. In the fields no insect pests causing sugar yield loss were observed. On clay soils, differences in the sugar yield could be explained by the *H. schachtii* and BNYVV infestation levels. On sandy soils, the infestation levels of *H. betae* and *Aphanomyces cochlioides*, number of fungicide sprayings and sowing date explained differences in sugar yield.

Despite crop protection measures, the calculated sugar yield losses due to pests and diseases ranged from 13.1 to 37.1% (24% average for all growers). Thus, it was concluded that the infestation levels of pests and diseases are among the explanations of the sugar yield differences between type top and type average growers.

The third publication shows the influence of soil management and intrinsic soil structure on temporal soil structure and its influence on sugar yield (Hanse et al., 2011b). Subsoil compaction, measured by the saturated hydraulic conductivity, Ks, and air-filled porosity, AP, explained 24.9% of the variance in sugar yield, although in dependency of subsoil sand content and sowing date. The Ks was explained by the content of 50-105 µm sand fraction in the subsoil and the depth of primary tillage. AP was found strongly dependent on clay content of the top soil. There was no difference between type top and type average growers for top soil AP. The type top growers' fields had a significantly higher Ks compared to the type average growers' fields. On 9% of the fields Ks was approximately 0.00 m day^{-1} and on 31% of the fields below the damage threshold of 0.10 m day^{-1}. Below this threshold, crop yield can be adversely influenced by soil structure (Lebert et al., 2004). AP below 10% was found on 25% of the type top growers' fields and 35% of the type average growers' fields. The type top growers used lower tractors tyre inflation pressure and less passes to prepare the seedbed, with the same equipment as the type average growers.

The fourth article is published in the proceedings based on a presentation at the 72^{nd} IIRB Congress in Copenhagen concerning losses while harvesting sugar beets in the SUSY-project (Hanse and Tijink, 2010). On average, 3 t sugar beet ha^{-1} are left on the fields, ranging from 0.45 to 9.1 t ha^{-1}. The losses due to overtopping and whole beet losses were significantly lower for type top growers. The losses due to root tip breakages did not differ between type top and type average growers. Total harvest losses (sum of losses by overtopping, whole beet and root tip breakage) did not differ between type top and type average growers. Options to point out the important harvest losses to both growers and harvester driver are presented.

This dissertation closes with the epilogue on the agronomical issues not yet published, as there are: fertilisation, sowing, and weed control of the sugar beet crop and the management influence of the growers.

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