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Dedication

It is our pleasure and great privilege to present the forty-first issue of the Academic Journal of Research and Scientific Publishing to all researchers and doctors who published their research in the issue, and we thanks and appreciate to all contributors and supporters of the academic journal and those involved in the production of this scientific knowledge edifice.

Academic Journal of Research and Scientific Publishing

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Effects of Banana Clones and Spacing on Growth, Yield and Fruit Quality of Some Banana Cultivars

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Abstract

A field experiment was carried out at the National Institute for the Promotion of Horticultural Exports (NIPHE) research farm, University of Gezira, Wad Medani, Sudan, to study the effects of banana clones and spacing on vegetative growth, crop earliness, yield and yield components, fruit green life and fruit quality of some introduced banana clones under Gezira state conditions. Treatments consisted of six new banana clones, namely, Williams hybrid clone 1 (WH1), Williams hybrid clone 2 (WH2), Grand Nain clone 1 (GN1), Grand Nain clone 2 (GN2), Zelig and Bio, which were introduced from South Africa by NIPHE. The introduced clones were compared with the local cultivar Dwarf Cavendish (DC). All clones were grown at spacings of 2x2 m and 3x3 m. These treatments were arranged in a split plot design with three replications and four plants each. Results showed that vegetative growth parameters, crop earliness, yield and yield components, fruit green life and fruit quality were significantly affected by spacing and banana clones. WH1 and Zelig obtained the best vegetative growth, whereas DC obtained the worst growth. Zelig and Bio scored the highest yield and yield components, while DC scored the lowest yield in the three ratoons. WH1 took the largest number of days from shooting to harvesting, whereas Zelig recorded the highest exportable yield in the three ratoons. Generally, the spacing of 2 x 2m resulted in an increase in pseudostem height and total yield (t/ha), but it resulted in a small pseudostem girth and low exportable yield in all banana clones as compared to the wider spacing (3 x 3 m). Banana clones grown at 3x3m had significantly longer fruit green lives than those grown at 2x2m.

Keywords: Effects, Banana clones, Spacing, growth, Yield, Yield component, Fruit quality, Exportable hands.

تأثير سلالات الموز ومسافات الزراعة على النمو، الإنتاج وجودة الثمار لبعض أصناف الموز

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المستخلص:

أجريت تجربة حقلية بحقل بحوث المعهد القومي لتنمية الصادرات البستانية، جامعة الجزيرة، ود مدني، السودان، لدراسة تأثير سلالات الموز ومسافات الزراعة على النمو الخضري، التكاثر في الإنتاج، الإنتاج ومكونات الإنتاج، مدة بقاء الثمار خضراء وجودة الثمار لبعض سلالات الموز المستجوبة تحت مناخ ولاية الجزيرة. تضمنت المعاملات ست سلالات موز جديدة هي (هجين وليامز سلالة 1، هجين وليامز سلالة 2، جرانين سلالة 1، جرانين سلالة 2، زلج وبابو)، والتي استجلبت من جنوب أفريقيا بواسطة المعهد القومي لتنمية الصادرات البستانية. تمت مقارنة السلالات المستجوبة مع الصنف المحلي كافندش القزم. تمت زراعة جميع السلالات على مسافات (3 × 3 و 2 × 2 متر). نظمت المعاملات باستخدام تصميم القطع المنشقة بثلاثة تكرارات وأربعة نباتات لكل تكرار. أوضحت النتائج أن النمو الخضري، التكاثر في الإنتاج، الإنتاج ومكونات الإنتاج، مدة بقاء الثمار خضراء وجودة الثمار تأثرت معنوياً بسلالات الموز ومسافات الزراعة. تحسنت السلالتان هجين وليامز سلالة 1 والزلج على أفضل صفات نمو خضري، بينما تحسنت كافندش القزم على أسوأ نمو. أحرزت السلالتان زلج وبابو أعلى إنتاجية ومكونات الإنتاجية، بينما أحرز كافندش القزم أقل محصول. استغرق هجين وليامز سلالة 1 أكبر عدد من الأيام من الإزهار إلى نضج الثمار، بينما سجلت السلالة زلج أعلى نسبة صادر من الثمار. عموماً أدت مسافات الزراعة 2 × 2 متر إلى زيادة في ارتفاع النبات والإنتاج الكلي (طن/هكتار) في كل السلالات المستخدمة في هذه الدراسة ولكنها أدت إلى انخفاض في محيط الساق وانخفاض في نسبة المحصول الصالح للصادرات مقارنةً بالمسافات الأوسع (3 × 3 م). سلالات الموز المزروعة على مسافة 3 × 3 م بقيت خضراء مدة أطول من تلك المزروعة على مسافة 2 × 2 م. لم تؤثر سلالات الموز ومسافات الزراعة معنوياً على عدد أيام النضج وتغير اللون والصلابة أثناء النضج. كان للسلالتين زلج وبابو أعلى قيمة في نسبة المواد السكرية الذائبة ومذاق الثمار، بينما نتج عن كافندش القزم أقل محتوى من المواد الصلبة الذائبة وأسوأ طعم مقارنةً بالسلالات المستجوبة. أدت مسافات الزراعة الأوسع (3×3م) إلى إنتاج ثمار ذات محتوى عالي من المواد الصلبة الذائبة وطعم أفضل مقارنةً بمسافات (2×2م).

