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DRIP VS PIVOT – AN ECONOMIC COMPARISON OF IRRIGATION SYSTEMS BASED ON THE WHOLE-FARM BUDGET MODEL OF SUGARCANE CROPS

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S u m m a r y

This article focuses on the financial and economic aspects of irrigation systems for sugarcane, taking the whole-farm budgeting approach. The irrigation system is a staple element in the cost of developing sugarcane farms; therefore, to achieve maximum profitability, selecting the right irrigation system is crucial. In the financial model, the author considers most of the components required in the investment and operation costs. Since both Center Pivot and subsurface drip irrigation have become the preferred methods for new sugarcane green field plantations, it is the aim of this article to assess the economic aspects of Center Pivot and subsurface drip irrigation in sugarcane production. This may give investors and economists a better perspective on the segment which is considered the most costly investment when developing a new sugarcane farm. The study will highlight which factors have the greatest influence on profitability, enabling producers to make the right decision, not only regarding the agronomic factors, but also the type of irrigation method required to achieve maximum return. The results show that while using subsurface drip irrigation, yields must be at least 12–14% higher than center pivot in order to justify the higher investment involved in the first method. Both Center Pivot and drip systems, require a minimum yield of 110–125 $t \cdot ha^{-1}$ and 40 $\$ \cdot t^{-1}$ justify the investment in advanced irrigation technology for sugarcane.

Key words: *center pivot, economic factors, irrigation systems, sub surface drip irrigation, sugarcane crop*

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INTRODUCTION

Approximately 1,700 million tons of sugarcane are produced annually across 24 million ha worldwide [FAO 2015]. While average sugarcane yields worldwide are 70.37 t·ha^{-1}, according to reports [FAO 2015], some countries attain averages of 100 t·ha^{-1} and above [Yara International 2012]. Climate and water supply are the major factors influencing the production on sugarcane farms. Sugarcane can grow in a hot and dry climate, however in such cases irrigation becomes a critical factor [REIIN *et al*. 2011]. To develop the sugarcane industry, investments in infrastructures and new technology, such irrigation, are required in order to modernize and expand farms [OLUKUNLE 2016]. Irrigation systems can guarantee long-term production sustainability [REIIN *et al*. 2011]. The investment in an irrigation system is influenced by two clusters of factors: the technical aspects of the irrigation systems, and the economics of the specific crop [O'BRIEN *et al.* 2010]. Technical aspects of irrigation systems include factors such as efficiency, the life span of the system, and the cost of the total investment. The economics of an irrigation system have been analyzed for decades, mainly by the direct investment cost, without considering annual expenses or other factors which have a direct influence on the investment assessment [O'BRIEN *et al.* 2010].

Drip irrigation is promoted as a favorite option for increasing irrigation efficiency [ALMARSHADI, ISMAIL 2011; BUCKS *et al*. 1982; IBRAGIMOV *et al*. 2007; SALIMOV 2012]. Applications are most commonly used in permanent crops, such as trees or vineyards, and are less popular for other applications, such as field crops [AYARSA *et al*. 1999]. The application of drip irrigation technology to field crops is more complicated, because surface drip can interfere with general cultivation practices and can cause major problems with crop establishment during germination [HOWELL *et al*. 1997]. Drip irrigation in sugarcane production is mostly based on subsurface drip irrigation (SDI). Results show that SDI can help conserve natural resources (water and fertilizers) and the quality of the environment (minimal deep percolation and leaching losses) while achieving improved crop quality, productivity and long-term agricultural sustainability The SDI being micro irrigation, with small passages in the emitters, is subject to blockages if misused, necessitating filtration of the irrigation water [REIIN *et al.* 2011]. Drip irrigation is being promoted positively by the academic world, from government entities to researchers in the field. Many studies have been performed over the years, focusing on the efficiency of drip irrigation, from the agronomic feasibility aspect (benefits to the plants), economic aspect (increased yields) [LIPIŃSKI 2016a, b; NORELDIN *et al*. 2015], and the engineering aspect (energy savings, etc.) [LAMM *et al*. 2010]. Most of the studies [BENOUNICHE *et al*. 2014; CASWELL, ZILBERMAN 1985; LUQUET *et al*. 2005] have shown that drip irrigation has advantages over other methods; or at the very least they show that there are no disadvantages.

