Using production-cost analysis to understand the competitiveness of sugarcane production: a comparison among Thailand, Vietnam, South Africa and Brazil

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Abstract The liberalization of sugar markets, along with lower logistic costs, has led to higher competition among sugar exporters. Understanding the differences in production systems and costs helps to identify competitive advantages and to understand future trends in the sugarcane production sector. The agri benchmark typical farm approach was used to analyze production systems and calculate sugarcane production costs of typical farms in Thailand, South Africa, Vietnam and Brazil. To ensure international comparability, the data was collected by national partners in an internationally consistent manner through focus-group discussions. The groups were composed of growers, extension agents and consultants, for the 2013 and 2014 seasons. All analyzed sugarcane farms show medium-term profitability as revenues cover the cash costs and depreciation. Nonetheless, the production costs differ substantially among farms. Results show that total cost per tonne of sugarcane (measured in recoverable sugar) are 150 USD/t lower on the typical Brazilian farm (Goiatuba) than on the other farms; this is mainly due to low operating costs. Conversely, the cost disadvantages for the typical Thai farm are mainly driven by operating costs (i.e. machinery), which are more than 100 USD/t higher than the Goiatuba (BR) farm. This is a result of insufficient economics of scale, as expensive machinery investments are under-utilized on low acreage farms. The Vietnamese farm has a high production cost but is still profitable due to significantly higher output prices. Possible drivers for the differences in production costs are the duration of the sugarcane cycle and yield levels that favor Brazil and South Africa. Size and operation scheme (contractor versus own machinery) play an important role in a farm’s performance. The findings indicate that the approach of using typical sugarcane farms in major production areas helps to understand competitive advantages, identify production processes to be improved and enables knowledge transfer.

Key words Production costs, sugarcane, international competitiveness

INTRODUCTION

The sugar market is well-known for being strongly influenced by protectionism, production incentives and government support, factors which affect its trade worldwide (Elobeid and Beghin 2004). Recently, however, there has been a significant increase in the world sugar trade; this increase was driven by market liberalization, as well as lower transportation and transaction costs (Reardon and Barrett 2000).

According to ITC (2016), the total traded sugar worldwide went from 36.8 Mt in 2001, to more than 56 Mt in 2014, i.e., an increase of more than 50%. Throughout this period, the positions of Brazil as the leading global exporter and Thailand in the second position have not changed. Together these countries account for more than 50% of the total world trade and have more than doubled their exports during the period between 2001 and 2014. Brazil’s exports rose form 11 Mt to more than 24 Mt, while Thailand’s went from 3 Mt to more than 6 Mt (ITC 2016). In comparison, South Africa exported less than 1 Mt in 2014, with most of its sugar being sold within other African countries (ITC 2016). Vietnam first became an exporter in 2013, with a relatively low export volume going almost exclusively to China (more than 90%) through quotas (Vu 2014), indicating that these countries may face different market frameworks than Thailand and Brazil.

Increasing international trade leads to more competition among exporting countries. Therefore, the question arises: which regions are more competitive and could be expected to expand their production? One way to answer this question is to compare the production systems and costs among different regions. However, internationally comparable data applicable for such analyses are very limited. Most of the literature explores either one cost component of the production cycle, for
example harvesting (Lamsal et al. 2016), or uses operating costs\(^1\) (aggregated) to compare cost-competitiveness (Crago et al. 2010).

In the last decade, the *agri benchmark* network developed a typical farm approach to compare production systems on an international level. This approach seeks a basic level of representativeness and analyzes in-depth information on production systems (Hemme 1999; Nehring 2011; Osaki and Batalha 2014). This approach has mainly been used to analyze production systems for grains and oilseeds. This paper is a first attempt to apply the *agri benchmark* typical farm approach to compare the competitiveness of sugarcane production systems in major production regions in Brazil, Thailand, South Africa and Vietnam.

**MATERIALS AND METHODS**

The advantages of using typical farms for agricultural policy, farming management and extension work has been discussed by several authors (e.g. Carter 1963; Day 1963; Plaxico and Tweeten 1963). According to Elliott (1928), a typical farm represents a modal farming enterprise producing under similar conditions and with modal characteristics such as size, organization and operational practices.