الكلمات المفتاحية: تأثير، سلالات الموز، مسافات الزراعة، النمو، الإنتاج، مكونات الإنتاج، جودة الثمار، كفاف قابلة للتصدير.

1. Introduction

Banana is one of the most popular and cheapest fruits in the Sudan and is available all the year round. The harvested banana area in Sudan in 2020 was about 47000 ha, and the production was estimated to be 923938 tones (FAO, 2021). It plays an important role in the diet of the people due to its high nutritive value. It has a high carbohydrate content and is a good source of vitamins A, B and C (Hamid, 1992). It is also rich in important minerals like Ca, K, P and Fe and contains little amounts of proteins and fats (Litzenberger, 1974).

The predominant banana clone grown in Sudan is the Dwarf Cavendish (DC), which is a low yielder, has small-sized fingers, short green life and does not meet international market standards (Hamed, 1992). Banana market trade requirements include a finger length of not less than 20 cm, firm, dark-green fingers and a green life of at least three weeks at 14⁰ C and 90% relative humidity (Robinson, 1996). Therefore, some of the most internationally popular clones, which possess these desirable characters, such as Williams Hybrid and Grand Nain, have been introduced by the National Institute for the Promotion of Horticultural Exports and evaluated compared to the local clone DC (Mahmoud and Elkashif, 2003; Elkashif and Mahmoud, 2005; Elkashif *et al.*, 2005; 2010; Elsiddig *et al.*, 2009).

Mahmoud *et al.* (2011) evaluated some introduced irradiated clones of Grand Nain (GN) and Williams Hybrid (WH) and found that they had significantly higher bunch weight, total and exportable yields and longer fruit green life, but slightly lower total soluble solids (TSS) content than the local clone DC. Similarly, Elsiddig *et al.* (2009) reported that introduced clones of GN and WH had the best vegetative growth and the highest exportable and total yields. However, the local clone DC resulted in the least parameters of vegetative growth and yield components but recorded the highest TSS content.

Banana spacing is one of the most important cultural practices because it determines plant population, number of bunches per unit area and, hence, total yield (Wills *et al.*, 1981). Therefore, the most appropriate plant spacing should be chosen, depending on cultivar, soil type and management of the plantation (Black and Peacock, 1971). Generally, wide plant spacing results in vigorous vegetative growth, large bunches and fingers, high exportable yield but low total yield (Litzberger, 1974).

However, close spacing results in taller and slender plants, low exportable yield due to small-sized fingers and high total yield due to the large number of bunches per unit area. Also, wide plant spacing resulted in an early crop and *vice versa* (Elsiddig *et al.*, 2009).

Mahmoud *et al.* (2011) studied the effects of plant spacing and number of suckers on growth and yield of bananas. They found that plant spacing of 3x3 m (1111 plants/ha) with two suckers resulted in the best vegetative growth, the largest fingers and the highest exportable yield. However, it produced the lowest total yield. The close spacing of 2x2 m (2500 plants/ha) produced the highest total yield, but the smallest fingers and the lowest exportable yield. Hence, there is a need to find out the optimum plant spacing of these introduced banana clones that would give high exportable yield of fruit with a long green life and good quality. Therefore, the objective of this study was to evaluate the effects of banana clones and spacing on vegetative growth, crop earliness, yield and yield components, fruit green life and fruit quality of the first three ratoons of these introduced clones.