Centre pivot (CP) irrigation has the potential to increase productivity through more uniform water application [MAGWENZI, NKAMBULE 2003]. CP is increasingly being adopted by large acreage farmers. However, CP performance is often lower than claimed and should be evaluated [RAINE 2008]. The CP appears to satisfy the immediate needs of irrigators by applying uniform irrigation to large areas with moderate pressure and with very little labor [TEELUCK 1997]. CP is used for irrigating large area of sugarcane and has a clear advantage when used on larger areas [O'BRIEN *et al.* 1998]. The larger the pivot in size, the smaller the capital cost per unit [REIIN *et al* 2011].

In another study by O'BRIEN *et al.* [2010], the authors carried out a comparison of SDI vs CP on corn and challenged the fact that in most cases SDI requires a higher initial investment than CP, and that CP generally has an advantage in large fields. They concluded that SDI can increase income by having a higher percentage of utilized irrigated area in a specific field. However, the lower cost and assumed longer life span for the CP is offsetting the higher SDI revenue advantage.

QURESHI *et al*. [2002] compared three irrigation methods on existing sugarcane farms. The authors checked the NPV[1)] on furrow, CP and SDI. The results show that furrow has the highest NPV followed by CP and SDI system. When the cost of water increases, the ranking of the irrigation systems changes and the CP has the highest NPV followed by furrow and SDI. However their analysis examined an existing sugarcane farming system, which was already under furrow irrigation. Therefore, the capital costs to establish the furrow system were not considered.

HESP *et al*. [2011] discussed issues affecting the environment, such as green cane, trash blanketing, nutrients, and pesticides, and rising ground water levels in the area. They performed a trial using lateral-move irrigation (similar to CP) and SDI, and compared them with the conventional furrow irrigation. According to the authors: "It is indeed possible to grow large sugarcane crops under lateral move and drip irrigation systems, and these crops could be subsequently harvested green." It was shown that the lateral move and drip systems also provided an opportunity for improved water use efficiency over furrow irrigation. The economic evaluation, using actual input costs from the trial sites, showed that the furrow and lateral-move had similar operating costs, which were significantly less than the drip system. However, if the analysis were to examine a green field investment comparison, then the economic results could significantly change because of the extra capital investment required to establish a furrow irrigation system.

Since both CP and SDI have become good alternative methods for new sugarcane green field plantation, it is the aim of this article to assess the economic aspects of SDI and CP in sugarcane production. Hence, an important aspect of this

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[1)] NPV (net present value) is a method that discounts all cash flows (inflows and outflows) from the cost of capital (equal in this model to the interest rate or to the cost of financing if the financing option is used) to the present value.

study is to conduct a financial and economic analysis of a new sugarcane farm adopting SDI and CP irrigation technologies, which will provide a better comparison between CP and SDI. The study will highlight which factors have the greatest influence on profitability, enabling producers to choose the right methods to achieve maximum return.

The main hypothesis of this article assumes that SDI is not suitable for sugarcane, due to the high cost of investment. Cane yields and price of ton sugar are the most influential factors on the bottom line profitability of sugarcane. CP in comparison to SDI leads to a greater profit due to the low initial investment. However, there is a threshold yield that can justify the investment in advanced irrigation technology in sugarcane production; there is also a threshold yield increment that can justify the investment in SDI over CP; and there is a minimum price $\$\cdot t^{-1}$ that can justify the investment in an advanced irrigation system.

MATERIALS AND METHOD

Two of the more commonly employed criteria for evaluating any capital expenditure are net present value (NPV) of the cash flow generated by the project over the project life and the discounted cash flow (DCF[2)]) or the internal rate of return (IRR[3)]) available on the project [DAVE, BHATT 1971; LIPIŃSKI 2016a, b]. Both these methodes have two advantages over the traditional pay back period (PB[4)]). Firstly, these criteria are not influenced by year to year variations in net cash flow; they are based on the total cash flow over the life span of the investment, and to that extent are independent of annual variations. Secondly, they bring into account the timing of the cash flow and payments, since both creteria are based on the present value of the cash flow over the life time of the project [DAVE, BHATT 1971]. The author used NPV, IRR and PB in his models as the parameters to asses the economic aspects of both SDI and CP irrigation systems.

The sugarcane model utilized in this paper was specially developed for a sugarcane crop under green field conditions and whole farm budgeting[5)]. The model is taking into consideration the particular characteristics of a sugarcane crop. The

[2)] A discounted cash flow (DCF) is an evaluation method used to estimate the attractiveness of an investment opportunity.

[3)] IRR – internal rate of return is the discount factor at which the NPV equals zero.

