

The True Cost of Sugar: Economic trade-offs in conventional, organic and Fairtrade sugarcane and sugar beet production.

A complete overview of the economic trade-offs in conventional, organic and Fairtrade sugarcane and sugar beet production in India and the Netherlands

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ABSTRACT

Sugar is an important economic commodity that is produced and consumed around the world. The impacts of different production methods differ on social, economic and environmental aspects. This research focuses on the economic trade-offs in conventional, organic and Fairtrade sugarcane production in India and sugar beet production in the Netherlands. Previous research provides insights into single production methods, but a complete comparison between different production methods is currently lacking. Data was collected using both literature research and interviews in the Netherlands and India. After developing a Multi-Criteria Analysis, it is concluded that organic sugarcane and Fairtrade sugarcane rank slightly higher than conventional sugarcane on the economic criteria. However, conventional sugar beet and organic sugar beet rank higher on all economic aspects, with conventional sugar beet ranking the highest. The main differences between the production methods can be seen in the innovation, and to a lesser extent the in the production.

1. Environmental problem definition

By 2050, increased crop production will be required to feed a predicted nine billion people (Grafton, Daugbjerg, & Qureshi, 2015). This must be done while taking factors such as changing patterns of consumption, climate change impacts, increasing water use and land scarcity into consideration. Even with the current population, preserving natural resources and supporting the livelihoods of farmers and the rural population around the world is a challenge. Sustainable production of all crop types is of increased concern to both producers and consumers. There is a pressing need for increased production without the adverse environmental, social and economic impacts (Baulcombe, 2009). Sugar is an important commodity that is produced and consumed around the world. It is a unique commodity, with two different crops competing in the same market. 83% of sugar production comes from cane and is produced in developing tropical countries such as India. The world production of sugarcane is approximately 1254.8 million tons/year cane, from a total of 13 million ha of land (FAO, 2019). 17% of sugar worldwide comes from sugar beet and is mostly produced in developed countries, one of which is the Netherlands (Chisanga, Meyer, Winter-Nelson, & Sitko, 2014). Present world production of sugar beet is about 234 million tons, from 5.9 million ha of land. (FAO, 2019).

There are multiple problems related to sugar production, such as bad labour conditions, low income for workers, uncertainty in prices and a shortage of labour, driving

up the costs for producers (Sharma & Prakash, 2011). Impacts differ greatly for different production methods. To minimize the negative impacts, there are certification institutions aimed at the sustainable production of sugar. Sugar produced following organic production methods is mainly aimed at sustaining the health of soils, ecosystems and people (IFOAM, 2019). In order for production to be certified organic, production processes have to follow organic standards. The exact standards differ depending on the certifying body. Fairtrade certification is aimed at the protection of small-scale farmers, in an attempt to improve social performance. Through a premium, farmers and their communities get access to better facilities. Organic beet sugar, conventional beet sugar, organic cane sugar, conventional cane sugar and Fairtrade cane sugar all have different characteristics and score differently on environmental, economic and social criteria.

Research has been conducted for different types of sugar production. Studies have been conducted related to the economic performance of sugar beet production (e.g. Tzili-vakis, Jaggard, Lewis, May, & Warner, 2005; Hanse, 2011) and sugarcane production (e.g. Dias et al., 2012; Moraes, Oliveira, & Diaz-Chavez, 2015). Furthermore, research has shown the impacts of Fairtrade (e.g. Fairtrade International, 2015) and organic production (e.g. De Ponti et al., 2012; Kshirsagar, 2008). However, these studies have always focused on a single production method. This makes comparing multiple production methods difficult.

The aim of this paper is to give a complete overview of the economic performance of different sugar production methods in the Netherlands and India¹. India was chosen as it is the second-largest producer of sugarcane in the world (FAO, 2019) and it has conventional, as well as organic and Fairtrade producers. The Netherlands was chosen as it is a large producer of sugar beet, and it is accessible for researchers from the Netherlands. Both conventional sugar beet and organic sugar beet are produced in the Netherlands.

The research question of this paper is: *What are the economic trade-offs in conventional, organic and Fairtrade sugarcane and sugar beet production?*

The sub-questions associated are:

- How do different farming methods economically affect sugar producers and farmers?
- How do the economic aspects differ within the value chain?
- What are the future possibilities towards economic sustainability in the sugar industry?

The structure of this research paper is as follows: First, relevant literature is discussed in the theoretical background. Second, the methods, data collection and data analysis are explained. Third, the results of the interviews and the Multi-Criteria Analysis are discussed. Finally, the conclusions and discussion are presented.

