Balancing profitability and environmental considerations in best practice cane growing

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Abstract Agricultural industries are faced with the challenge of supplying a growing world population with food and fibre whilst also protecting environmental and social values. Some sugar industries have developed ‘best practices’ for sugarcane growing to protect the environmental and social values they influence. There are best practices program for sugarcane growing regions in the Americas, Australia, Thailand and South Africa, but also global programs. Many are driven by environmental objectives, but some also by human health. However to be sustainable, industries need to consider the economic as well as environmental and social implications of these practices. The evaluation of multiple performance objectives may not have been adequately factored into the design of best practices. Due to the internationalization of sugar industries and potential trade imbalances, progressing environmental and social outcomes, without compromising economic competitiveness, will be critical. This paper examines how to achieve a balanced approach to developing best practices so that one set of values are not over-emphasized at the expense of others. We first frame the problem by reviewing how particular values have driven management practice changes in various parts of the world, and critique whether they are holistic and balanced. We then review methods for and examples of the joint evaluation of economic, environmental and social considerations, for informing more balanced decision-making. We then draw on an Australian case study of where this has been done to better understand the implications of this industry’s SmartCane Best Management Practice (BMP) program. The case study used a farm economic assessment tool (FEAT) and a life cycle assessment eco-efficiency tool (CaneLCA) to quantify profitability and environmental performance changes from best practice adoption. It showed that best practices can bring both profitability and environmental improvements, but profitability may be quite sensitive to cane yields. We conclude that such multi-criteria evaluation of practice change implications should occur at the farm level based on actual operations to inform best practice formulation at the industry level.

Key words Sugarcane growing practices, best management practices, sustainability, environment, social, economics

INTRODUCTION

Agricultural industries are faced with the challenge of supplying a growing world population with food and fibre whilst also protecting environmental and social values (Malcolm 2011). One way agricultural industries deliver environmental and social stewardship is through the definition and promotion of ‘best practices’ within their farming communities. However, in the formulation of best practices there appears to have been little integration of agronomic, social, environmental and economic considerations. This means that best practices can run the risk of over-emphasizing a particular objective, say environmental outcomes over economic outcomes, or productivity outcomes over social outcomes, for instance.

The aim of this paper is to examine how a balanced approach to best practices can be facilitated in sugarcane industries, with a focus on the role of evaluation in informing best practice decisions. More emphasis is directed to the balance between economic and environmental aspects as there has been some progress in this regard, but social aspects are also touched on. By way of background, we first review best practices programs in sugarcane industries and the values driving them, and critique whether a balanced approach has been taken in their formulation. We then review the role of evaluation during the research and development phase for informing more balanced best practices. Finally, we describe a framework for doing this, which draws on the experiences of an Australian case study project that jointly evaluated economic and environmental aspects of the Australian SmartCane Best Management Practice (BMP) program.

This work is relevant to industry and government policy makers, in relation to informed decision-making about best practice sugarcane growing. The intent is to open up discussion about consistent frameworks for considering the multiple...
dimensions of cane growing – agronomic, economic, environmental and social – for more informed policy. The topic is currently relevant to the Australian sugarcane industry due to a strong push for water-quality improvements in sugarcane growing regions adjacent to the Great Barrier Reef. However, it is equally relevant to cane industries in other regions responding to community expectations.

BEST PRACTICE PROGRAMS

Best practices in agriculture are “farming method[s] that minimizes risk to the environment without sacrificing economic productivity” (Hilliard et al. 2002). As suggested in this definition, the term commonly refers to practices that avoid environmental impacts, but it can also refer to practices aimed at achieving other objectives, such as productivity, social welfare, worker health, etc. In sugarcane industries there are examples of best practice being recommended and/or promoted by peak industry groups and governments, driven by different objectives (Table 1). These programs typically define a set of farm management practices, the adoption of which may be voluntary or regulated, and which may lead to some form of certification and ongoing evaluation and auditing.