[4)] Payback period – the formula analyzes when the present value of the cash flow will become positive and the investment will be covered. A shorter period is better and means a faster return on investment.

[5)] Whole farm budgeting is defined as preparing a budget for the farm as a whole. Total budgeting takes into consideration all aspects of growing sugarcane. Oppositely, partial budgeting is defined as estimating the costs and returns for only a part of the farm (for example: the irrigation system). Because many factors affecting the total profitability are ignored with partial budgeting, this may lead to wrong estimates.

model compares two irrigation methods: center pivot (CP) and subsurface drip irrigation (SDI). The sugarcane lifecycle is 8–9 years (namely ratoons) and the model is analyzing 20 consecutive years of farm operation. Since dripline life expectancy is up to 8–9 years, the model assumes dripline replacement after 9 years. The whole farm budgeting requires a substantial amount of information, such as energy demands, water use, land preparation and machinery. To ensure the costing is accurate and updated, the costing is based on the author's field experience in developing sugarcane farms and information from commercial companies [Yara International 2012] and sugarcane consultants [HESP *et al*. 2011; QURESHI *et al*. 2002; REIIN *et al*. 2011].

The following assumptions were incorporated into the model: all operation expenses, such as land preparation, pest control, weeding, and fertilizer application management are the same for CP and SDI. Water consumption, and therefore energy, is 15% higher in CP compared to SDI due to the higher efficiency of SDI [REIIN *et al*. 2011]. The water cost is assumed as nil in the model; however the energy cost is based on yearly water consumption, and the pressure required for operating the irrigation system. The total investment cost in SDI is assumed to be 23% higher compared to CP; however due to the high efficiency of land utilization, the model reduced the gap to 17% only. In the model, the author used a total irrigated area of 356 ha in SDI compared to 280 in CP (4x70 ha). SDI can fit into any shape of block, utilizing 100% of the block, compared to CP; therefore, SDI can utilize 21.5% more land, representing 21.5% more yield. According to WESTERCAMP *et al*. [2015] in their article the interest rates for agriculture projects are higher than commercial loans, due to the banks'perception of the high risk in the agriculture sector and the degree of macroeconomic uncertainty. Agriculture projects are classified as a higher risk profile since collateral, such as land or equipments is harder to recover in case of defaults. Agricultural projects are sometimes linked to poorly controlled developments. As of 2015, comercial loans in Brazil can exceed more than 20% annually. In the USA, loans for agriculture can vary from 3.6% to 16% according to the profile of the loan. For this specific model, the author is using an annual interest rate of 8% to represent the risks involved with sugarcane agriculture projects.

The author decided to examine variances of: yields, price of cane, the total investment cost, and the irrigated block size, aiming to check their influence on profitability and other financial factors. The model assumes the following assumption regarding the variance: the yield $t \cdot ha^{-1}$ has been set to 125 and 115 average for SDI and CP respectively, representing a ~10% difference between SDI and CP. A fixed price for a ton of sugarcane was set at 40 $\$ \cdot t^{-1}$, and the initial investment at 11 950 $\$ \cdot ha^{-1}$ and 9 650 $\$ \cdot ha^{-1}$ for SDI and CP respectively.

RESULTS AND DISCUSSION

The set of tests comparing SDI to CP is presented in Table 1. Set number 1 compares different yield scenarios for SDI and CP. The results show that the IRR and PB are higher and lower respectively in CP compared to SDI, due to the lower cost of the initial investment, while NPV, income per ha and profitability per ha are generally higher in SDI because of the larger area irrigated by SDI. This phenomenon remains the same until the yield difference reaches 12% to 14% higher in SDI. The investments in both CP and SDI cannot be justified unless a threshold of 110–125 $t \cdot ha^{-1}$ is achieved, compared to the global average of 70.37 $t \cdot ha^{-1}$ [FAO 2015].

The second test takes into consideration the price of a ton of sugar, which ranges from 30–60 $\$ \cdot t^{-1}$. Results show that for the low 30 $\$ \cdot t^{-1}$ neither method can justify the investment in an advanced irrigation system, however when the sugar price rises to 50–60 $\$ \cdot t^{-1}$, both irrigation methods are very profitable, where SDI shows higher profitability than CP.