2. Theoretical background

The two main crops from which sugar can be produced are sugarcane and sugar beet. Historically, sugarcane has always had a higher production quantity than sugar beet, as shown in Figure 1. The production of sugarcane mainly happens in tropical, developing countries, with optimal sprouting of stem cuttings at 32 to 38°C. The production of sugar beet happens in colder climates, as temperatures greater than 30°C greatly decrease sugar yields (FAO, 2019).

2.1 Sugarcane

Employment in sugarcane production is an important part of agricultural labour in India. 7.5% of the rural population works in the sugar industry. The sugar industry in India is regulated and provides for the livelihood of 50 million farmers and their families (Venkatesh & Venkateswarlu, 2017). The sugar industry has been partially responsible for socio-economic development in villages. Benefits generated by the sugarcane industry include employment, increase in income, better transport and

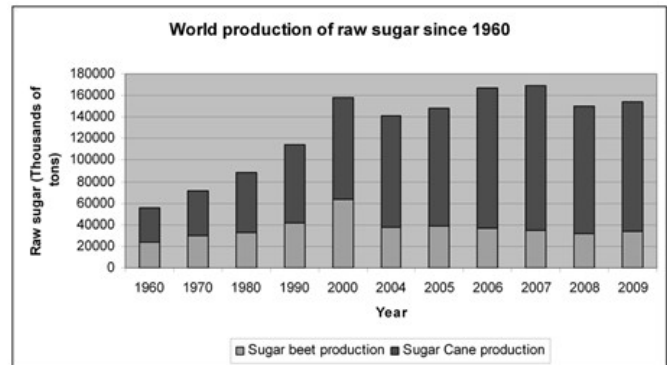


Figure 1: Part of sugar beet and sugar cane in world sugar production since 1960 by Desoignies (2012)

communication facilities, schools, colleges, medical centres and hospitals (Solomon, 2014). However, there are numerous problems in the industry as well. Slavery has been a common feature of sugarcane production throughout history (Galloway, 2005). Currently, working in sugarcane plants is generally still under poor circumstances and for low wages. A study based on data on the use of human labour for sugarcane from 1980 to 2010 has found that sugarcane cultivation is backbreaking work and that working conditions are inhuman (Sharma & Prakash, 2011). The fluctuating world sugar prices, as shown in Figure 2, lead to increased uncertainty for workers in the industry (Fairtrade International, 2015). Cyclicity in sugarcane production has been of great impact on sugar prices in India. The Indian sugar industry has to deal with large swings in production quantities due to crashing domestic prices with overproduction and high fixed costs leading to non-competitiveness when there is a shortage.

Another factor problematic for sugarcane farmers in India, is the suboptimal yield. Solomon (2014) analyses crop yield in Indian regions and compares it with the maximum experimental yields. He finds that, where the maximum experimental yield is 325 tons/ha, tropical regions in India average 80 tons/ha. The gap between the potential yield and the yield level achieved is only widening (Nair, 2011). Improvements in productivity are necessary to keep a competitive position in the world market. This is also found by Pandey (2007) in an analysis of the sugar industry in India, where it is concluded that India needs to improve sugarcane yield at par with competing countries to assure viability of sugarcane cultivation and sugar industry (Pandey, 2007). Research in the Uttar Pradesh region showed that there is a great instability in production. This puts the income of the farmer at risk (A. Singh & Srivastava, 2003).

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In India, most of the sugarcane production is undertaken by using traditional tools and equipment (Yadav, 2007). Improvements in the sugarcane sector are dependent on innovation. The gap between potential yield and the yield levels achieved could be cut back with technology adoption (Venkatesh & Venkateswarlu, 2017) and increased research and development (Sharma & Prakash, 2011). According to Venkatesh and Venkateswarlu (2017): “In sugar industry to increase profitability we should reduce the cost of cultivation and improving the productivity per unit. It is possible through new research innovations, technological interventions and mechanization”. Similar conclusions are drawn by J. Singh, Singh, Sharma, Singh, and Srivastava (2011) who find that mechanization will lead to improved timeliness of operation, reducing human drudgery and improving overall production efficiency.

2.2 Sugar beet

Since 29 September 2017, the prices of sugar have dropped significantly in Europe. Sugar beet crop used to be a relatively profitable crop (Becchetti & Rosati, 2005), as prices were stable under the EU regime (Vrolijk, de Bont, van der Veen, Wisman, & Poppe, 2009). However, negotiations lead by the World Trade Organisation (WTO), lead to the EU opening the market for sugar from outside the EU. Consequently, the sugar price dropped from €404/t in September 2017 to €312/t in January 2019, as shown in Figure 2 (European Commission, 2019).