Best practices are commonly formulated at the industry level (and sometimes at the international level), but it is at the farm level that the environmental and social stewardship response will ultimately occur. For farmers, it can be difficult to change to best practices as some (but not all) involve capital investment, new production operations, learning new skills, changes in human investment, and may potentially compromise production and productivity.

Table 1. Best practice programs in sugar industries.

<table>
<thead>
<tr>
<th>Region</th>
<th>Best practice program</th>
<th>Driver</th>
<th>Institution/reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global</td>
<td>Good management practices for the cane industry</td>
<td>Unspecified</td>
<td>International Finance Corporation (2011)</td>
</tr>
<tr>
<td></td>
<td>Bonsucro Production Standard</td>
<td>Sustainability (environmental, social and productivity)</td>
<td>Bonsucro (2016)</td>
</tr>
<tr>
<td></td>
<td>Paddock to Reef ABCD Program</td>
<td>Water quality protection</td>
<td>Queensland Government (Harvey et al. 2015)</td>
</tr>
<tr>
<td></td>
<td>Natural resource management (NRM) improved practice frameworks</td>
<td>Water quality protection</td>
<td>NRM bodies (Harvey et al. 2015)</td>
</tr>
<tr>
<td>Brazil</td>
<td>Brazilian Sugarcane Industry Association (UNICA) Best Cultivation Practices</td>
<td>Human health impacts from cane burning</td>
<td>Sugarcane.org</td>
</tr>
<tr>
<td>Nicaragua</td>
<td>Corporate Social Responsibility (CSR)</td>
<td>Social, environmental, health and safety issue</td>
<td>Nicaraguan sugar industry (Anon. 2012)</td>
</tr>
<tr>
<td>USA (Louisiana)</td>
<td>Sugarcane Environmental Best Management Practices</td>
<td>Water quality protection</td>
<td>Gravois et al. (2006)</td>
</tr>
<tr>
<td>USA (Florida)</td>
<td>Everglades Forever Act (EFA)</td>
<td>Water quality and water quantity</td>
<td>State of Florida, Everglades Agricultural Area (Izuno and Bottcher 1994)</td>
</tr>
<tr>
<td>South Africa</td>
<td>Sustainable Sugarcane Farm Management System (SuSFarMS)</td>
<td>Sugarcane production, conservation of natural assets, maintenance of critical ecosystem services and social and economic issues.</td>
<td>Maher (2007)</td>
</tr>
</tbody>
</table>
For sugarcane industries, changing farm business environments\(^1\) over the past few decades make it problematic to ascertain if changing management practices adversely affect profitability over time. Sugarcane farmers are typically price takers, competing in a global market against suppliers in differing trade settings (Harvey et al. 2015), and therefore it is often difficult to directly pass on the costs of environmental and social stewardship to customers. Internationalization of sugar industries, along with trade imbalances, means that progressing environmental and social outcomes may compromise competitiveness.

Therefore, best practice programs can present a risk to sugarcane industries if they are detrimental to farm and mill profitability and competitiveness. It may also transfer environmental and social risk elsewhere in the global economy where best practice requirements do not exist. This leads to the inefficient allocation of resources and detracts from other farm-level investments that may provide better outcomes for industry and community. It may also lead to reduced economic growth and the ability for industry to invest into research and development to address environmental and social issues.

To be sustainable, best practice programs need to include consideration of the economic as well as the environmental and social implications (van Grieken 2013). Revisiting Hilliard’s definition of best practice (“farming method[s] that minimizes risk to the environment without sacrificing economic productivity”), we note there is at least an appreciation for economic considerations. Given the environment is often a driver for the development of BMPs, it is not often clear whether best practice programs balance multiple objectives in their formulation. For example, are economics adequately factored into the design of best practices aimed at reducing environmental impacts? Do best practices targeting productivity recognize the potential environmental and social trade-offs?