2. Materials and Methods

This study was conducted at the national Institute for the Promotion of Horticultural Exports (NIPHE) research farm at Hantoub area along the east bank of the Blue Nile, lat. 14.5⁰N, and long. 33.4⁰E. The area lies within an arid climate of summer rains and relatively warm winter. The mean minimum temperature is 14⁰C in January and the mean maximum is 43⁰C in May. Average annual rainfall is 320 mm; however, the total annual varies from year to year. The rainy season lasts from June to October, with a well-defined peak in August. Humidity is generally low with a peak of 60% in August and decreases to a lowest of about 12% in April. The soil at the experimental site is classified as vertic, ustifluvents, fine loamy, mixed, isohyprthermic (SSAS, 1999). Six banana clones were introduced at the plantlet stage from tissue culture laboratories in South Africa by the NIPHE, University of Gezira. They were William's hybrid clone 1 (WH1), William's hybrid clone 2 (WH2), Grand Nain clone 1 (GN1), Grand Nain clone 2 (GN2), Zelig and Bio. The clones were compared with the local Dwarf Cavendish (DC). The clones were raised in the nursery for 7 months and then transplanted in the field. The introduced clones and the local clone Dwarf Cavendish (DC) were transplanted in the field at the spacing of 2x2m and 3x3m. Treatments were arranged in a split plot design with spacing as the main plots and clones as subplots and replicated three times.

Plot size was 5x5 m and each plot consisted of four plants. Uniform, vigorous suckers were selected and planted in pits 30x30x30 cm. The plots were irrigated every 5-to7 days according to weather conditions. Roundup herbicide was used for weed control one month after planting at the rate of 750 ml/ha. Nitrogen in the form of urea was applied at the rate of 400g per mat/year in split doses every four months. Two plants from each plot were randomly selected, tagged and used for data collection. Data were collected for the first, second and third ratoons and consisted of the following:

Growth parameters:

Growth parameters data consisted of the measurement of pseudostem height and girth (cm) at shooting. Pseudostem height was measured from the soil surface up to the point of intersection of petioles of the two youngest leaves. Pseudostem girth was measured at 10 cm above the soil surface. Number of days from shooting to harvesting was determined.

Yield and yield components:

Bunches were harvested when fruits were at the mature green stage "full three quarter" and bunch weight was recorded. Bunches were dehanded using a sharp curved knife. Hands and stalks were separately weighed. The number of hands per bunch were counted. The exportable hands were selected by measuring the length of the middle finger on the outer whorl of each hand. Any finger length equal to 203mm or more was considered to be exportable (Robinson, 1996) Exportable yield percentage was determined as follows:

$$= \frac{\text{Weight of exportable hands}}{\text{Total weight of hands}} \times 100$$

Determination of the green life of banana fruit:

Green life was calculated as the number of days from harvest till the fruits reached colour score number 3, according to Chiquita Company colour chart. Bunches of the first three ratoons were harvested when fruits were at the mature green stage "full three quarter" and cut into hands. Banana hands were washed with tap water to remove latex and dust and were disinfected in a solution of commercial bleach (Chlorox) of 5.25% sodium hypochlorite at a concentration of 5 ml/liter and then placed in intact polyethylene bags and stored at 14⁰ C to determine the green life of banana fruit. Green life was terminated when fruits reached colour code number 3 according to Chiquita Company colour chart.

Fruit quality measurements:

At colour score number 3, the banana hands were treated with Ethrel (2 ml/l) by dipping for two minutes, air dried, packed in intact polyethylene bags and ripened at 20°C and 70% relative humidity. The number of days required to reach the colour score number 6, according to Chiquita Company colour chart, was recorded. Fruit firmness was determined using thumb and forefinger pressure test, which was rated on a scale of 1 to 5 as follows: 1, very firm; 2, firm; 3, slightly soft; 4, soft and 5, very soft. Colour development was rated according to Chiquita Company colour chart as follows: 1, dark green; 2, green; 3, yellowish green; 4, more yellow than green; 5, yellow with green tips; 6, yellow and 7, yellow with brown flecks. Fruit taste was determined using a taste panel to evaluate banana fruit quality and acceptability. Ten panelists were asked to evaluate the fruit taste according to a scale ranging from 1 to 5 as follows: 1, unacceptable; 2, slightly acceptable; 3, acceptable; 4, sweet and 5, very sweet. Total soluble solids were measured at the full ripe stage (colour score number 6) using a hand refractometer (Bellingham and Stanley Ltd, Tunbridge Wells, England). The data were subjected to analysis of variance (ANOVA) procedure. In the cases of significant F values, Duncan's Multiple Range Test (DMRT) at $p=0.05$ was used to compare treatments means.

3. Results and Discussion

The effects of banana clones and spacing on growth, yield and fruit quality of the plant crop of these introduced banana clones have already been published (Elsiddig *et al.*, 2009).