The *agri benchmark* network is a non-profit and non-political network of global agricultural economists, coordinated by the Thünen Institute of Farm Economics in Germany. The network developed an internationally harmonized Standard Operating Procedure (SOP) to establish typical farms in major global agricultural production regions (Zimmer and Deblitz 2005).

To establish the typical sugarcane farms, the SOP described by Zimmer and Deblitz (2005) was applied, following these steps:

1. The important sugarcane production regions in each country were identified by considering the share of sugarcane cultivation area to total arable land. Hence, the typical farms represent countries’ important production areas (not national figures) and should therefore be interpreted on a micro- to macro-regional level. Nonetheless, since these regions produce a major share of the world’s sugarcane, knowledge regarding their competitive advantages helps with understanding supply and cropping developments.

2. Determining the major farm features, such as size, acreage distribution of cultivated crops, level of management and location, among others, should be derived from regional statistical data. Doing so ensures that the typical farm reflects the key characteristics of farms that are responsible for the major output from the studied region. In the case of absence of available regional statistics (e.g., average farm size), farmers and advisors with in-depth knowledge of the region were asked to estimate the missing parameters.

3. After selecting and characterizing one typical farm, the first on-field data collection took place. In this phase, the national partners\(^2\) collected all major cost components (e.g. machinery, inputs, buildings, workforce, etc.), as well as a detailed description of the production systems, by interviewing farmers and agronomic advisors from the regions and during the focus groups.

The focus groups were used as a tool for data collection and validation of the typical farm. Focus-group discussions are a commonly used research technique that aims to collect data from a group interaction, in which a researcher is responsible for addressing the questions of interest (Morgan 1996). One of the characteristics of the focus group is that there is an expectation of synergy among the discussion points, as individual opinions are directly taken into account in the general debate between all members. This enhances the depth of the outcome, in comparison to individual interviews (Goldman 1962).

The focus groups were composed of 5-10 participants, with the vast majority being farmers. In addition to farmers, regionally active advisors were also invited. During the focus-group discussions, all values of the typical farms were defined jointly in order to capture the most common figure for each studied region. The interaction among participants allowed

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\(^1\) In this case, operating costs are defined as direct input costs plus machinery, labor and contractor costs. Conversely, throughout the paper, operating costs solely refers to the sum of machinery costs, diesel, labor and contractor, treating direct input costs separately.

\(^2\) The data was collected by the following national *agri benchmark* partners: PECEGE (University of Sao Paulo) and Dr. Carlos Xavier – Brazil; Dr. Pipat Weerathaworn – Thailand; Dr. Ngoc Luan Nguyen (SDCC) – Vietnam; BFAP and Canegrowers Association – South Africa.
farmers to balance between their own farms against their neighbors’ farms, resulting in a clearer identification of typical versus individual practices. The data was originally collected in 2013 and updated in 2014. Therefore, the information in this paper represents 2-year average data.

Typical farm data allow detailed analysis of production systems and its costs. However, only a limited number of farmers can be established and updated considering the significant resources required for establishing and updating each farm (e.g. focus group). Therefore, the data delivers interesting information but does not represent the farm population of each region.

Finally, the collected data were analyzed using the TYPICROP model that was also developed for the agri benchmark network. This model runs a farm-level cost calculation, using key economic indicators to measure a farm’s performance and competitiveness. An extended discussion and explanation of the agri benchmark methods and model can be found in Hemme (1999), Nehring (2011) and Walther (2014).

RESULTS AND DISCUSSION

In order to facilitate the comprehension of the results, this section is divided into five subsections; first, an overview of the typical farms and natural conditions is given. Afterwards sugar yields, cane-establishment costs, operating costs and overall performance of sugarcane farms are compared.