Reviews of research and extension literature suggests there has been little integration of agronomic, social, environmental and economic considerations (referred to as ASEE in future for brevity) when evaluating alternative sugarcane growing practices (Collier et al. 2015). It is most common for there to be a focus on one particular aspect. By inference, we would suggest that formulation of best practices generally do not consider the multiple dimensions, based on an assumption that research activities inform best practice formulation. Therefore, policy makers may be relying on a partial picture of the relative merits of practice alternatives and the implications of practice change. Practices recommended on the basis of a single performance indicator may lead to inadvertent consequences for other aspects, because the potential trade-offs were not explored. Consequently, we argue there is a need for a more balanced approach to best practice formulation.

**THE ROLE OF EVALUATION IN INFORMING MORE BALANCED BEST PRACTICES**

Achieving a balanced approach to best practice formulation requires consideration of multiple objectives in decision making. Decision making occurs as part of industry policy and is influenced by institutional and political objectives. We are not concerned here with the decision making process, but with the evaluation and information that supports decision making. We suggest that evaluating ASEE implications should be a necessary component of developing sound best practices. This may be achieved by evaluating alternative practices against a range of relevant performance indicators (Table 2) at the research and development stage, so that the resulting ‘best practices’ are a balanced improvement on standard practices.

**Table 2.** Examples of the multiple objectives of sugarcane growing.

<table>
<thead>
<tr>
<th>Agronomic</th>
<th>Economic</th>
<th>Environmental</th>
<th>Social</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production (cane yield, sugar content)</td>
<td>Gross margin</td>
<td>Land use efficiency</td>
<td>Human health</td>
</tr>
<tr>
<td></td>
<td>Farm operating return</td>
<td>Water use efficiency</td>
<td>Community development</td>
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<tr>
<td></td>
<td>Return on investment</td>
<td>Energy use efficiency</td>
<td>Farmer empowerment</td>
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<tr>
<td></td>
<td>Net present value</td>
<td>Greenhouse gas emissions</td>
<td>Capacity building</td>
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<td></td>
<td>Internal rate of return</td>
<td>Water quality</td>
<td>Property management planning</td>
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<tr>
<td></td>
<td>Discounted payback period</td>
<td>Air pollution</td>
<td>Likelihood of adoption</td>
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<tr>
<td></td>
<td>Business risk</td>
<td></td>
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</tr>
</tbody>
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\(^1\) Increase in mechanisation, continued adoption of new technologies, growing capital investment per worker, large amounts of borrowed capital, increasing farm size, new marketing techniques and increased risk (Kay and Edwards 1994, p 1).
Evaluating agronomic productivity

From an agronomic perspective, research and development programs typically strive to identify farming practices that improve production and productivity. They often focus on field trials or simulations to assess productivity (e.g. cane yield, sugar content) and productivity (inputs versus outputs) implications. Production is a measure of total output expressed as total quantity or value (e.g. tonnes of cane per hectare). Productivity is a ratio of inputs to outputs, such as nitrogen (N) use efficiency (NUE) or water use efficiency (WUE) per tonne of cane. It is used to measure performance in terms of reducing inputs per unit of output or increasing outputs per unit of input.

Improvements in productivity do not necessarily translate to improvements in profitability, with the law of diminishing returns resulting in the economic optimal being different from the productivity optimal. Evaluating the agronomic implications of alternative practices is critical, particularly as a first step in understanding implications for production and the farming system (Schroeder et al. 2013). However, one must not assume it provides a process or measure to determine the optimal profitability for a farming enterprise, which is discussed later.

For example, in evaluating N-management strategies in the Australian sugar industry Schroeder et al. (2009) showed that although a higher than best practice N application rate slightly improved cane yield, this did not translate into an increase in partial net return. It was also shown that an N application rate lower than best practice was more acceptable environmentally, but resulted in a loss in productivity and profitability.