Vegetative growth parameters:

Pseudostem height is a very important character, which affects many management practices. For example, tall plants are liable to wind damage and falling down, in addition to difficulty of harvest. Large pseudostem girth is an important factor to support plants against strong winds that cause plants to fall down and result in losses of mature or immature bunches.

The main effects of banana clones on pseudostem height and girth of the first, second and third ratoons at shooting are significant (Table 1). William's hybrid clone 1 resulted in the tallest pseudostem in the three ratoons, whereas DC resulted in the shortest. However, William's hybrid clone2, Grand Nain clone 2 and Zelig were comparable in pseudostem height. Zelig obtained the largest pseudostem girth, which was comparable with William's hybrid clone1 in both cycles.

William's hybrid clone 1, Grand Nain clone 1 and Bio were comparable in pseudostem girth in second and third ratoons. However, DC resulted in the smallest girth. Elsiddig et al. (2009) have reported similar results for the plant crop of these introduced clones. Ali (2000) recorded a pseudostem height and girth of 172 and 64.7 cm, respectively, for Dwarf Cavendish.

The main effects of spacing on pseudostem height and girth at shooting were significant (Table 1). Plant spacing of 2x2 m resulted in the tallest and thinnest pseudostems in the three ratoons as compared with 3x3 m. These results were consistent with the reports of Elsiddig (2003) who stated that banana plants grown at a close spacing were taller with thinner pseudostems than those grown under a wide spacing. This was due to the high competition between plants grown at a close spacing for sunlight.

The interaction effects between banana clones and spacing on pseudostem height and girth at shooting of the three ratoons were significant (Table 3). The tallest and thinnest pseudostems were produced at a spacing of 2x2 m compared to 3x 3 m in all clones. William's hybrid clone 1 in the three ratoons obtained the tallest pseudostems, whereas Bio resulted in the shortest. Zelig and William's hybrid clone 1 grown at 3 x3 m recorded the largest pseudostem girth, whereas Grand Nain clone 2 grown at 2x2 m recorded the lowest. These results were in agreement with the findings of Kesavan *et al.* (2001).

Table 1. Main effects of banana clones and spacing on the vegetative growth of the three ratoons at shooting.

Clones	Pseudostem height (cm)			Pseudostem girth (cm)		
	R ₁	R ₂	R ₃	R ₁	R ₂	R ₃
WH1	234.7 a	243.8 a	250.0 a	61.8 b	66.2 ab	70.2 ab
WH2	197.2 b	218.7 b	229.2 b	58.8 c	63.3 bc	65.8 bc
GN1	189.8 cd	191.3 c	228.3 b	59.2 c	63.2 bc	67.8 bc
GN2	191.2bc	202.2bc	213.3 c	60.7 b	62.2 c	68.8 abc
Zelig	198.3 b	210.0 bc	222.8 b	64.7 a	68.2 a	71.7 a
Bio	183.5 d	192.2 c	201.2 d	60.3 b	65.7 ab	67.2 bc
DC	163.2 e	172.5 d	180.6 e	56.3 d	58.7 d	60.4 d
CV (%)	2.9	7.9	2.3	6.1	4.0	3.9
Sig. level	***	***	***	*	**	**

Spacing (m)						
3x3	195.7	207.9	218.1	62.8	67.2	72.3
2x2	202.5	211.4	230.2	59.1	62.3	64.8
CV (%)	7.0	8.0	3.3	7.3	6.9	5.8
Sig. level	*	*	*	NS	*	**

WH1= Williams hybrid clone 1, WH2= Williams hybrid clone 2, GN1= Grand Nain clone 1, GN2= Grand Nain clone 2, DC= Dwarf Cavendish.

*, **, *** and NS indicate significance at 5%, 1%, 0.1% levels and not significant, respectively.

R₁, R₂ and R₃ indicate first ratoon, second ratoon and third ratoon, respectively.

Means in columns followed by the same letter(s) are not significantly different according to Duncan's Multiple Range Test.

Table 2. Interaction effects of banana clones and spacing on vegetative growth of the three ratoons at shooting.