Overview of the typical farms

In order to better understand the overall framework of the typical farms, Table 1 shows the important features regarding each farm’s area, location, climatic conditions, seedcane input, cycle duration and degree of mechanization.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Location</th>
<th>Typical farms (indicators)</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>BR220ST</td>
<td>BR6300GO</td>
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<td></td>
<td></td>
<td>Sertaozinho</td>
<td>Goiatuba</td>
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<td>TH24KK</td>
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<td>Location</td>
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<td>Brazil</td>
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<td>Country</td>
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<td>Thailand</td>
<td>Vietnam</td>
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<td>Region</td>
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<td>Sertaozinho</td>
<td>Goiatuba</td>
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<td>Climate</td>
<td></td>
<td>Sertaozinho</td>
<td>Goiatuba</td>
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<tr>
<td>Average rainfall</td>
<td>mm/year</td>
<td>1500</td>
<td>1320</td>
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<tr>
<td>Rain distribution</td>
<td>Months</td>
<td>10-04</td>
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<tr>
<td>Production</td>
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<td>Cane acreage</td>
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<td>ha</td>
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<td>200</td>
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¹ On average, 20% of the planting area is harvested after 12 months, whereas the remaining is after 18 months

² Mechanized planting considering only “all-in-one” planting machinery.

Source: agri benchmark (2016) – Authors’ calculations

It is important to note that the name of the typical farms should be interpreted throughout the paper as such: the first two letters indicate the country (e.g., BR indicating Brazil); the following numbers indicate the total arable land available on the farm (e.g., 220 ha); and the last sequence of letters show the region/county (e.g. ST serves as an abbreviation for Sertaozinho).

The characteristics of the typical farm are important for understanding some of the following differences in production costs. For example, the strong differences in production cycle duration; only 3 harvests in Thailand, for instance, compared to 10 harvests in South Africa, is expected to strongly affect the amortization of establishment costs. The quantity of seedcane per hectare also varies substantially among the farms; the farm in Goiatuba (BR) uses 8 t/ha more than the farms in...
Vietnam and South Africa. This can partly be explained by the use of mechanical planting, which normally requires a larger amount of seedcane.

Sugar yields

Figure 1 shows the yields of typical sugarcane farms. These are represented in the sugar content (i.e. Pol) that can be recovered by mills, according the most common sugarcane payment system based on quality (Keerthipala and Thomson 1999). Using recoverable sugar content allows for a cross-country comparison, even with competitive crops such as sugar beet.

![Graph showing sugarcane yields of typical farms in Brazil, Thailand, Vietnam and South Africa; represented in recoverable sugar content for 2013 and 2014. Source: agri benchmark (2016) – Authors' calculations.](image)

As shown in Figure 1, Brazilian farms have relatively higher yields when compared to the other analyzed countries. The farm in Goiatuba (BR) has the highest yields, roughly 30% higher than those in Thailand, Vietnam and South Africa. Interestingly, the Brazilian and Vietnamese farmers had relatively stable yields in the years analyzed, whereas the TH24KK farm suffered greatly from drought, resulting in a significant reduction in yield. Conversely, the South African farm experienced higher yields in 2014, even though both years were considered rather dry by local farmers and experts. In order to understand international competitiveness of the sugar market, it is important to keep in mind the different yield levels obtained in the studied countries. As the following sections shows, costs are mostly treated and compared on a per tonne of output basis, so that the difference in yields becomes more important.

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3 Since Brazilian cane farmers are paid for the total recoverable sugar (ATR in Portuguese), we divided this amount in Pol and other sugars (RS), considering the former as ‘main product’ and the latter as ‘by-product’. Hence, the overall return to farmers considers the actual payment system, without overestimating the sugar content in a cross-country comparison.
Establishment costs

An important cost component of sugarcane production is the establishment costs. Figure 2 depicts the cost of establishing cane (in USD/ha)\(^4\), while further breaking these costs down to their components.

![Figure 2: Sugarcane establishment costs in the analyzed typical farms in USD/ha. Values depict an average between 2013 and 2014. Source: agri benchmark (2016) – Authors’ calculations.](image)

Our results show that in most of the countries, around USD 1,000/ha are spent in direct inputs for the establishment of the sugarcane, with seedcane representing roughly 50% of the direct cost expenditures. The Thai farm has significantly higher seedcane costs of around USD 800/ha, yet has lower fertilizer costs, resulting in only a slightly higher overall establishment cost. Across countries, the total establishment costs range from about USD 2,400 to USD 2,900/ha, with the largest share coming from operating costs. It is important to note, that the operating costs here account for land preparation, seedcane harvesting and transport (if applicable) and all operations necessary for planting.

