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EFFECT OF CROP BURNING IN THE PRODUCTIVITY AND INCOME OF SUGARCANE FARMERS AT NORTHERN CEBU, PHILIPPINES.

Dr. Paulino A. Onal, Jr.
Faculty-Lecturer, School of Agriculture
UNO-R, Bacolod City, Philippines
docpaulonal011260@gmail.com
Dr. Violeta A. Neri
Dean, College of Business and Education
JBLCF-Bacolod, Philippines
neri_v37@yahoo.com
Virgeun M. Eraldo
Agriculturist, Sugar Regulatory Administration
Medellin, Cebu, Philippines
totovirgeun14@gmail.com
Irish P. Guilaran
Agriculturist, Sugar Regulatory Administration
Iloilo, Philippines
airishprequencia@gmail.com

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Abstract:
Plantation fire is very detrimental to productivity, income, and soil properties. In the Philippines, the farmers in Northern Cebu are one of the sugarcane areas that openly practice open field burning. They usually burn the cane before harvesting hence, productivity is very low as compared to the Visayan average However, statistics related to the area subjected to burning and its corresponding losses are seldom can be found. Hence, this study aims to determine the impact of cane burning in terms of losses in sugar production and the income of the farmers.
An actual survey was first done last 2016 as a benchmark and every year thereafter until 2019. The GPS instrument was utilized in measuring the actual area subjected to burning. For the succeeding year, data was gathered on the actual burned area in all localities. The data gathered were encoded in the excel format template and analysis was done using the SPSS software.
For the year 2019, average sugar production was "very highly productive from "less productive" for the last 3 years (2016 to 2018). The area subjected to burning was described as "very highly practiced" in 2016 reversing it to "very low practiced" in 2019. In terms of losses in sugar and income, the year 2016 was described as "very high losses" and "very low losses" in 2019.
Recommended that more studies should be conducted related to this subject, in order to contribute on the pool of knowledge related to the ill effect of burning especially on the environment.

Keywords: Sugarcane Burning, Productivity Loss, Income Loss, Sugarcane Farmers

1.INTRODUCTION

1.1. Background

One of the risks experienced by sugarcane plantations in the Philippines is the occurrence of fire, either accidental or done intentionally. At this time there is no available data regarding the area coverage of sugarcane subjected to burning but not in the area of Northern Cebu.

In the area in Northern Cebu Philippines however, the 2016 data showed that out of 6,635 hectares planted to sugarcane, around 3,137.14 hectares or 42.28% of the total area were subject to burning. The total village involved was 72 (67.92%). The actual data was gather during the field-by-field validation work of extension workers from July 2015 to February 2016.

Plantation fire is very detrimental on the productivity, income, and soil properties:

In terms of productivity, burned cane if not milled within 3 days there will be a rapid sugar inversion of sucrose. Sugar inversion results in the breakdown of sucrose into simple sugars, glucose, and fructose, which are used by plants to energize growth processes.

Fructose deteriorations similarly occur because of microbial action after the canes were cut. The delay of milling from 3 to 15 days of burned cane but left standing on the field could reduce the sugar content by 0.20% to a maximum of 98.64%, respectively [1]. On the other hand, the latest research shows that delayed milling from 4 to 24 days of burned cane but left standing could reduce the sugar content by 9.24% to a maximum of 98.12% [8]. Furthermore, burned cane not milled for 3-15 days, but cut and piled only on the field, can reduce production by 2.20% to as much as 99.99%, respectively [1].

Relatively reduction in production will directly affect the income of the farmer [1]. Aside from production the cane tops of 6-8 laksa per hectare, will not be available anymore. Said cane points can be utilized as planting materials for the establishment of new crops or replanting for ratoon crops if left fresh in the field. If not needed, these cane points can still be sold to other farms, which will be an added income to the farmer if the field was not subject to burning.

For the effect of burning on soil properties, burned areas usually had low organic matter [1]. Un-burned cane trash if left to decompose on the field could produce as much as 10-15 tons of organic matter (OM) per hectare. High OM of not more than 9% (ideal range for sugarcane) can help reduce the use of nitrogenous organic fertilizer. Hence, it can reduce the cost of fertilizers. Other benefits of non-burning the cane trash is:

1. Reduction in in-field cultivation because only one-half of the area will be available for ridge busting, on-barring, off-barring, etc. These are some of the major cultivation operations.
2. Moisture can be conserved because the cane trash serves as mulching materials. Water is needed critically especially in the germination stage. The germination stage of the cane is within the first month after planting or stubble shaving of new plant or ratoon crop, respectively. Furthermore, survival of stool of ratoon crop is greater in non-burned areas.
3. Cost of weeding will be reduced too, only half of the area will be weeded. Area being mulch retard the growth of weeds because of the absence of sunlight.