Clones	Spacing	Pseudostem height (cm)			Pseudostem girth (cm)		
		R ₁	R ₂	R ₃	R ₁	R ₂	R ₃
WH1	3 x3	230.0 a	343.3a	248.3a	64.3 b	70.0 ab	76.7 a
	2x2	239.3 a	244.3a	251.7a	59.3 c	62.3 cd	63.7 e
WH2	3x3	195.0 bcd	216.7ab	228.3b	59.7 c	65.0 cd	66.7 cde
	2x2	199.3 bc	220.7ab	230.0b	58.0 c	61.7 cd	65.0 de
GN1	3x3	187.7 de	193.3b	203.3de	59.7 c	64.3 cd	69.0 bcd
	2x2	192.0 cde	189.3b	253.3a	58.7 c	62.0 cd	66.7 cde
GN2	3x3	188.3 de	201.7b	211.7cd	61.7 c	63.3 cd	71.0 bc
	2x2	194.0 cd	202.7b	215.0c	59.7 c	61.0 d	66.7 cde
Zelig	3x3	191.7 cde	201.7b	216.7c	68.0 a	74.0 a	79.0 a
	2x2	205.0 b	218.3ab	229.0b	61.3 c	62.3 cd	64.3 de
Bio	3x3	181.7 e	191.0b	200.3e	63.3 b	66.7 bc	71.7 b
	2x2	185.3 de	193.3b	202.0e	57.3 d	64.7 cd	62.7 e
DC	3x3	169.5 g	170.2 d	172.6 g	53.2	55.4 e	58.7 e
	2x2	172.7 f	173.3 c	174.5	49.1	52.6 f	55.4 f

		f					
CV (%)		2.9	7.9	2.3	6.1	4.0	3.9
Sig. leve		***	***	***	NS	*	***

WH1= Williams hybrid clone 1, WH2= Williams hybrid clone 2, GN1= Grand Nain clone 1, GN2= Grand Nain clone 2, DC= Dwarf Cavendish.

*, *** and NS indicate significance at 5%, 0.1% levels and not significant, respectively.

R₁, R₂ and R₃ indicate first ratoon, second ratoon and third ratoon, respectively.

Means in columns followed by the same letter(s) are not significantly different according to Duncan's Multiple Range Test.

Crop earliness:

The main effects of banana clones and spacing on number of days from shooting to harvesting of the three ratoons are shown in Table 3. Results indicated highly significant differences between banana clones in number of days from shooting to harvesting in the three ratoons.

The longest duration for bunch maturation was taken by William's hybrid clone 1 and 2 in the three ratoons, while the shortest was taken by Grand Nain clone 1, Zelig and DC in all ratoon crops.

However, the local clone DC was the earliest clone as compared to the introduced clones. Spacing had highly significant effects on number of days from shooting to harvesting in the three ratoons (Table 3). The largest numbers of days from shooting to harvesting were obtained at the spacing of 2x2 m compared to 3x3 m in all clones. Elsiddig *et al.* (2009) reported the same results for the plant crop of these clones. Robinson and Nel (1989) reported that the crop cycle duration was extended under close spacing.

The interaction effects of banana clones and spacing on number of days from shooting to harvesting are presented in Table 4. Results showed significant differences in the first ratoon and highly significant differences in the second and third ratoons. Generally, in all clones, plants grown at the closer spacing took more time for bunch maturation for the three ratoons, as compared to the wider spacing. This was because, plants grown at the closer were weak and had poor vegetative growth and hence took more time for bunch growth and maturation. Kesavan *et al.* (2001) reported similar results.

William's hybrid clone 1 at both spacings took a longer duration from shooting to harvesting in the three ratoons, while Grand Nain clone 1 and DC at the spacing of 3x3 m took the shortest. These findings were in conformity with the reports of Robinson and Nel (1988) who stated that the duration from flowering to harvest of Cavendish subgroup ranged between 100 to 240 days in subtropical areas.

Table 3. Main effects of banana clones and spacing on number of days from shooting to harvesting of the three ratoons

Clones	R ₁	R ₂	R ₃
WH1	115.5 a	116.3 a	116.8 a
WH2	108.7 b	113.7 a	115.3 a
GN1	98.8 c	101.2 d	102.8 c
GN2	107.5 b	109.3 b	111.2b
Zelig	100.0 c	103.0 cd	104.0 c
Bio	105.2 b	106.3 bc	108.2 b
DC	104.6 b	105.2 c	104.7 c
CV (%)	3.8	3.0	2.3
Sig. level	***	***	***
Spacing (m)			
3x3	102.5	105.4	107.3
2x2	109.4	111.2	112.1
CV (%)	4.5	3.7	2.9
Sig. level	**	**	**

WH1= Williams hybrid clone 1, WH2= Williams hybrid clone 2, GN1= Grand Nain clone 1, GN2= Grand Nain clone 2, DC= Dwarf Cavendish.