Even though the overall establishment costs appear to be similar, there is an important difference related to the duration of the production cycle. Longer producing cycles, as observed in South Africa (about 10 harvests), lead to lower participation of the establishment costs in the total output cost, since they are amortized over more years. This leads to a competitive advantage when compared to the typical farms in Thailand and Vietnam where the production cycles last just 3 and 4 years, respectively. Finally, understanding establishment costs is important since they usually account for the greatest single expenditures throughout the cane production cycle.

Operating costs

In addition to establishment costs, operating costs are an important cost component of sugarcane production. Figure 3 shows the operating costs for producing sugarcane on a USD/t of output basis. Comparing costs per tonne of output makes the cross-country comparison easier while focusing in international competitiveness. Costs per hectare may lead to misleading interpretation if countries have high intensity (high cost per hectare) with high yields.

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\(^4\) The graph is on USD/ha because establishment costs are usually seen by farmers as investment on area bases. These costs are also accounted for in USD/t in the following graphs, but with a different costs composition (e.g. operating costs, etc.).
The results presented in Figure 3 allow for identifying the different strategies adopted by farmers regarding their operations and highlights the importance of harvesting as a component of these costs. On the Brazilian farms, the one in Goiutuba (BR6300GO) uses mainly contractors for all operations; therefore, the need for hired and family labor, as well as machinery is almost negligible. On the other hand, the farm in Sertãozinho (BR220ST) has to cope with higher machinery and labor costs, since a substantial share of operations is done using their own assets. Similarly, the Thai farm has more than USD 50/t of machinery costs due to relatively low acreage to consider for the amortization of expensive machinery. In contrast, the harvest on the South Africa farm is done by hired labor resulting in higher labor costs.

Even though the degree of mechanization for the harvest varies greatly, i.e. Brazil using mainly mechanical harvesting, whereas the others employ manual cutting, the harvesting costs are similar, ranging from USD 40 to USD 60/t. The only exception is Vietnam with three times higher harvesting costs. With regard to international competitiveness, this means that mechanized harvest does not necessarily lead to cost advantages. This can partly be explained by the relatively low wage rates in Thailand and South Africa, which compensate for the high labor input. The low operating costs of the BR6300GO farm indicate that outsourcing operations to contractors is a way of reducing these costs. However, outsourcing operations may lead to additional losses (e.g. harvest losses) that we did not assess.

**Overall performance of sugarcane farms**

The economic performances of the typical farms are shown in Figure 4, highlighting cash costs, depreciation, opportunity costs and farm gate prices received by farmers (in USD/t).
Our results show that all typical farms are able to cover cash costs, which in other words means that they are able to cover their expenditures, accounting for all stages of the sugarcane production process. Moreover, the farms are also able to cover their depreciation costs, which can be seen as an indicator of medium-term profitability. The Brazilian farm located in Sertaozinho and the South African farm were not able to cover their opportunity costs (i.e. remuneration of own capital, land and family labor), indicating that these farms are not profitable in the long run. Conversely, the Brazilian farm located in Goiatuba and the farm in Vietnam were able to generate actual profits in both analyzed years, indicating that these farms are generating enough revenue to cover all costs, including those of their own assets. The Thai farm was able to generate profit in the 2013 season, but not in the following year; this was due to a significant yield drop in 2014, from 8.5 t/ha in 2013 to 6.8 t/ha in 2014, as a result of drought. The differences in the Brazilian farms are mainly driven by a strong divergence in opportunity costs, which can be explained by the significantly higher opportunity costs of utilizing their own land\(^5\), family labor and their own capital invested in machinery.

In addition to the total cost, revenues differ substantially among the farms. The Brazilian typical farms have to produce at lower costs as they are faced with the lowest prices in the comparison, around USD 220/t, whereas the farm located in an exporting country (i.e. Thailand) had at least USD 50/t higher prices for their output. The South African farm had similar prices as the Thai farm, but with slightly higher prices in 2013. The Vietnamese farm received the highest price, reaching values above USD 400/t, almost twice as much as the prices in the Brazilian enterprises. This confirms our expectation that Vietnam and South Africa face different marketing conditions, since those countries tend to trade with protected partners, inducing higher domestic prices. This comparison indicates that high prices due to market distortions lead to more expensive (less efficient) production systems. Even though profitability is currently high (e.g. the Vietnamese farm), these production systems are expected to face higher economic pressure if markets further liberalize in the future.