Recent research into sugar beet productivity in the Netherlands is lacking. In 2002, De Koeijer et al. found that technical efficiency in Dutch sugar beet production was still far from perfect. The average technical efficiency, measured by the ratio of actual to best practice production, was only 50%. Similar results are found by Van Swaaij (2007) in the period 2002–2006. The average yield was 10.6 t/ha, whereas the potential yield was calculated at 23 t/ha. The 2017 yield in the Netherlands was 15.5 t/ha and in 2018 it was 13.2 t/ha, due to weather conditions (Suiker Unie, 2018). As the potential yield is calculated at 23 t/ha, the beet production still shows room for improvement.

Sugar beet productivity is highly dependent on weather conditions. This makes the production more unstable, because it is difficult to take measures against the weather. Freckleton, Watkinson, Webb, and Thomas (1999) analysed the yield of sugar beet in relation to weather and nutrients, finding that the length of the growing season and the weather conditions have a strong effect on yields. Similarly, Kenter, Hoffmann, and Märlander (2006) concluded that in order to achieve maximum yield, weather condi-

tions are crucial. To optimize productivity, deep, water-retentive soils with sufficient rainfall, and daily temperatures of around 18 °C during summer are necessary.

Dillen, Demont, and Tollens (2008) analysed the effect of the EU reforms on innovation in the sugar beet industry. According to their research, the new regime spurs innovation for medium-competitive producers while taking away incentives for uncompetitive producers, crowding out high-cost producers.

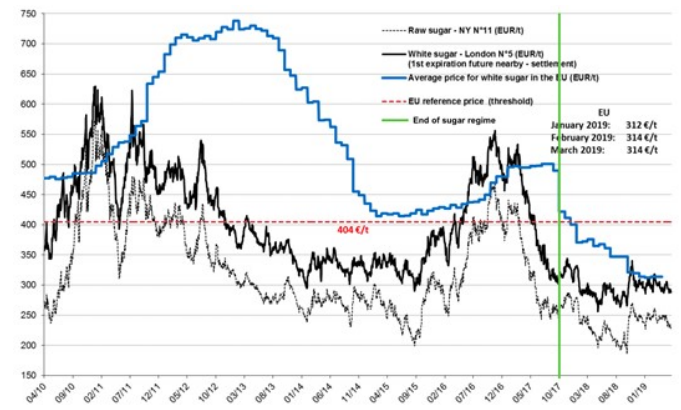


Figure 2: EU and world market sugar prices since April 2010, adapted from European Commission, 2019

2.3 Fairtrade

To tackle some of the problems related to the production of sugar, there are various programs in place, which all focus on different problems in the industry. Fairtrade certification is aimed at the protection of small-scale sugar farmers. Through the Fairtrade program, sugarcane farmers gain skills to be more competitive in the global market. Fairtrade sugar was first introduced in various European markets in the late 1990s, followed by introduction in the United Kingdom in 2000. Global retail sales of Fairtrade cane sugar have since grown to 185,000 tons in 2011, see Figure 3 (Fairtrade International, 2015).

A commonly used definition of ‘Fairtrade’ is that of the World Fair Trade Organisation (WFTO): “Fair Trade is a trading partnership based on dialogue, transparency, and respect, that seeks greater equity in international trade. It contributes to sustainable development by offering better trading conditions to, and securing the rights of, marginalized producers and workers – especially in the South. Fair Trade organisations are engaged actively in supporting producers, awareness raising and in campaigning for changes in the rules and practice of international trade.” (Moore, 2004).

Previous studies have shown the effects of Fairtrade certification on different economic aspects, such as reducing poverty (Calo, 2005; Imhof & Lee, 2007; Le Mare, 2007) and

the well-being of farmers (Becchetti and Costantino, 2005; Imhof & Lee, 2007; Lyon, 2007; Millford, 2004). Improvements are found in different aspects such as varieties of products sold, price satisfaction, monthly household food consumption, satisfaction with living conditions (Becchetti & Costantino, 2008) and higher prices, stable market access, organizational capacity building, market information, and access to credit (Lyon, 2007). For the community, the extra income and social premiums provide economic and social benefits. Fairtrade helps with the supply of important market information, financing and investments in quality and new technology (Nigh, 2002; Raynolds, 2002).