The non-popular benefit of not burning trash is beneficial micro-organisms in the soil. Beneficial micro-organisms in sugarcane growing helps a lot especially on solubilizing of elements which makes them (the elements) available to the crop. Other (BMOs) helps in fixing nitrogen from the air. The fixed nitrogen can reduce the use of commercial nitrogenous fertilizers [2].

1.2. Objectives

1.2.1 The general objective of this study is to determine the effect of burning on the sugarcane crop in the area of Northern Cebu, Central Visayas, the Philippines for the years 2016 to 2019 in terms of the loss in productivity and income:

1.2.2 Specific objectives

1.2.2.a. Determine the level of productivity based on average sugar production per hectare

1.2.2.b. Determine the level of burning practices of sugarcane farmers

1.2.2.c. Determine the frequency of seminars, the number of participants, and farmers involved in one-on-one consultation conducted

1.2.2.d. Determine the projected reduction in sugar and amount loss of burned cane with delays in milling at 4 and 24 days

1.3. Statement of the Problem

The sugarcane plant is one of the most important high-value crops in the Northern part of Cebu. It is one of the major dollar income industries in the country. Sugarcane farmers in the area tend to practice burning the standing cane then cut because of the lack of cane-cutter and sometimes due to the presence of viny weeds. Hence this study aims to review the extent of sugarcane areas subjected to burning and its impact on the production losses as well as the income.

2. MATERIALS AND METHODS

2.1. Research Method

The primary data were retrieved from the data bank and reports prepared by the author. The analytical-descriptive method is used in this study. The method was purposive which focused on analyzing the data gathered on sugarcane areas subjected to burning including the corresponding losses in terms of production and monetary value at Northern Cebu, Central Visayas, the Philippines for the period 2017 to 2019.

2.2. Research Environment

The study was conducted in the 8 municipalities and 2 cities at Northern Cebu, Central Visayas Region, Philippines. Specifically, the study covered the municipalities of Tuburan, Tabuelan, San Remegio, Daan Bantayan, Danao, Tabogon, Borbon, Medeliin and the City of Bogo and Danao.

2.3. Respondents

The respondents of the study were the sugarcane farmers whose areas were subject to burning.

2.4. Measuring Instrument

A GPS (global positioning satellite) instrument was used to measure the total area that was subjected to burning. The data gathered was processed and plotted on the existing map of areas planted to sugarcane. Data were encoded on the excel formatted spreadsheet for computation and secured in the database.

2.5. Data Gathering Procedure

The researcher had personally administered the gathering of data for the period 2017 to 2019 with the assistance of the government agency Technical Personnel/Junior Agriculturist in the area of Northern Cebu, Central Visayas, Philippines. Upon retrieval of the primary data from the data bank, the researcher had analyzed the data using the Statistical Package for Social Sciences (SPSS) software under the close supervision and guidance of the statistician. Subsequently, tables were prepared for easier interpretation.

2.6. Statistical Tool

In the analysis of data, the following statistical tools were used in accordance with the nature of the specific problems raise and their corresponding hypotheses.

Frequency and percentage were used to describe the level of losses in the production and level of income for the area at Northern Cebu, the Philippines that were subjected to burning. The description was determined using the Likert's rating.

3.RESULTS AND DISCUSSION

Area planted and level of productivity

Table 1 shows the total area planted and the level of productivity in Northern Cebu for the years 2016 to 2019. For the year 2016, the area planted was 6,635, 2017 was 6,500, 2018 it was 6,300, and in 2019 the total area planted was 6,325 hectares, respectively.

Average sugar production is described as "less productive" for the years 2016 (46.50 LKG), 2017 (47.03 LKG), and 2018 (48.00 LKG), respectively. For 2019, the average sugar production was 55.58 LKG/hectare and described as "very highly productive."

Table 1. Area Planted (ha) and Level of Productivity of Northern Cebu for the Year 2016 to 2019.