The competitive edge observed in the farm in Goiatuba (BR) may help explain the strong increase in sugarcane area in this region in recent years (CONAB 2016). However, it is important to consider that the high returns observed for this farm are partly driven by the pricing systems currently in place, in which sugar mills in other states pay the same sugarcane prices as in Sao Paulo, even though the factory is located more than an additional 500 km away from the exporting harbors. This situation can be partly explained by the strategy/necessity of mills to source cane from regions where soybean and corn are the major production crops. The Thai farm also has a good competitive position, but experienced more volatile farm profitability due to more extreme climate conditions (drought).

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\(^5\) Land rents are used to estimate opportunity costs of own land. The land rent in BR6300GO is roughly 50% of the land rent in BR220ST.
CONCLUSIONS

With the liberalization and globalization of sugar markets, understanding the competition drivers of production countries is essential. The lack of internationally comparable and consistent data has prevented cross-country systematical analysis of these competition edges in the past. The results of this analysis give a comprehensive overview of the major cost components in sugarcane production in Brazil, Thailand, Vietnam and South Africa.

Regarding future optimization of current production systems, it is necessary to consider that cane-establishment costs are mainly driven by operating costs. Hence, strategies to improve efficiency of tillage and planting, e.g. mechanized planting and direct seeding, might be useful for reducing this important component of costs. The opportunity for outsourcing operations appears to greatly reduce the overall operating costs throughout the production cycle, mainly due to a reduction of machinery idle time, depreciation and required full-time labor. However, there might be other factors affecting the overall performance of the contractor, e.g. operation quality and damage to the crop, which were not in the costs. Further research is required to understand the overall performance of service providers. Harvest costs are similar among the studied countries (except for Vietnam), being around USD 50/t regardless of the type of operation, i.e., manual versus mechanized and own versus contractor. This indicates that producers are rationally employing the most suitable practice according to the relationship between wages and machinery costs.

The overall performance of the farms depicts an interesting situation that indicates that all countries are able to cover at least cash costs and depreciation. The farm in Goiatuba (BR) demonstrated the best performance, which might explain the expansion of cane seen in that region.

In terms of international competitiveness and future growth in sugarcane production, our results indicate that the growing regions in Brazil especially will have a strong position in the future, along with the option to expand production. On the other hand, the production systems in South Africa and Vietnam may face increasing economic pressure in a more liberalized world.

However, our analyses focused on the production of sugarcane, which can only be seen as a raw material for the actual internationally traded commodity – sugar. It is likely that competitive advantages also come from other steps in the value chain, especially in processing (milling). Hence, future analyses on the processing cost of sugar mills would help to further understand the international competitiveness of sugar markets.

In conclusion, using the typical farm approach under the agri benchmark network is a suitable approach to understanding production systems in sugarcane, along with their related costs. A notable drawback of the concept is the lack of statistical representativeness of the results; however, the on-field checking and knowledge of national partners is expected to help minimize this problem. The generated information can help technicians to understand what is happening in competing regions, allowing for the identification and improvement of processes that drive-up production costs.

REFERENCES

Utilisation de l’analyse des coûts de production pour comprendre la compétitivité de la canne à sucre: une comparaison entre le Thaïlande, le Viêt-Nam, l’Afrique du Sud et le Brésil

