Agricultural Systems 141 (2015) 24–35

Contents lists available at ScienceDirect

Agricultural Systems

journal homepage: www.elsevier.com/locate/agsy

Analysing yield trends in the South African sugar industry

M.R. Jones [a,*], A. Singels [a,b]

[a] South African Sugarcane Research Institute, Private Bag X02, Mount Edgecombe 4300, South Africa
[b] Department of Plant Production and Soil Science, University of Pretoria, Pretoria, South Africa

ARTICLE INFO

Article history:
Received 26 January 2015
Received in revised form 15 September 2015
Accepted 17 September 2015
Available online 2 October 2015

Keywords:
Yield gap
Yield decline
Crop model
Cane yield
Weather data
Harvest age
Production data

ABSTRACT

A perception exists in the South African (SA) sugar industry that sugarcane yields are declining. The objective of this study was to quantify yield decline in the SA sugar industry to inform future research and extension efforts to decrease yield gaps. Regional trends in cane yield were calculated from mill-level cane delivery and harvest area data. Benchmark simulated yields for each region were estimated by the Canesim Crop Forecasting System, using inferred harvest age and observed weather data. Actual yields were annualised to remove harvest age effects and then expressed as fractions of corresponding simulated yields, in order to remove effects of inter-seasonal variations in weather. Trends in this yield ratio (YR) were calculated for several regions and grower categories. Yield decline was defined as a decreasing trend in YR over time (1981–2010).

Applying this methodology to historic production data for the South African sugar industry revealed that large scale grower (LSG) yield ratios have declined significantly over the period 1986 to 2010, for the South Coast (1.12%/year) and North Coast (1.24%/year). LSG yield ratios increased in Zululand and the Northern irrigated regions, suggesting that growers were able to cope with deteriorating weather and/or exploit technology improvements. Small-scale grower (SSG) yield ratios declined from 1993 to 2010 by 1.73%/year in the Northern Irrigated region. Since 2001 industry average LSG yield ratios declined by 1.97%/year compared to a decline of 2.37%/year for SSG yields (both significant). On a regional basis SSG yield ratios declined in the Midlands (1.43%/year) and Zululand (3.33%/year) regions.

Yield decline was perceived by stakeholders to be caused mainly by soil degradation, decreased investment as a result of unresolved land claims, and increasing pest and weed pressures, and suggested increased top/sub-soil liming, green manuring, in-field traffic control and soil and leaf testing as possible means of addressing yield decline. Closing the gap between current and maximum economically-attainable yields has the potential to increase annual industry production by approximately 32% (6.3 million t), and annual grower revenue by ZAR 2.6 billion (based on 2006–2010 industry production). It is recommended that research and extension efforts should be focussed on further understanding and addressing yield decline, particularly for LSGs and SSGs in the Midlands region, LSGs in coastal regions, and SSGs in the Northern Irrigated and Zululand regions.

1. Introduction

Sugarcane (complex hybrid of *Saccharum* spp.) in South Africa is grown in the KwaZulu-Natal (mostly coastal rainfed production) and Mpumalanga (under irrigation) provinces. Industry sugarcane production has gradually decreased over the last 15 years, from nearly 23 million t in 1999/2000 to about 16.8 million t in 2011/12, while area under sugarcane has also shown a gradual decrease, from 421,600 in 1999/2000 to 378,300 ha in 2011/12 (SASA, 2014). Decreased sugarcane production is of great concern to the South African sugar industry.

Sugarcane in South Africa (Fig. 1) is grown by large-scale growers (LSGs), mill-owned estates, and small-scale growers (SSGs). SSGs are defined as growers farming on land units smaller than 30 ha (Eweg, 2004), the majority of whom are black growers with poor access to capital. During the 2012/13 season, 13,044 SSGs delivered 9.31% of the total crop, with the remainder produced by 1730 LSGs and miller estates (SASA, 2014). Just over 20% of the total sugarcane land area is irrigated, and irrigated sugarcane accounts for about 30% of total production, depending on seasonal rainfall in rainfed areas, as well as irrigation water availability.

Garside et al. (2000) defined yield decline as "the loss of productive capacity of sugarcane-growing soils under long-term monoculture", following identification of a yield 'plateau' in the Australian industry from 1970 to 1990. Average cane yields have decreased from 89 t/ha to 69 t/ha in recent years in Brazil, while in the USA cane yields have remained roughly constant since 1980/81 (Chudasama, 2013).