Year	Planted Area (hectare)	Average Sugar Production per Hectare (LKg)	Description
2016	6,635	46.50	Less Productive
2017	6,500	47.03	Less Productive
2018	6,300	48.00	Less Productive
2019	6,325	55.58	Very Highly Productive

Level of the burning practices of sugarcane

The area that was subjected to burning for sugarcane areas at Northern Cebu is shown in Table 2. A descending trend in terms of the area subjected to burning is very transparent for the years 2016 to 2019. The total area subjected to burning for 2016 is 42.38%, and describe as "very highly practiced." For the year 2017, the area subjected is 30.00% and for 2018 it is 18.00% and described as "highly practiced" and "low practiced", respectively. The farmers had further reduced their burned area to only 4% in 2019, which is described as "very low practiced."

Relative to the results, Oñal (2018) had found out in his study that majority of the sugarcane farmers that continuously burned their thrash after harvesting have low production [5].

Table 2. Level of the Burning Practice of Sugarcane at Northern Cebu, the Philippines for the Year 2016 to 2019.

Year	Area Planted (ha)	Area (ha) Subjected to Burning	Percent of Area Subjected to Burning	Description
2016	6,635	3,137	42.38	Very Highly Practiced
2017	6,500	1,950	30.00	Highly Practiced
2018	6,300	1,134	18.00	Low Practiced
2019	6,325	253	4.00	Very Low Practiced

Frequency of seminars conducted, number of participants and farmers involved in a one-on-one consultation

Table 3 shows the frequency of seminars conducted, the number of participants as well as the farmers involved in a one-on-one consultation, which was done at Northern Cebu for the years 2016 to 2019.

The conduct of the seminars and the one-on-one consultation were the strategies designed and implemented by the group of the author. The primary aim is to enhance the advocacy in order to lessen the practice of burning and hopefully to increase their productivity.

There were 14 seminars conducted for the years 2017 (30.43%) and 2018 (30.43%). For the year 2019 on the other hand, 18 seminars (39.14%) were conducted. The seminars conducted for the above-mentioned years were described as "very frequent."

Relatively the number of participants that had attended the seminars were as follows: for the year 2017, 1,178 farmers (49.23%) had attended; 2018, 451 participants (18.85%); and, 764 farmers (31.92%) had attended for the year 2019, respectively. The number of participants attended was described as "very high extent."

Hand in hand with the seminars conducted, one-on-one consultation with the farmers was also done as the second strategy. Still, the aim is to convince farmers to reduce the burning practice. For 2017, there were 530 farmers (43.16%), that had avail the consultation. In the year 2018, 379 farmers (30.86%) had availed the services, and there were 319 farmers (25.28%) in 2019.

Relative to the result, the study of Cerbo (2009) indicates that Agrarian Reform Beneficiaries' (ARBs) standard of living where alleviated after they attended the Outreach Program for Sugarcane Industry (OPSI) seminars [3]. Their standard of living were alleviated because of the increase in sugar production, family income, and net profit per hectare.

Generally, extension service has a limited scope of coverage. Hence, extension officers should propagate new farming methods, and because farmers have the last say, agricultural extension officers must always consult and work closely with them. Extension officers should encourage farmers to adopt new, improved methods of farming using a variety of methods to reach the farmers [4]. The best method though is through personal contact with farmers on their farm or farm visits (Mandallos, 2014).

Table 3. Frequency of Seminars Conducted, Number of Participants and Farmers Involved in One-on One Consultation Conducted at Northern Cebu, the Philippines for the year 2017 to 2019.

Year	Frequency	Percentage	Description
Seminar Conducted			
2017	14	30.43	Very Frequent
2018	14	30.43	Very Frequent
2019	18	39.14	Very Frequent
Total	**46**	**100.00**	
Number of Participants			
2017	1,178	49.23	Very High Extent
2018	451	18.85	Very High Extent
2019	764	31.92	Very High Extent
Total	**2,393**	**100.00**	
Farmers Involved in one-on-one Consultation			
2017	530	43.16	Very High Extent
2018	379	30.86	Very High Extent
2019	319	25.98	Very High Extent
Total	**1,228**	**100.00**	

Level of losses in sugarcane production at 4 and 24 days of milling of burned cane

Using the Formula No. 1 as designed by the author, total losses in terms of percentages for both 4-days and 24-days delay in milling were as follows; for 2016, it is 47.67% (very high losses), 2017, it is 29.97% (high losses), 2018, it is 17.79% (moderate losses), and for 2019 it is 4.57% (very low losses). The decreasing trend in production losses is clearly indicated in the table.