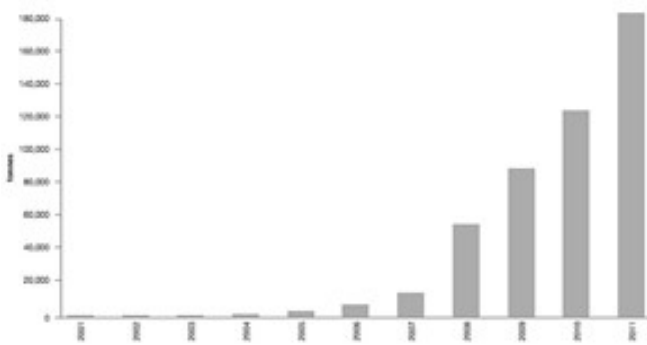


Figure 3: Global sales of Fairtrade cane sugar in tonnes by Fairtrade, 2015

2.4 Organic production

Another type of production that is of interest to this research is organic production. Certified organic sugar is made from organic cane or beet and the whole production process has to follow organic standards. The exact conditions depend on the certification body and may differ slightly. There are multiple definitions of “organic”, however, the most common definition is used for this research. The International Federation of Organic Agriculture Movement (IFOAM) states that: “Organic agriculture is a production system that sustains the health of soils, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects. Organic Agriculture combines tradition, innovation and science to benefit the shared environment and promote fair relationships and a good quality of life for all involved” (IFOAM, 2019).

Research has shown the effects of organic production on productivity. Rupela, Humayun, Venkateswarlu, and Yadav (2006) revealed that organic agriculture is more productive from the second year onwards. Other research (Eyhorn, Mäder, & Ramakrishnan, 2005; Clark, Klonsky, Livingston, & Temple, 1999; Delate & Cambardella, 2004) showed the equal or higher productivity with organic production as

well. Furthermore, it is found that organic farming leads to higher soil quality than conventional farming (Fließbach, Oberholzer, Gunst, & Mäder, 2007; Drinkwater, Letourneau, Workneh, van Bruggen, & Shennan, 1995; Droogers, Ferment, & Bouma, 1996).

Shivanaikar (2012) researched the costs of cultivation of organic sugarcane farming in India. He found that the average cost of sugarcane cultivation on organic farm was 15% lower than the costs at an inorganic farm. Kshirsagar (2008) researched organic sugarcane, and found 14% lower cost on organic farms, because of non-use of chemical fertilizers and lower costs of irrigation. Partap and Vaidya (2009) found that organic farmers secure higher profitability. Likewise, Gawade, Lohar, Killedar, Babar, and Bonder (2005) studied the resource use and the costs of organic and inorganic sugarcane cultivation in the Kolhapur District of Maharashtra, India. Results showed the cost of cultivation of organic was 14% lower than that of inorganic sugarcane.

3. Methods & Data

To analyse the impacts of the different production methods, a framework needs to be developed. This framework has to make the production methods comparable on all aspects of economic sustainability. To achieve this, GAPFRAME is used as a framework. Data was collected through a mixed method approach, using both interviews and literature research. The interview data is analysed using a Multi Criteria Analysis.

3.1 Gapframe

GAPFRAME is a normative framework that that uses TBL and translates the United Nations Sustainable Development Goals into specific measures (Muff et al., 2018). The United Nations Sustainable Development Goals (SDGs) provide objectives aimed at peace and prosperity for people and the planet, in present times and in the future. The SDGs were composed in 2015 after an extensive political alignment process between political institutions, global businesses and NGOs. 193 nations have signed to support the 17 underlying SDG-based goals. It is applicable in a wide range of applications, therefore allowing the comparison of different production methods (Muff, Karpalka, & Dyllick, 2017). The GAPFRAME fits research into sugar production well as its intended use is that of a planning tool for business, identifying long-term business opportunities. Muff et al. (2017): “The Gap Frame identifies a “safe space for all of us” and serves as a basis for multi-stakeholder coalitions to address relevant global

challenges. This can be done by sector, across industries, for an enterprise or as a responsible management educator.”

The sub-criteria are selected from the GAPFRAME framework and altered to fit the research at hand. For this research, the sub-criteria are employment, production and innovation. For employment, the indicators of job security and income are considered. For production, the indicators consist of productivity and stability of production. Concerning innovation, the ease of access to loans and availability of loans is used as a measure. The sub-criteria are listed in Table 1.