Evaluating environmental aspects

Environmental aspects can be evaluated at two different scopes – direct impacts (on the farm), or product life cycle impacts (indirect off-farm as well as direct on-farm). The first considers the effects of sugarcane growing on the water, air and soil quality of the immediate environment, through measurement or computer simulation. For this there is an existing body of literature from Australia, USA and Brazil, particularly for practices aimed at reducing N, phosphorus and pesticides losses to water, and nitrous oxide emissions and air pollutants to air (reviewed in Collier et al. 2015). The second uses environmental life cycle assessment (LCA), which considers the off-farm production of farming inputs, as well as on-farm aspects, and a range of environmental impacts, to give a more holistic picture. There is an existing body of literature from Brazil, Thailand, South Africa, Australia etc., but mostly in the context of sugarcane-based bioenergy (reviewed in Renouf 2016). There are examples of LCA-based environmental evaluation tools, such as the BonSucro Greenhouse Gas Calculator2 and the CaneLCA Eco-efficiency Calculator3.

The more comprehensive picture offered by LCA can flag inadvertent environmental consequences of cane-growing practices not obvious in studies of direct emissions alone. It has been used to a limited degree to compare alternative growing practices (van der Laan et al. 2015; Fukushima and Chen 2009; Renouf et al. 2014). Findings suggest that practices aimed at reducing inputs per unit of cane (for example, N-use efficiency or water-use efficiency) or avoiding emissions (for example, ceasing cane burning) generally result in environmental improvements, but some practice changes can have inadvertent trade-offs. For instance, improving productivity through greater use of irrigation can come at the expense of energy and greenhouse gas emissions for pumping water. The full scope of practices is yet to be assessed, and it is possible other potential trade-offs will emerge. For example, replacing synthetic fertilisers with other forms of fertiliser (organic fertilisers or controlled-release fertilisers) may help manage N losses on farm, but may increase fossil fuels use and greenhouse gas emissions in the up-stream input manufacturing and transport phases.

LCA considers environmental impacts in terms of end products (i.e. per unit of cane or sugar produced) rather than per hectare, as that is the desired end outcome of agricultural production. Practice changes that reduce or compromise cane or sugar yields run the risk of increasing impacts per unit of product. So LCA also flags the (sometimes delicate) balance between lowering emissions-intensive inputs whilst maintaining yields.

Evaluating economic aspects

Profitability is a primary goal for farmers and without it businesses will not survive in the long run. So understanding the farm profitability implications of practice change is crucial for farm and industry viability, and for practice change adoption.

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2 http://bonsucro.com/site/certification-process/bonsucro-calculator/
Farmers are unlikely to adopt new management practices if they have an adverse impact on profitability (Pannell et al. 2006).

Whilst it is often implied that an increase in production or productivity will improve farm profitability, this is not necessarily the case. They are indeed key determinants of farm profit, however they do not consider the “amalgamated effects of the technical relations between all inputs and outputs, how the inputs are combined, and including the effects of changes in prices received and paid” (Malcolm 2011, p. 76).

There are examples of whole-of-farm economic evaluation tools, such as the Farm Economic Analysis Tool (FEAT) (Stewart and Cameron 2006), that can be used in conjunction with capital budgeting techniques and risk analysis to evaluate farm profitability and economic impact. Other methods include the use of bio-economic models to simulate the production and corresponding economic impact of a change in practice. Some of the common economic performance indicators used include farm operating return, return on investment and net present value.

Evaluating social aspects

Social considerations can encompass different things in different regions, including the welfare and income of workers, the contribution that sugarcane industries make to local and regional economies, financial sustainability for family businesses, the participation and empowerment of growers and workers in farm decision-making. For this discussion we are primarily interested in the social implications of practice change, for example, changes to employment opportunities through mechanisation, or farm participation in decision-making. Health implications, for example when changes are made to agro-chemicals use and cane burning, can be assessed as part of environmental LCA, which can include human health indicators. Social impacts of practice change can potentially be assessed using a technique known as Social Hot Spot analysis. It is similar to environmental LCA in that it tracks social implications across the life cycle of supply chains to highlight areas where potentially negative social issues occur. However, it is an emerging method and there are currently no examples of its use in sugarcane systems.