** and *** indicate significance at 1% and 0.1% levels, respectively.

R₁, R₂ and R₃ indicate first ratoon, second ratoon and third ratoon, respectively.

Means in columns followed by the same letter(s) are not significantly different according to Duncan's Multiple Range Test.

Table 4. Interactions effects of banana clones and spacing on number of days from shooting to harvesting of the three ratoons.

Clones	Spacing	R ₁	R ₂	R ₃
WH1	3x3	115.3 a	116.0 a	116.3 a
	2x2	115.7 a	116.7 a	117.3 a
WH2	3x3	104.0 cd	112.0 abc	114.3 ab
	2x2	113.3 ab	115.3 ab	116.3 a
GN1	3x3	92.0 e	92.7 f	95.3 f
	2x2	105.7 cd	109.7 bcd	110.3 bc
GN2	3x3	101.7 cd	105.3 de	108.0 cd
	2x2	113.3 ab	113.3 abc	114.3 ab
Zelig	3x3	99.0 d	102.0 e	103.3 e
	2x2	101.0 cd	104.0 de	104.7 de
Bio	3x3	103.0 cd	104.3 de	106.7 cde
	2x2	107.3 bc	108.3 cd	109.7 c
DC	3x3	94.6 e	95.7 f	95.8 f
	2x2	98.8 d	99.2 e	99.1 e
CV (%)		3.8	3.0	2.3
Sig. level		*	**	***

WH1= Williams hybrid clone 1, WH2=Williams hybrid clone 2, GN1= Grand Nain clone 1, GN2= Grand Nain clone 2, DC= Dwarf Cavendish.

*,**and *** indicate significance at 5% , 1% and 0.1% levels, respectively.

R₁, R₂ and R₃ indicate first ratoon, second ratoon and third ratoon, respectively. Means in columns followed by the same letter(s) are not significantly different according to Duncan's Multiple Range Test.

Yield and yield components:

The main effects of banana clones and plant spacing on yield components of the three ratoons were highly significant (Table 5). The clones Zelig and Bio resulted in the highest bunch weight, the largest number of hands per bunch and the highest yield of all crops, whereas Grand Nain clone I and DC resulted in the lowest yield parameters.

Elkashif *et al.* (2005) reported that DC clone produced the smallest bunches as compared to introduced WH clones, which were evaluated in Kassala State. Yield increased slowly as the number of ratoons increased. Mahmoud and Elkashif (2003) recorded a bunch weight of 15.1 kg for Dwarf Cavendish cultivar. Robinson (1996) reported that the weight of a Cavendish bunch could vary from 15 kg to 50 kg depending on cultural practices and soil fertility.

The main effects of plant spacing on yield parameters are significant (Table 5). The highest bunch weight and the largest number of hands per bunch were produced at the spacing of 3x3 m compared to 2x2 m in the three ratoons. However, the spacing of 2x2 m resulted in higher yield due to the large plant population per unit area and hence a large number of bunches, irrespective of their small size. Similar results have been reported by Elsiddig *et al.* (2009) for the plant crop of these introduced clones. Robinson and Nel (1988) stated that high plant density induced smaller bunches.

Exportable yield:

Banana clones had no significant effects on exportable yield of the three ratoons. The effects of spacing on exportable yield of the three ratoons are highly significant (table 6). The highest exportable yield was obtained at the spacing of 3 x 3 m.

The interaction effects of banana clones and spacing on exportable yield of the three ratoons are highly significant (Table 7). Zelig clone grown at the spacing of 3 x 3 m obtained the highest exportable yield, whereas DC grown at the spacing of 2 x 2m resulted in the lowest in the three ratoons. Generally, in all clones, exportable yield was higher at the spacing of 3 x 3m as compared to 2 x 2m. This was because there was less competition between plants grown at the wider spacing that resulted in bigger bunches with large fingers suitable for export.

On the other hand, plants grown at the closer spacing suffered from competition and hence produced small bunches with small fingers that were not acceptable in international markets. Elsiddig *et al.* (2009) reported the same results for the plant crop of these clones.

Table 5. Main effects of banana clones and spacing on yield and yield components of the three ratoons.