Old literature by Wiedenfeld (2009) shows that soil organic matter content after three years had increased by green harvesting compared to burning prior to harvest [9]. Harvesting green compared to burning caused a 20% reduction in yield in the 2nd ratoon and a slight reduction in crop growth but an 8% increase in sucrose content in the 3rd ratoon crop. While the effects due to green harvesting on soil properties and crop growth were relatively minor, the residue remaining on the soil presents considerable challenges in cultivation, weed control, and irrigation.

The study of Sandhu *et al.* (2013) on the harvesting of green (un-burnt) and burned cane [7]. They explained that the air and soil temperature are microclimatic factors, which control sugarcane emergence and growth and may be significantly affected by the harvest method.

The result indicated that young shoots that emerged from green cane harvested fields may suffer frost damage and delayed growth when air temperatures are near or below freezing. In addition, transient increases in soil temperatures following burning were smaller than normal seasonal variations in soil temperatures, suggesting that burning has minimal impact on soil micro-flora and fauna within the 2- to 10-cm soil profile range.

Relative study on burning done by the group of Rachid (2013) in Brazil this time on the effect on the population of beneficial micro-organisms (BMOs) on the soil [6]. Nineteen different phyla were identified, with Acidobacteria (≈35%), Proteobacteria (≈24%), and Actinobacteria (≈21%) being the most abundant.

Results show that significant structural changes of the community were observed with burnt cane management having a greater impact than green cane management on local soil communities.

Table 4. The Level of Losses in Sugar Production (LKG) at 4 and 24 days Delay in Milling at Northern Cebu, the Philippines for the Year 2016 to 2019.

Year	Total Reduction in Production (LKg)	Percentage	Description
4-days delay			
2016	13,478	47.67	Very High Losses
2017	8,474	29.97	High Losses
2018	5,030	17.79	Moderate Losses
2019	1,295	4.57	Very Low Losses
Total	**28,277**	**100.00**	
24-days delay			
2016	143,099	47.67	Very High Losses
2017	89,985	29.97	High Losses
2018	53,409	17.79	Moderate Losses
2019	13,748	4.57	Very Low Losses
Total	**300,241**	**100.00**	

*Projected loss [8]

Formula: *(Source: Authors' design)*

$$P_l = a_s \times p_a \qquad (1)$$

P_l - Production loss
a_s - area subjected to burning
p_a - average production

Level of losses in the amount at 4 and 24 days delay of milling of burned cane

Relative to Table 4, the next table (Table 5) shows the level of losses in income at 4 and 24 days of delay milling. The tables show that with the same percentages of losses as follows: for 2016 the income losses are described as "very high losses; for 2017, it is described as "high losses; for 2018, it is described as "moderate losses"; and, for 2019, it is described as "very low losses." The decreasing trend is very transparent on the gathered as further shown in Table 5.

Formula No. 2 designed by the author is used in the computation of total losses in income.

Table 5. The Level of Losses in the Farmers Income (in USD) at 4 and 24 days in Delay Milling at Northern Cebu, the Philippines for the Year 2016 to 2019.

Year	Total Reduction in Income (in million USD)	Percentage	Description
4-days delay			
2016	0.404	47.67	Very High Losses
2017	0.254	29.97	High Losses
2018	0.151	17.79	Moderate Losses
2019	0.039	4.57	Very Low Losses
Total	**0.848**	**100.00**	
24-days delay			
2016	4.293	47.67	Very High Losses
2017	2.700	29.97	High Losses
2018	1.602	17.79	Moderate Losses
2019	0.412	4.57	Very Low Losses
Total	**9.007**	**100.00**	

Average Sugar Price: 30 USD/LKg (Conversion: Php 50.00 per 1 USD)

Formula: *(Source: Authors' design)*

$$A_l = P_l \times f_l \times s_p \quad (2)$$

A_l - amount loss
P_l - production loss
f_l - factor loss (9.24% or 98.12%
s_p - sugar price

4. CONCLUSIONS AND RECOMMENDATIONS

4.1. Conclusions

1. The average sugar production was very highly productive in 2019 from less productive for the last three preceding years.
2. The practice of burning had gradually decreased from very highly practice in 2016 to very low practiced in 2019
3. The conduct of seminars was done very frequent from 2016 to 2019 same with one-on-one consultation which very high extent.
4. Losses in production and income had tremendously decreased which was from very high losses to very low losses.

4.2. Recommendations

1. The government should double time in conducting seminars and consultation with farmers on the ill effect of cane burning including the trash.
2. The local government units (LGUs) should religiously implement the RA 9003
3. Farmers association should assist the government in implementing the non-burning policy.
4. Individual farmers should learn the bad effect of burning with climate change.

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