Criteria	Sub-criteria	Indicators
Economic impact	Employment	Job security Income
	Production	Productivity Stability of production
	Innovation	Ease of access to loans Availability of latest technologies

Table 1: Economic sub-criteria and indicators of sugar production

The issue of employment is concerned with achieving a sustained and robust job situation that boosts shared prosperity and social cohesion for all. All individuals are to be protected from forced labour, human trafficking or other slavery-related practices. The issue of employment is strongly aligned with the Sustainable Development Goal 8: “Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all” (Muff et al., 2018).

Sustainable production is aimed at creating products and services with attention to the environmental, economic and social impacts. Produced goods should be safe for workers and the communities they are produced in. Waste and ecologically incompatible by-products should be minimized throughout the supply chain. The issue of sustainable production is strongly aligned with the Sustainable Development Goal 12: “Sustainable patterns of consumption and production” (Muff et al., 2018).

Innovation is aimed at the promoting of technological progress and investments in research and development. Access to information and knowledge to enhance entrepreneurship, technological progress and social innovation are pivotal. The issue of innovation concerns Sustainable Development Goal 9: “Building resilient infrastructure, promoting inclusive and sustainable industrialization and encouraging innovation” (Muff et al., 2018).

3.2 Mixed Method

Both qualitative and quantitative methods and data is used. More general, quantitative data is gathered from literature review. More specific, qualitative data is collected through interviews with farmers in the Netherlands and India. As literature on these forms of sugar production is limited, interviewing allowed for achieving results that cannot be foreseen. Additionally, interviewing allowed for the comparison of dissimilar conditions, which is the case in the divergent scenarios in this research. Furthermore, all interviewees were asked to score the sub-criteria using a Likert scale ranging from 1 to 5. The interviews took place in Lelystad, Elsendorp, Voerendaal and Dinteloord in the Netherlands and in Pune, Kolhapur, Belgaum, Dharwad and Goa in India.

3.3 Multi Criteria Analysis

As there are different scenarios and criteria to be considered, the analysis of the data is based on a Multi-Criteria Analysis (MCA). MCA is a decision-making tool which can give insights into trade-offs between different options. An MCA provides a systematic method for comparing criteria that can be both in quantitative and qualitative scale. Scoring is done based on the results of the interviews and literature review. The standardized scores are converted into values between 0 and 1 (++ = 1, + = 0.75, ± = 0.5, - = 0.25, -- = 0). The criteria are weighed by experts. In Table 2, the weights are summarized. The overall weights represent the overall weight of the sub-criterion, adjusted for the weight of the corresponding criterion. The final step toward the MCA is to multiply the standardised scores of the sub-criteria with their corresponding weights, resulting in final scores. Additionally, a sensitivity analysis is performed.

Sub-criteria	Weight (%)
Employment	29
Production	44
Innovation	27

Table 2: Experts weights

4. Results

The summarized results from the interviews are discussed first. After the interview results, the MCA results are shown.

4.1 Interview results

The results of the interviews are summarized in Table 3. It becomes clear that beet scores better than cane on all economic sub-criteria. The biggest differences are in inno-

vation, where beet scores considerably higher than cane. The differences are slightly smaller in production, and the smallest in employment. The scoring of each alternative is discussed next. First, conventional cane, organic cane and Fairtrade cane are discussed. Then, conventional beet and organic beet are elaborated upon.

Criteria	Conv. Cane	Org. Cane	FT Cane	Conv. Beet	Org. beet
Employment	-	+/-	+/-	+	+
Production	-	-	-	+	+/-
Innovation	-	-	+/-	++	++

Table 3: Scores resulting from interviews

4.1.1 Conventional cane

Conventional cane is the main production method in India. Mostly, smallholder famers deliver their sugarcane to large mills. The mills process it to sugar and use the waste products for energy and ethanol production.

Employment in conventional cane scores low as farmers cannot afford anything more than basic living expenses, obstructing them in improving their quality of life. Job insecurity is not an issue for Indian sugarcane farmers and millers, income is low.

Production in conventional cane is also suboptimal. Production levels are steadily increasing due to better varieties and improved knowledge of farmers and millers. However, with both weather conditions and pest attacks, stability of production is one of the biggest problems that Indian farmers face.

Innovation in conventional cane is at a level that shows significant room for improvement. Some basic technologies are used in certain farms, although most labour is still done manually. Many farmers are unaware about financing options. In comparison to sugar beet production, innovation is very limited.

4.1.2 Organic cane

Organic cane production is happening at a small scale in India. Mills process organic sugar in the first days of the crushing season, as the mill is still chemical-free from the cleaning during downtime.

Employment in organic cane scores average, which can be explained by the fact that job security is similar in organic and conventional production. The main advantage of organic production for the farmer is the reduction in costs. This significantly improves income as compared to conventional production.