Clones	Bunch weight (kg)			No. of hands / bunch			Yield (ton / ha.)		
	R1	R2	R3	R1	R2	R3	R1	R2	R3
WH1	16.4 c	17.5 b	18.3 c	9.3 a	9.2 bc	9.8 a	26.5 c	28.8 b	30.2 c

WH2	16.1 c	17.0 b	17.5 c	9.2 a	9.3 bc	10.2 a	27.1 c	28.2 b	29.3 c
GN1	11.9 e	13.7 c	14.8 d	7.8 b	8.5 c	8.7 b	20.3 d	24.3 c	26.4 d
GN2	13.5 d	17.1 b	19.8 b	8.2 b	9.0 bc	9.8 a	22.0 d	27.7 b	33.6 b
Zelig	20.9 a	21.5 a	22.4 a	9.8 a	10.5 a	10.7 a	32.7 a	33.8 a	36.0 a
Bio	19.7 b	21.1 a	22.5 a	9.3 a	9.8 ab	10.5 a	29.5 b	32.3 a	35.5 ab
DC	12.6 e	12.5 d	13.2 e	7.6 b	8.3 c	8.7 b	17.1 e	18.5 d	18.9 e
CV (%)	5.3	4.5	4.7	8.2	6.9	6.6	5.5	5.8	5.1
Sig. level	***	***	***	***	***	***	***	***	***
Spacing (m)									
3x3	21.2	22.7	23.2	10.3	10.4	10.6	23.6	25.2	25.7
2x2	11.6	13.3	15.2	7.6	8.4	9.3	29.1	33.2	38.0
CV (%)	24.1	20.1	18.4	4.2	5.0	7.3	26.4	22.2	18.0
Sig. level	**	**	**	***	***	***	NS	*	**

WH1= Williams hybrid clone 1, WH2= Williams hybrid clone 2, GN1= Grand Nain clone 1, GN2= Grand Nain clone 2, DC= Dwarf Cavendish.

*, **, *** and NS indicate significance at 5%, 1%, 0.1% levels and not significant, respectively.

R₁, R₂ and R₃ indicate first ratoon, second ratoon and third ratoon, respectively.

Means in columns followed by the same letter(s) are not significantly different according to Duncan's Multiple Range Test.

Table 6: Effects of spacing on exportable yield (Percentage) of the first, second and third ratoons.

Spacing	R ₁	R ₂	R ₃
3 x 3	66.4	68.2	66.8
2 x 2	38.6	44.5	42.3
CV %	20.3	18.1	12.8
Sig. level	***	**	***

** and *** indicate significance at 1% and 0.1% levels, respectively.

R₁, R₂ and R₃ indicate first, second and third ratoons, respectively.

Green life (days):

There were significant differences in the green life among the different banana clones in the three ratoons (table 8). The clones Bio, Zelig, GN1 and GN2 had the longest green lives in all the ratoon crops, as compared to the other clones. The locally grown clone, Dwarf Cavendish, had the shortest green life in all ratoon crops. These results indicate the superiority of the introduced clones as compared to the local cultivar DC and their suitability for export due to their longer green lives. Mahmoud and Elakashif (2003) and Elsiddig *et al.* (2009) have reported similar results for the plant crop of these introduced clones. These results confirm the findings of Black and Peacock (1971) who reported that variations in the green lives of the different banana clones were mainly due to genetically factors.

Banana clones grown at the spacing of 3x3m had a significantly longer green life than those grown at 2x2m in all ratoon crops (table 8).

This was probably because bananas grown at a wider spacing produced larger, well developed fruits which stayed firm and green for a longer period of time than those produced by plants grown at a closer spacing (Robinson, 1996). These results are in agreement with those reported by Elsiddig *et al.* (2009) and Elakashif *et al.* (2010).

Number of days to ripen:

There were no significant differences among clones and spacing with respect to the number of days required for ripening after treatment with ethylene at 20°C for all ratoons.

This indicates that all clones responded similarly to exogenous ethylene and they required about 5 days to full ripening (Table 9). These results are in conformity with those reported by Elakashif *et al.* (2005) and Seymour *et al.*, (1987).

Banana fruit colour:

There were no significant differences among clones and spacing on colour development during ripening with Ethrel treatment at 20°C of the first, second and third ratoons. All fruits of different banana clones reached colour 6 (full yellow) after 5 to 6 days (table 10). This indicated that all introduced clones responded similarly and positively to Ethrel and reached high fruit quality standards. Our findings were consistent with those reported by Seymour *et al.* (1989) who mentioned that banana fruit treated with ethylene at 20°C resulted in good colour development which is an important characteristic trait required in international trade.

Table 7. Interaction effects of banana clones and spacing on exportable yield (percentage) of the three ratoons.