Anecdotal evidence exists of yield decline in the South African sugar industry. The perception of yield decline probably derives from the decrease in industry cane production. Several authors have published

* Corresponding author.
E-mail addresses: matthew.jones@sugar.org.za (M.R. Jones), abraham.singels@sugar.org.za (A. Singels).

http://dx.doi.org/10.1016/j.agsy.2015.09.004
0308-521X/

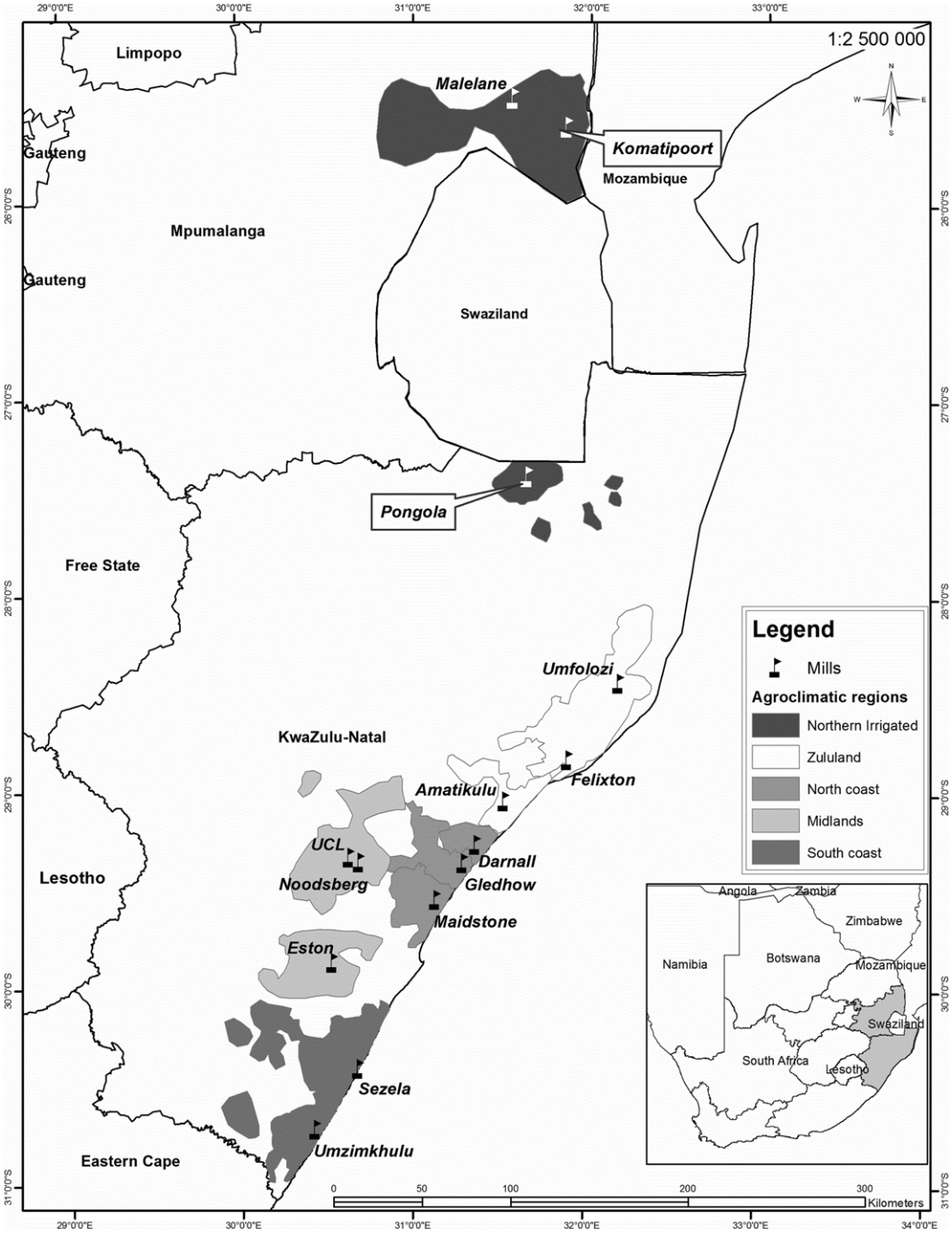

Fig. 1. Map of the South African sugarcane industry. Production regions and locations of current sugar mills are shown.

detailed strategies for combating sugarcane yield decline in South Africa, without formally exploring the extent or spatial distribution of yield decline (e.g. van Antwerpen and Meyer (1996); Lagerwall et al., 2010; Sumner, 2011). Jones (2010) indicated declining per-area harvested yield trends in many regions from 1995/96 until 2009/10, but did not attempt to make corrections for climatic variability. The sugarcane yield plateau that was identified in Australia in the early 1990s (Garside et al., 2000), was attributed to consequences of intensive monocropping of sugarcane — a common feature of the South African industry. Causes of and solutions to yield decline in the literature have generally addressed aspects of sugarcane crop management — be it variety choice, pest and disease control, soil health, or nutrient management, among others.

Several factors could have influenced yields in the SA sugar industry over the last 30 years. Singels et al. (2005) found that climatic potential yields increased at Mount Edgecombe from 1954 to 2004, intuitively suggesting that actual yields should have increased over this period. Improvements in technology in recent decades, such as new sugarcane varieties, improved agronomic techniques, widespread computerisation of machinery and record-keeping and instantaneous access to information on the internet, should have had a positive impact on yields. Van den Berg and Singels (2013) indicate that there appears to have been a gradual decrease in yields over the last decade, perhaps longer, in many regions in the South African sugar industry, although they made no objective quantification of trends. Decreasing area of land under cane (A, ha) would result in reduced sugarcane production (tons), but