Production in organic cane scores similar to production in conventional cane. Productivity is at equal levels as conventional production. Stability of production may be marginally higher because of healthier soil, but it is still at a level that forms a big threat to farmers.

Innovation in organic cane shows room for improvement, too. Ease of access to loans is not impacted by producing organic. Most labour is done manually; no other innovations take place. This is similar for conventional production.

4.1.3 Fairtrade cane

The main advantage of Fairtrade is that the premium the consumer pays goes back to farmers. It does not have an effect on millers. Employment in Fairtrade cane scores average. Job security is similar for Fairtrade producers as for conventional producers. Most advantages are on a community level. Through the community premiums farmers get increased access to facilities such as mosques, schools, colleges, hospitals. It impacts their personal income on a smaller scale.

Production in Fairtrade cane is not greatly affected by the Fairtrade program. Stability of production can be equally problematic for Fairtrade producers as for conventional producers. Innovation in Fairtrade cane scores slightly better, as educating farmers in getting loans improves their accessibility to finance. Furthermore, the Fairtrade premiums can be used for multiple causes, one of which is shared production technologies. This improves innovation as compared to conventional producers, even though it is still at a relatively low level.

4.1.4 Conventional beet

For conventional beet sugar, Dutch farmers and the Suiker Unie mill were interviewed. All Dutch sugar farmers are cooperative owners of Suiker Unie, which is part of Cosun.

Employment in conventional beet is at an above average level. Job security does not seem to be a problem for farmers and millers. However, volatility in the world sugar price makes income slightly less certain. Even though the price has been unstable for the last few years, expected prices for sugar beet are still relatively good.

Production in conventional beet scores better than cane, which is reflected in a higher score. Productivity is among the highest levels in the world, at approximately twice the yield of Indian farmers. Generally, there are plans to guarantee volume of production and the compliance with quality standards in the event of facing social, environmental

and economic shock. However, changing legislation puts pressure on protection of crops, making plans in case of shocks such as pests and diseases more difficult.

Innovation in conventional beet is at the highest level due to the innovative machinery used by farmers and the mills using the most modern production techniques. The best available technologies (BATS) guarantee that the production technologies are always updated with new innovations.

4.1.5 Organic beet

In the Netherlands, organic beet production only happens to a small extent. Even though the prices for organic beet are higher, the amount of manual labour involved makes it less appealing to many farmers.

Employment in organic beet is similar to conventional beet, resulting in an equal score. Even though the price of organic beet is much higher, the time investments and additional costs make income from organic production similar to income from conventional production. Additionally, job security and income are similar in both organic beet and conventional beet.

Production in organic beet worsens with relative to conventional production of beet. Productivity is lower in growing organic beet compared to conventional beet. Furthermore, not being able to use all measures available to conventional farmers to counter pest attacks and diseases makes the crop more vulnerable.

Innovation in organic beet is at a high level, especially compared to cane production methods. Even though innovation is at similar levels for organic farmers as it is for conventional farmers, it does have more potential, as weeding is a very costly manual process at this moment. Future innovations could make the costs of organic beet more comparable to the costs of conventional beet, making it more appealing to farmers.

4.2 Multi criteria analysis

Experts rate production the most important sub-criterion, with a 44% rating. After that, employment is weighed at 29%, close to 27% for innovation. In the resulting ranking, cane production scored substantially lower than beet production. The MCA is shown in Figure 4.

Income in cane production in India is low: farmers can only provide for basic costs of living. Income is slightly higher for organic and Fairtrade production, but nowhere near the levels in beet production, where income is better in both conventional and organic production.

Furthermore, productivity measured in tons of sugar per hectare in beet is approximately twice as high as productivity in cane. There is also great instability in production due to weather conditions, and pests and diseases in cane. This is the same for conventional, organic and Fairtrade production. There are better back-up plans and prevention methods in place in beet production. However, due to the lack of chemicals that are allowed for organic production, these crops are more vulnerable, making stability of production lower. As production is weighed most heavily, these differences are very apparent in the ultimate MCA.

Lastly, the innovation rate is low to non-existent in cane production. Most work is done manually, and no new techniques are used. In Fairtrade production, more modern machinery is used. However, in beet production in the Netherlands, new and innovating technologies are present at a large scale, especially in factories which are some of the most innovative in the world. This makes the score for innovation significantly higher for beet production than for cane production.