The third test compares the factor of block sizes, to examine if there is any effect of economy of scale on the preferred methods. A range from 5 001 000 ha was tested and the results show that no significant difference was found between 500–1000 ha. The fourth factor tested was the cost of investment in the irrigation system. Two scenarios were checked: one where the investment is the same for SDI and CP. In the second, the investment was 13% higher in SDI compared to CP. The results show that when the system cost is the same, there is a significant advantage to SDI in all parameters. Even at a price difference of 13% SDI shows a better economic return in most parameters.

Results presented in Table 1 indicated that "yields" are the most influential parameter on the profitability of sugarcane production using SDI and CP. Hence, the author decided to run an additional set of analysis, presented in Table 2, examining different yield levels keeping an 8–9% difference between SDI and CP yields. The results indicated that there are no siginificant differences between SDI to CP at various yield levels as indicated above.

When examining the payback of certain yield levels, it was also noticed that unless a threshold above 110–125 $t \cdot ha^{-1}$ was attained it is not economically viable to invest in CP or SDI, since a payback value above 6 years is not economically justified.

Table 3 demonstrates a sensitivity analysis of SDI solely. Analyzing the sensitivity of SDI to yield decreases and increases, shows that considering the high investment required for SDI, a threshold of 125 $t \cdot ha^{-1}$ is the minimum yield to justify the investment in SDI. The results indicate that SDI is sensitive to increases in yield: a 20% increase in yield results in an increase of 40% and 50% in IRR and

Table 1. Sensitivity analysis of various factors of sub-surface drip irrigation (SDI) vs Center Pivot (CP)

Tabela 1. Analiza wrażliwości czynników zmiennych w nawadnianiu kroplowym podpowierzchniowym i za pomocą deszczowni ruchomych

Test	Irrigation system System nawodnień	Variable Zmienna				Financial results Wynik finansowy					
		area powie-rzchnia ha	yield plon $t \cdot ha^{-1}$	investment nakłady $\$ \cdot ha^{-1}$	cane price cena trzciny cukrowej $\$ \cdot t^{-1}$	IRR %	NPV thous. $ tys. $	payback years okres zwrotu	production cost koszt produkcji $\$ \cdot ha^{-1}$	income przychód $\$ \cdot ha^{-1}$	profitability zysk $\$ \cdot ha^{-1}$
1	SDI	356	115	11 950	40	17	2 738	8.1	2 703	4 589	1 886
	CP	280	115	9 650	40	21	2 705	6.0	2 675	4 583	1 908
	SDI	356	125	11 950	40	20	3 865	6.1	2 782	4 988	2 206
	CP	280	115	9 650	40	21	2 705	6.0	2 675	4 583	1 908
	SDI	356	131	11 950	40	22	4 570	5.4	2 832	5 237	2 405
	CP	280	115	9 650	40	21	2 705	6.0	2 675	4 583	1 908
	SDI	356	137	11 950	40	24	24	4.8	2 282	5 487	2 605
	CP	280	115	9 650	40	21	21	6.0	2 675	4 583	1 908
2	SDI	356	125	11 950	30	5	(537)	–	2 782	3 741	959
	CP	280	115	9 650	30	6	(472)	–	2 675	3 438	762
	SDI	356	125	11 950	50	33	8 268	3.3	2 782	6 235	3 453
	CP	280	115	9 650	50	34	5 884	3.2	2 675	5 729	3 054
	SDI	356	125	11 950	60	45	12 671	2.4	2 782	7 482	4 700
	CP	280	115	9 650	60	48	9 063	2.2	2 675	6 875	4 200
3	SDI	500	125	11 950	40	19	5 181	6.7	2 782	4 988	2 206
	CP	500	115	9 650	40	21	4 833	6.0	2 674	4 583	1 909
	SDI	1 000	125	11 950	40	19	10 266	6.7	2 781	4 988	2 207
	CP	1 000	115	9 650	40	21	9 667	6.0	2 673	4 583	1 910
4	SDI	356	115	9 650	40	21	3 717	5.8	2 702	5 489	1 887
	CP	280	115	9 650	40	21	2 705	6.0	2 673	4 583	1 908
	SDI	356	115	11 950	40	17	2 738	8.1	2 703	4 589	1 886
	CP	280	115	11 950	40	16	2 061	8.6	2 676	4 583	1 908
	SDI	356	125	11 950	40	22	4 207	5.3	2 782	4 988	2 206
	CP	280	115	9 650	40	21	2 705	6.0	2 676	4 583	1 908

Explanations: IRR = internal rate of return; NPV = net present value. Objaśnienia IRR = wewnętrzna stopa zwrotu, NPV = wartość bieżąca netto.