Résumé. La libéralisation des marchés de sucre ensemble avec les coûts de logistique plus bas, a entrainé une concurrence accrue entre les exportateurs de sucre. Entendre la différence entre les systèmes de production et frais aide à identifier les avantages compétitifs et les tendances futures dans le secteur de production de la canne à sucre. L’approche ferme typique agri benchmark a été utilisée pour l’analyse des systèmes de production et pour le calcul des coûts de production des exploitations agricoles typiques au Thaïlande, Afrique du Sud, Viêt-Nam et Brésil. Pour assurer la comparabilité internationale, les données ont été collectionnées par des partenaires nationaux de manière cohérente sur le plan international par des discussions de groupe cible. Les groupes pour les périodes 2013 et 2014 ont regroupé des multiplicateurs, des agents de développement agricoles et des consultants. Toutes les fermes de canne à sucre montrent de la rentabilité à moyen terme, étant donné que les revenus couvrent les coûts au comptant et aux dépréciations. Néanmoins, les coûts de production sont substantiellement différents entre des différentes fermes. Les résultats montrent que les coûts par tonne de canne à sucre (mesuré à sucre extractible) sont supérieurs de 150 USD/t pour la ferme Brésilienne (Goiatuba) que pour les autres fermes – ce qui est dû aux coûts de fonctionnement faibles. Inversement, les désavantages pour la ferme typique Thaïlandaise sont principalement motivés par les coûts de fonctionnement (p.ex. les machines) qui sont plus de 100 USD/t plus chers que pour la ferme à Goiatuba (BR). C’est un résultat des économies d’échelles insuffisantes, étant donné que les investissements pour la machinerie coûteuse sont sous-utilisés dans des fermes à superficies limités. La ferme vietnamienne montre des coûts de production élevés mais en raison des coûts de rendement beaucoup plus élevés, elle est encore profitable. Les conducteurs possibles pour les différences des coûts sont la durée du cycle de la canne à sucre et le niveau de rendement qui favorise le Brésil et l’Afrique du Sud. La dimension et le système d’exploitation (entrepreneur vs. propre machines) jouent un rôle important dans les résultats d’une ferme. Ces conclusions montrent que l’approche d’utiliser les fermes typiques de canne à sucre dans des régions importantes de la production aide à comprendre des avantages compétitifs, à identifier le processus de production à améliorer et permet le transfert de connaissances.

Mots-clés: Coûts de production, canne à sucre, compétitivité internationale

Uso del análisis de costes de producción para entender la competitividad de los productores azucareros: una comparación entre Tailandia, Vietnam, Sudáfrica y Brasil

Resumen. La liberalización de los mercados de azúcar junto con los bajos costes logísticos, han conducido a una mayor competencia entre los exportadores de azúcar. Comprender las diferencias en los sistemas de producción y sus costes ayuda a identificar las ventajas competitivas, y a prever las tendencias futuras en el sector productor de azúcar. Empleando la metodología de “granjas típicas” de agri benchmark se han analizado los sistemas de producción de azúcar y calculado sus costes de producción en explotaciones típicas en Tailandia, Sudáfrica, Vietnam y Brasil. Con el objetivo de asegurar la comparabilidad internacional, los datos fueron recogidos por los investigadores nacionales de manera consistente mediante grupos de discusión compuestos de productores, extensionistas y asesores, para las temporadas de 2013 y 2014. Todas las explotaciones productoras de azúcar analizadas son rentables a medio plazo, es decir, los ingresos cubren los costes efectivos y la depreciación. Sin embargo, los costes de producción difieren sustancialmente entre explotaciones. Los resultados indican que el coste total por tonelada de caña (en azúcar recuperable) es 150 USD/t más bajo en la explotación brasileña (Goiauba) que en el resto de explotaciones, esto se debe principalmente a los bajos costes de operación. A la inversa, las desventajas en costes para la explotación tailandesa se deben a los costes de
operación (p.ej. maquinaria), los cuales exceden en más de 100 USD/t a los de la explotación ubicada en Goiatuba, Brasil. Esto es un resultado de las economías de escala insuficientes, pues inversiones caras en maquinaria son infrautilizadas en fincas pequeñas. La explotación vietnamesa tiene un alto coste de producción pero, gracias a los precios más altos, todavía resulta rentable. Posibles razones para las diferencias en costes de producción son la duración del ciclo de la caña y la productividad que son más favorables en Brasil y Sudáfrica. El tamaño y la organización de las operaciones (maquinaria propia o contratista) juegan un papel muy importante en el rendimiento de las explotaciones. Los resultados indican que la metodología de “granja típica” en las regiones clave de producción ayuda a comprender las ventajas competitivas, a identificar los procesos de producción susceptibles de mejora y a facilitar la transferencia del conocimiento.

**Palabras clave:** Costes de producción, caña de azúcar, competitividad internacional