Ultimately, beet production scored higher on all criterion than cane production. The lowest score is for conventional cane. Because of the improved employment, organic cane scored slightly higher. Fairtrade cane also provides better employment and has more innovation. This results in the highest ranking for the three cane-based production methods. All criteria are scored better for beet. Employment, production and innovation are at high levels for conventional beet, resulting in the highest ranking. Organic beet has a slightly lower score for production, making it rank second, just after conventional beet.

4.2.1 Sensitivity analysis

A sensitivity analysis is executed, where the scores of all alternatives are weighed evenly. This way, the resulting ranking without the expert weights can be shown in order to control for big differences. This is shown in Figure 5.

Beet production is rated more closely to cane production by weighing all criteria evenly. In cane, the stability of production forms a big problem, which results in a low score for conventional, organic and Fairtrade cane production. By putting less weight on this criterion, the relative position of cane improves. Employment and innovations become slightly more important than when all criteria are weighed by experts. This mostly affects organic and Fairtrade cane production, which score better compared to conventional cane production with expert weights. However, differences are minor. This indicates that the results are robust, as they are similar with and without the expert weights.

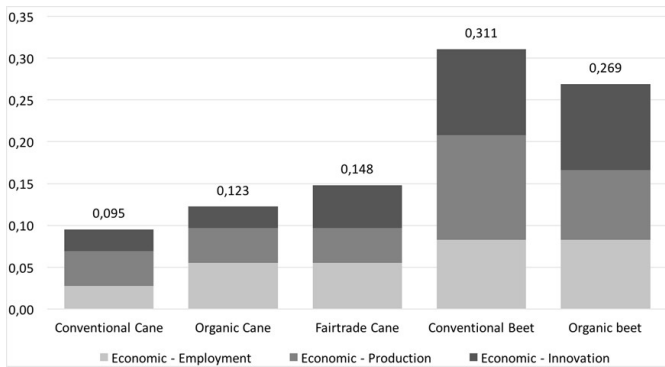


Figure 4: MCA economic impact

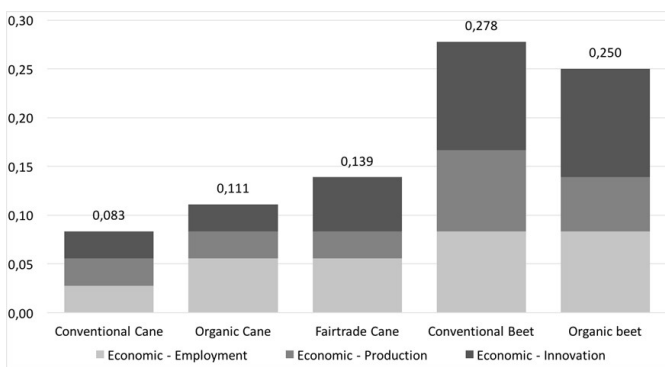


Figure 5: Sensitivity analysis

5. Conclusions

This section discusses the conclusions of this research. Each of the four sub-questions is answered first, followed by the main Research Question of this study.

How do different farming methods economically affect sugar producers and farmers?

For conventional cane production, farmers cannot afford anything more than basic living expenses, obstructing them in improving quality of life. Production levels are steadily increasing, but with both weather conditions and pest attacks, stability of production is one of the biggest problems faced by Indian farmers. Most labour is still done manually and innovation is very limited.

The main advantage of organic production for the farmer is the reduction in costs. This significantly improves income as compared to conventional production. Productivity is at equal levels as conventional production, but the lack of stability of production still forms a big threat to farmers. Innovation levels are low, preventing farmers from improving production levels.

By producing Fairtrade cane, most advantages are on a community level. It impacts their personal income on a smaller scale. Neither productivity nor stability of pro-

duction are greatly affected by the Fairtrade program. Educating farmers in getting loans and new production technologies through the premiums improves innovation as compared to conventional producers, even though it is still at a relatively low level.

Conventional beet farmers have a higher income, mostly through productivity that is approximately twice as high the productivity of cane producers. There are better plans to guarantee volume of production and the compliance with quality standards in the event of shocks. The best available technologies are used.

Organic beet farmers get a higher price for their produce, however the time investments and additional costs lead to a comparable income as for conventional production. Productivity is lower and the crop is more vulnerable. Future innovations could make the costs of organic beet more comparable to the costs of conventional beet, making it more appealing to farmers.

How do the economic aspects differ within the value chain?