Joint evaluation of multiple objectives

Since the late 1990s there has been evaluation of the conflicts and trade-offs between maximising productivity and profitability, and minimising adverse environmental and social impacts. Some academic exercises have jointly analysed economic, environmental (and sometimes social) indicators using techniques such as trade-off analysis, sustainability indices that integrate economic and environmental indicators, and farm models that simulate agronomic, environmental and economic parameters within the one tool (reviewed in Collier et al. 2015). For agriculture generally, there can be a strong conflict between competing interests (Cisneros et al. 2011; Semaan et al. 2007), but also opportunity to optimise both economic and environmental outcomes (Meyer-Aurich 2005). For sugarcane, an Australian example of joint evaluation of farm profitability and water quality implications of practice change, based on representative sugarcane farming systems (van Grieken et al. 2014), found that a number of practice changes achieve environmental and economic benefits, but trade-offs also exist and may require different policy approaches. Despite some practices being identified as more cost-effective for water quality improvement, this did not necessarily correspond to optimising farm profitability (e.g. moving to an N-replacement nutrient management strategy).

Most work to date has compared farm practices based on hypothetical scenarios, but there are arguments for evaluating practices based on actual farming operations. In their work on water use efficiency in Australian dairy farms, Makeham and Malcolm (1993) stressed that farm management decisions need to consider the complex combination of human, production, environmental, economic, and financial considerations, and that in-depth examination of a small number of businesses is best for this. For farmers, a key objective is to deploy the available resources of land, labour and capital to produce the best profit, subject to the opportunities and constraints that apply to the business (Kay and Edwards 1994). Therefore, decisions about best practice needs a good understanding of the impacts at the farm level.

A framework to evaluate the agronomic, social, economic and environmental implications at the farm level is vital for a balanced approach to best practice and a sustainable sugarcane industry.
A FRAMEWORK FOR JOINT EVALUATION OF BEST PRACTICES

This section describes an Australian research project that aims to jointly evaluate the economic, environmental and social (to a less extent) implications of the SmartCane Best Management Practice (BMP) program being promoted in Australia sugarcane industry. It provides a framework of how the economic and environmental implication can be quantified at the farm level to inform best practice formulation at the industry level. The practice changes evaluated are those implemented in the Wet Tropics sugarcane growing region, in the north of Queensland, Australia.

A key component of the project was the direct engagement with growers to undertake case study evaluations of BMP adoption using real farm data rather than modelling of hypothetical scenarios. This enabled the evaluation of BMPs in a commercial setting, which is important in capturing the impacts on the whole farm system, along with barriers to adoption and other social implications. Five case studies are evaluated in the project, but here we summarize the findings of one of the case studies as an example. The case study farm had changed to SmartCane BMP over 8 years by making changes to nutrient, soil and pest management practices.

The practice changes had already been validated agronomically in prior research trials, and in this project it was the farm profitability and environmental implications that were evaluated using a Farm Economic Assessment Tool (FEAT)\(^4\) and a Cane Life Cycle Assessment (CaneLCA) Eco-efficiency Calculator\(^5\), respectively.

The environmental assessments (using CaneLCA) found that the BMP adoption results in substantial environmental benefits (Figure 1). After BMP adoption, annual fossil-fuel use for the whole life cycle of the farming operation reduced by 15% overall. More than half of this occurs off-farm, due to less fertiliser being produced at the factory, and the remainder is due to on-farm reduction in fuel use for tractor operations, planting and harvesting as a result of wider row spacing. The greenhouse gases emitted (carbon footprint) also reduce, mostly due to less on-farm emissions of nitrous oxide (a strong greenhouse gas) from less N fertilizer, but also from the on-farm reductions in fuel use. The potential for water quality impacts from nutrient runoff was reduced by 20% overall, because less N has been applied. The potential for water quality impacts from pesticides losses was also reduced by 45%.

The economic assessments (using FEAT) found that BMP adoption can result in a cost saving by reducing the amount spent on fertiliser, fuel and labour (Fig. 2). The investment analysis shows that cost savings from BMP adoption have more than offset the capital investment in new machinery and equipment (Table 3).

A risk analysis found that profitability can be quite sensitive to cane yield. If cane yields were to decline by more than 7%, investing in BMP adoption may be unprofitable (Fig. 3). The environmental benefits were found to be less sensitive to yield, needing a yield reduction of around 20% or more to be offset.