Source: own study. Źródło: wyniki własne.

Table 2. Analysis results for different sugar cane yields of sub-surface drip irrigation (SDI) vs Center Pivot (CP)

Tabela 2. Analiza wyników nawadniania trzciny cukrowej systemem kroplowym i za pomocą deszczowni ruchomych w warunkach różnych plonów

Irrigation system System nawadniania	Yield Plon $t \cdot ha^{-1}$	Cane price Cena trzciny cukrowej $\$ \cdot t^{-1}$	Area Powierzchnia ha	IRR %	NPV thous. $ tys. $	Payback years Okres zwrotu	Production cost Koszt produkcji $\$ \cdot ha^{-1}$	Income Przychód $\$ \cdot ha^{-1}$	Profitability Zysk $\$ \cdot ha^{-1}$
SDI	100	40	356	12	1 047	12.0	2 583	3 990	1 407
CP	92	40	280	11	671	12.2	2 492	3 667	1 175
SDI	112	40	356	16	2 456	8.5	2 683	4 489	1 807
CP	103	40	280	16	1 688	8.5	2 584	4 125	1 541
SDI	125	40	356	20	3 865	6.1	2 782	4 988	2 206
CP	115	40	280	21	2 705	6.0	2 675	4 583	1 908
SDI	137	40	356	24	5 274	4.8	2 882	5 487	2 605
CP	126	40	280	25	3 722	4.6	2 767	5 042	2 275
SDI	150	40	356	28	6 683	3.9	2 982	5 986	3 004
CP	137	40	280	29	4 740	3.8	2 859	4 739	2 641

Explanations as in Table 1. Objaśnienia jak pod tabelą 1.

Source: own study. Źródło: wyniki własne.

Table 3. Sensitivity analysis of subsurface drip irrigation (SDI) for various variables

Tabela 3. Analiza wrażliwości różnych zmiennych w nawadnianiu kroplowym podpowierzchniowym

Increment Przyrost %	Yield Plon t·ha⁻¹	IRR %	NPV thous. $ tys. $	Payback years Okres zwrotu	Production cost Koszt prdukcji $·ha⁻¹	Income Przychód $·ha⁻¹	Profitability Zysk $·ha⁻¹
Yield differential Różnica wydajności							
–25	80	3	(1 206)	–	2 423	3 192	769
–20	100	12	1 047	12.0	2 583	3 990	1 407
–4	120	19	3 332	7.0	2 743	4 788	2 046
0	125	20	3 865	6.1	2 782	4 986	2 206
+12	140	25	5 556	4.6	2 992	5 587	2 684
+20	150	28	6 683	3.9	2 987	5 986	3 004
Cane price Cena trzciny cukrowej							
0	40	20	3 865	6.1	2 782	4 988	2 206
+5	42	23	4 746	5.2	2 782	5 237	2 455
+10	44	25	5 627	4.6	2 782	5 487	2 704
+15	46	26	6 507	4.0	2 782	5 736	2 954
+20	48	30	7 388	3.7	2 782	5 986	3 203
+25	50	33	8 268	3.3	2 782	6 235	3 453
Growing area, ha Obszar uprawy, ha							
–50	237	20	2 572	6.1	2 784	4 988	2 204
–25	285	22	3 094	6.1	2 783	4 988	2 205
0	356	22	3 963	6.1	2 782	4 988	2 206
+25	445	20	4 832	6.1	2 782	4 988	2 206
+50	534	20	5 794	6.1	2 782	4 988	2 206
SDI irrigation cost, $·ha⁻¹ Koszt podpowierzchniowego nawadniania kroplowego, $·ha⁻¹							
–20	3 333	22	4 136	5.5	2 782	4 988	2 206
–12.5	3 478	21	4 034	5.7	2 782	4 988	2 206
–10	3 636	21	4 001	5.8	2 782	4 988	2 206
0	4 000	20	3 865	6.1	2 782	4 988	2 206
+10	4 400	19	3 730	6.5	2 783	4 988	2 205
+20	4 800	21	3 595	6.9	2 783	4 988	2 205

Explanations: SDI = subsurface drip irrigation, other as in Table 1.

Objaśnienia: SDI = nawodnienia kroplowe podpowierzchniowe, pozostałe jak pod tabelą 1.

Source: own study. Źródło: wyniki własne.