There is a close relationship and interdependency between farms and mills. In the end, they both depend on the world price of sugar. On average, because of the size and capacity to invest, innovation is more apparent at the mill-level. Because smallholder farmers have fewer modern technologies and less sources of income than mills, they are more vulnerable. As the mills have alternative sources of income, such as ethanol and energy production, there are some backups that can partially compensate in the case of a low sugar price. However, their major source of income for the mills is still sugar, making them dependent on the world price of sugar as well.

What are the future possibilities towards economic sustainability in the sugar industry?

The future possibilities towards economic sustainability in the sugar industry mainly lie in building knowledge and innovations. In India, further development and education of farmers can realize major improvements in yields and reductions in costs. For example, by switching to organic production, the farmers reduce costs. This can be done without any big investments, as it is done using their farms' organic residues for fertilizer production. A problem still seems to be that farmers do not want to take the advice of mills or other institutions, firmly believing in the methods they have been using all their lives. If knowledge and trust are better transferred, yields can increase, costs can go down and more innovation can take place.

For conventional beet production, anticipating on new legislation is critical as this can put pressure on stability of production. Future possibilities are less apparent here than in cane production, as this sector is more advanced already. For organic beet production, the main problem lies in the weeding, which has to be done manually. This increases the production costs significantly. With innovations such as robots that can assist with weeding, organic beet production can become more economically sensible. If more farmers start to produce organic beet, it will lead to better availability of shared equipment, improving the position of organic beet relative to conventional beet.

What are the economic trade-offs in conventional, organic and Fairtrade sugarcane and sugar beet production?

Beet sugar production outperforms cane production on all economic aspects. Cane production mainly happens in developing countries where farmers are struggling with affording living expenses, (stability of) production is low and innovation is limited. In beet production, development is much further advanced. Even though for cane and beet the ultimate income depends on the same world price, the process of beet production is much more advanced and refined. The most apparent trade-offs are found in the innovation aspect. Beet sugar greatly outperforms cane sugar in terms of innovation. For cane production, most of the work is done manually, without any innovation taking place. This prevents cane producers from further developing the production process. The techniques for beet production in the Netherlands are among the best in the world, putting it far ahead of cane production. Within cane production, Fairtrade producers are more involved in innovation through improved access to financing and machinery. However, the innovation levels are still low.

The trade-offs regarding production are weighed more heavily by experts. All cane production scores low, because of the lack of stability of production. Beet has slightly better production, however, it is under threat of changing legislation. The employment is less divergent than the other criteria. Organic and Fairtrade cane producers have a slightly higher income than conventional cane producers. However, beet sugar still performs better than cane. With the end of the European regime in 2017, the prices paid for the sugar in India and the Netherlands converged. Thereby, the production methods are less far apart on this criterion.

6. Discussion

Most results are closely linked to what was found in previous literature. A comparison had never been made, and thus the relative position of the production methods to each other were not known before. This research places previous research in a contextual framework. The existing body of work into different production methods can be put into perspective, which is highly valuable, as it shows the relation between existing studies.

There are limitations to be considered. First, interviewing (using strategic sampling) does not lead to objectively verifiable results. The researchers' interpretations and personal experience and knowledge will always influence the result. The fact that it does not lead to objectively verifiable results is something that has to be mentioned and taken into account when using the data. Second, MCA is reliant on the judgment of the writer, in defining alternatives and criteria and in estimating the scores of each criterion. Because of the subjective nature of this part of the study, an attempt is made to keep this part as transparent as possible. Third, there is a response bias. It has to be taken into account that for some interviews, it might be in the interest of the interviewees to give a positive perspective of the sector and production method. It places their business into a perspective that will be published in research, and a positive image can be beneficial. This response bias is accounted for by taking the position of the interviewee into consideration and by not only interviewing farmers and millers, but also experts. These experts can possibly give more nuanced insights.

Furthermore, there is a selection bias. It is important to note that not all farmers and mills were willing to cooperate. It is possible that the farmers and mills who were willing to do so were performing better than average. This mostly took place for interviews in India, where multiple farmers and mills did not welcome the research. Dutch farmers were all open to our requests. Lastly, there are geographical and time constraint. The area of research does not cover all areas where sugar production takes place. Both in the Netherlands and in India we have seen large geographical differences in productivity and income for instance. This might make the results less generalizable.

Future research could expand the area of research in India or perform similar research in other countries. Moreover, the sample could be broadened. By including more than the most easily accessible farmers and millers, as well as additional experts, the response bias and selection bias can be minimized. In addition, as this research provides an overview placing all previous research on the

topic into perspective, the same type of research could be done for different commodities. Thereby, similar valuable insights can be gained into other production methods and it can become more understandable how certain production methods relate.

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