Hence, this case study demonstrates a win-win outcome for economic and environmental objectives if yields are not compromised, but there is a risk that the changes may not be profitable if yields decline. It highlights the potential economic risk which should be understood at the research and development stage. It is often tempting to oversimplify the message communicated to growers through the use of a single or proxy performance indicator. However in the development of BMPs, using a multi-criteria analysis is vital to the adoption of profitable and sustainable BMPs in the sugarcane industry.

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\(^4\) FEAT is a Microsoft Excel-based tool designed to calculate the cost, revenues and profitability of sugarcane growing (Stewart and Cameron 2006). It generates economic performance indicators including gross margin, farm operating return and break-even / sensitivity calculations.

\(^5\) CaneLCA is a Microsoft Excel-based LCA tool designed to calculate and compare the environmental performance of different sugarcane growing practices (Renouf et al. 2013). It generates environmental efficiency indicators (per tonne of harvested sugarcane), for the environmental aspects known to be most important for sugarcane growing, i.e. water quality, water use, fossil fuel use and greenhouse gas emissions (carbon footprint).
**Fig. 1.** Example changes in environmental impacts after BMP adoption at the case study farm.

**Fig. 2.** Example changes in farm operating costs after BMP adoption at the case study farm.

**Fig. 3.** Sensitivity of economic and environmental improvements to cane yields after BMP adoption at the case study farm.
### CONCLUSIONS

Our review found that best practices for sugarcane growing, defined by sugarcane industry bodies often in response to a particular issue of industry or political importance at the time, can be biased against other objectives. We argue that more careful evaluation of practices and their alternatives across multiple objectives (agronomic, economic, environmental, and social) can help better decision making in best practice formulation. Methods for evaluating the multiple dimensions of sustainability are described in the academic literature, and there is a growing understanding of how they can be jointly considered to understand the benefits and trade-offs of different practices.

Such multi-criteria evaluation of practice change implications using these emerging methods should occur at the farm level based on actual operations (as opposed to hypothetical scenarios) to inform best practice formulation at the industry level. An example of such an evaluation in Australia showed that farm profitability and environmental implications, in the first instance, can be readily evaluated using streamlined industry tools, and the findings brought together to test practices against these two criteria and to understand the potential risks of inadvertent trade-offs. Although social implications were not explicitly explored in this project, they are equally important through factors such as barriers to adoption, cultural awareness and potential impact on human health and wellbeing (e.g. mental health).

Being able to test the implications of practice change across multiple objectives enables industry policy makers to identify and prioritise the win-win opportunities, be aware of potential risks, and gives farmers greater confidence of the outcomes.

### ACKNOWLEDGEMENTS

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### REFERENCES

Équilibre entre rentabilité et considérations environnementales dans le cadre des meilleures pratiques de production en canne à sucre