PB respectively. The second parameter analyzed was the price per ton of cane cost per ton of cane[6)] and how it affects the economic parameters of SDI. The results show that an increase of 25% in $\$\cdot t^{-1}$ will create a 65% increase in IRR and 84% reduction in PB. The third parameter checked was the block size, to examine if there is any effect of the economy of scale on the SDI investment. The model assumes that all investments and expenses are per hectare, and therefore the results show that there is no effect either way on the size of the block irrigated by SDI.

6) Price -per-ton-of- cane is the average annual price paid by the sugar mill to the farmers at the sugar mill gate. The price is usually derived from the world commodities market of row sugar, with a large influence on the prices by the local specific governments.

The fourth parameter tested is the investment in SDI. SDI is preceived as a high cost invesment; therefore its important to examine how the cost increase/ decrease influences the IRR and PB. $4000 per ha was taken as an acceptable cost of an SDI system. The results show that an increase/decrease of 20% in the system cost has a 10–15% effect only on the the IRR and PB.

CONCLUSIONS AND RECOMMENDATIONS

CP and SDI advanced irrigation technologies are considerd today as the most popular systems for any new sugarcane development; however, the high investments required make it essential to examine the investments carefully. Thus, special awareness and knowledge are needed to achieve maximum profitability. Among the four factors analyzed in this article, the author pointed out that yields and cost of cane are the most influential factors in the economic parameters of sugarcane producton. A threshold of 110 and 125 $t \cdot ha^{-1}$ is required for CP and SDI respectively to justify the investment. Furthermore, a 12–14% higher yield is required with SDI to justify this system over CP. It was also noticed that a minimum price of 40 $\$ \cdot t^{-1}$ is required to justify the investment in SDI or CP. It is reccomended that the investor will perform a financial analysis before making any decisions on the type of irrigation system to install in sugarcane production. Since today it is almost imposible to develop a sugarcane farm based on rainfed or furrow irrigation, investors must plan their investment carefully.

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NAWADNIANIE KROPLOWE A DESZCZOWANIE W UPRAWIE TRZCINY CUKROWEJ – PORÓWNANIE EFEKTYWNOŚCI SYSTEMÓW NAWADNIANIA NA PRZYKŁADZIE MODELU BUDŻETU CAŁOŚCIOWEGO GOSPODARSTWA ROLNEGO

Słowa kluczowe: *czynniki ekonomiczne, deszczownie ruchome, nawadnianie deszczowniane, podpowierzchniowe nawadnianie kroplowe, systemy nawadniania, uprawa trzciny cukrowej*

S t r e s z c z e n i e

Artykuł dotyczy finansowych i ekonomicznych aspektów wprowadzenia systemów nawadniania w uprawie trzciny cukrowej. System nawadniania jest podstawowym elementem kosztów w procesie rozwoju gospodarstw zajmujących się uprawą trzciny cukrowej. Dlatego też wybór odpowiedniego systemu nawadniania ma kluczowe znaczenie ze względu na maksymalizację zysku. W przyjętym modelu finansowym autor uwzględnił większość elementów związanych z kosztami inwestycji i kosztami operacyjnymi. Ponieważ zarówno nawadnianie za pomocą deszczowni ruchomych, jak i nawadnianie podpowierzchniowe kroplowe należą do preferowanych sposobów irygacji stosowanych na nowo powstałych plantacjach trzciny cukrowej, za cel artykułu przyjęto ich porównanie pod względem ekonomicznym. Pozwoli to inwestorom i ekonomistom na lepszą ocenę tego najbardziej kosztownego elementu inwestycji związanych z rozwojem gospodarstwa uprawiającego trzcinę cukrową. Wyniki badań wskazują, które czynniki mają największy wpływ na rentowność, umożliwiając producentom podjęcie właściwej decyzji nie tylko na podstawie czynników agrotechnicznych, ale również wybrać taki sposób nawadniania, który pozwoli na osiągnięcie maksymalnego zysku. Zgodnie z wynikami badań wyższy koszt inwestycji związany ze stosowaniem podpowierzchniowego nawadniania kroplowego jest uzasadniony tylko, gdy plon jest przynajmniej 12–14% większy niż w warunkach stosowania nawadniania deszczownianego. W przypadku obu systemów nawadniania minimalne plony trzciny cukrowej musiałyby wynosić 110–125 $t \cdot ha^{-1}$ i 40 $\$ \cdot t^{-1}$, żeby było uzasadnione wprowadzenie zaawansowanych technologii irygacyjnych w jej uprawie.

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