Résumé. Les industries agricoles sont confrontées au défi de produire de la nourriture et des fibres pour une population mondiale croissante tout en protégeant les valeurs environnementales et sociales. Certaines industries sucrières ont développé de meilleures pratiques pour la production de la canne à sucre, afin de protéger les valeurs environnementales et sociales. Des programmes de meilleures pratiques pour la production de canne à sucre existent en Amérique, Australie, Thaïlande et Afrique du Sud, ainsi que des programmes mondiaux. La plupart de ces programmes sont motivés par des objectifs environnementaux, certains sont aussi orientés vers la santé humaine. Cependant, pour être durables, les industries agricoles doivent examiner les conséquences économiques en plus des implications écologiques et sociales de ces pratiques. L’évaluation d’objectifs de performance multiples n’a peut-être pas été prise en compte de manière adéquate dans la conception des meilleures pratiques. En raison de l’internationalisation des industries sucrières et d’éventuels déséquilibres commerciaux, il est crucial d’améliorer les résultats environnementaux et sociaux, sans compromettre la compétitivité économique. Cet article examine comment parvenir à une approche équilibrée pour élaborer de meilleures pratiques afin que certaines valeurs ne soient pas accentuées au détriment des autres. Nous approchons d’abord le problème en passant en revue la façon dont certaines valeurs ont entrainé des changements de pratiques dans diverses parties du monde et examinons si elles sont équilibrées et holistiques. Nous examinons ensuite des méthodes et exemples de considérations économiques, environnementales et sociales conjointes pour informer une prise de décisions plus équilibrée. Nous nous concentrons ensuite sur une étude de cas en Australie pour mieux comprendre les incidences du programme de meilleures pratiques « SmartCane Best Management Practices » (BMP). Cette étude de cas a utilisé un outil d’évaluation économique agricole (FEAT) et un outil d’évaluation de l’impact environnemental du cycle de vie de la canne (CaneLCA) afin de quantifier les changements en terme de rentabilité et de performance environnementale issus de l’adoption des meilleures pratiques. Cette étude de cas a montré que les meilleures pratiques peuvent à la fois améliorer la rentabilité et l’impact sur l’environnement, bien que la rentabilité soit assez liée aux rendements de la canne. Nous conclurons que cette évaluation
multicritère sur les incidences des changements de pratique devrait se faire à l’échelle de l’exploitation, basée sur des opérations concrètes afin d’élaborer les meilleures pratiques à l’échelle de l’industrie.

Mots-clés: Pratiques de production de la canne à sucre, meilleures pratiques de production, développement durable, environnement, social, économie

**Equilibrando consideraciones medioambientales y de rentabilidad en el cultivo de caña de azúcar bajo Buenas Prácticas Agrícolas**

**Resumen.** Las industrias agrícolas se enfrentan al reto de abastecer con alimento y fibra a una creciente población mundial mientras se protege el medio ambiente y los valores sociales. Algunas industrias azucareras han desarrollado “buenas prácticas” para la caña de azúcar para proteger los valores medioambientales y sociales en las que influyen. Existen programas de buenas prácticas para el cultivo de caña de azúcar en las Américas, Australia, Tailandia y Sudáfrica, pero también globalmente. Muchos están motivados por objetivos medioambientales, pero otros también por la salud humana. Sin embargo, para ser sostenibles, las industrias deben considerar las consecuencias económicas de éstas prácticas además de las consecuencias medioambientales y sociales. La evaluación de múltiples objetivos de rendimiento puede que no hayan sido adecuadamente tenidos en cuenta en el diseño de buenas prácticas hasta la fecha. Debido a la internacionalización de las industrias azucareras y los posibles desequilibrios comerciales, es fundamental avanzar en los resultados medioambientales y sociales sin comprometer la competitividad económica. Este artículo analiza cómo alcanzar un enfoque equilibrado para desarrollar buenas prácticas, de manera que una serie de valores no sean exagerados a costa de otros. Primero, planteamos el problema analizando cómo valores específicos han dirigido cambios en prácticas de gestión en diferentes partes del mundo y analizamos si son holísticos y equilibrados. A continuación, analizamos métodos y ejemplos de la evaluación conjunta de las consideraciones económicas, medioambientales y sociales para una toma de decisiones más equilibrada. Después utilizamos un caso práctico en Australia donde esto se ha hecho para comprender mejor las implicaciones del programa SmartCane de Mejores Prácticas de Gestión (BMP). El caso práctico utilizó una herramienta de análisis económico (FEAT) y un análisis de ciclo vital y herramienta de eco-efficiencia (CaneLCA) para cuantificar cambios en la rentabilidad y el rendimiento medioambiental tras la adopción de buenas prácticas. Demostró que las buenas prácticas pueden proporcionar mejoras en la rentabilidad y en el medio ambiente, pero la rentabilidad puede ser muy sensible al rendimiento del cultivo. Concluimos que tal evaluación multicriterio de las implicaciones de cambio de prácticas debería ocurrir a nivel de finca y basada en sus prácticas para desarrollar una formulación de mejores prácticas a nivel de industria.

**Palabras clave:** Prácticas de desarrollo de caña de azúcar, mejores prácticas de gestión, sostenibilidad, medio ambiente, social, rentabilidad