Clones	Spacing	R ₁	R ₂	R ₃
WH1	3x3	57.7 bc	59.9 ab	58.0 ab
	2x2	39.2 cd	42.5 c	53.4 bc
WH2	3x3	54.6 bc	60.9 ab	51.6 bc
	2x2	34.5 d	36.8 d	44.6 bcd
GN1	3x3	71.8 ab	73.8 a	72.5 a
	2x2	20.5 d	30.7 cd	37.2 cd
GN2	3x3	66.1 ab	68.0 a	72.3 a
	2x2	52.2 bc	47.9 bc	46.8 bc
Zelig	3 x3	79.6 a	73.0 a	73.5 a
	2x2	42.8 c	47.6 bc	43.8 bcd
Bio	3x3	68.3 ab	73.7 a	73.2 a
	2x2	22.3 d	19.2 e	27.8 d
DC	3x3	43.7	45.2	48.5
	2x2	19.3	22.4	25.8
CV (%)		20.7	18.5	17.6
Sig. level		**	***	**

WH1= Williams hybrid clone 1, WH2= Williams hybrid clone 2, GN1= Grand Nain clone 1, GN2= Grand Nain clone 2, DC= Dwarf Cavendish.

and * indicate significance at 1% and 0.1% levels, respectively.

R₁, R₂ and R₃ indicate first ratoon, second ratoon and third ratoon, respectively.

Means in columns followed by the same letter(s) are not significantly different according to Duncan's Multiple Range Test.

Table 8: Effect of banana clones and spacing on fruit green life (days).

Clone	R ₁	R ₂	R ₃
WH1	15.3 c	16.7 b	19.5 b
WH2	16.5 bc	16.2 b	20.2 a

GN1	19.0 a	19.2 a	20.5 a
GN2	17.7 ab	19.2 a	20.2 a
Zelig	19.3 a	19.8 a	20.7 a
Bio	19.0 a	19.5 a	20.5 a
DC	15.6 c	16.2 c	16.8 c
CV (%)	7.9	6.9	3.5
Sig. level	***	***	*
Spacing (m)			
3x3	21.2	21.8	21.7
2x2	17.5	18.7	18.9
Sig. level	*	*	*

WH1=Williams hybrid clone 1, WH2=Williams hybrid clone 2, GN1= Grand Nian clone 1, GN2=GrandNain clone 2, DC=Dwarf Cavendish.

* and*** indicate significance at 5%, and 0.1% level, respectively.

R₁, R₂ and R₃ indicate first, second and third ratoons, respectively.

Means in columns followed by the same letter(s) are not significantly different according to Duncan's Multiple Range Test.

Table 9. Number of days to ripen with Ethrel at 20°C.

Banana clones	Days		
	R1	R2	R3
WH1	5.3	5.2	5.0
WH2	5.2	5.3	5.0
GN1	5.0	5.0	5.0
GN2	4.8	5.0	5.0
Zelig	5.0	4.8	5.0
Bio	4.8	4.8	4.8
DC	4.5	4.7	4.6
CV (%)	8.0	6.6	3.4

Sig. level	NS	NS	NS
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WH1= Williams hybrid clone 1, WH2= Williams hybrid clone 2, GN1= Grand Nain clone 1, GN2= Grand Nain clone 2, DC= Dwarf Cavendish.

NS indicates not significant.

R₁, R₂ and R₃ indicate first, second and third ratoons, respectively.

Means in columns followed by the same letter(s) are not significantly different according to Duncan's Multiple Range Test.

Table 10. Colour score of fruits of banana clones at the ripe stage.

Banana clones	Colour score		
	R1	R2	R3
WH1	6.3	6.2	6.1
WH2	6.2	6.3	6.2
GN1	6.0	6.0	6.0
GN2	5.8	6.0	6.1
Zelig	6.0	5.8	6.0
Bio	5.8	5.8	5.8
DC	5.5	5.7	5.6
CV (%)	7.2	5.6	4.4
Sig. level	NS	NS	NS

WH1= Williams hybrid clone 1, WH2= Williams hybrid clone 2, GN1= Grand Nain clone 1, GN2= Grand Nain clone 2, DC= Dwarf Cavendish.

NS indicates not significant.

R₁, R₂ and R₃ indicate first, second and third ratoons, respectively.

Means in columns followed by the same letter(s) are not significantly different according to Duncan's Multiple Range Test.

Banana fruit firmness during ripening:

There were no significant differences among banana clones and spacing on fruit firmness during ripening of the first, second and third ratoons with Ethrel treatment at 20⁰ C. There was a gradual decrease in fruit firmness with the progress of ripening.

All fruits of the different banana clones became soft 5 to 6 days after Ethrel treatment (Table 11). These findings were in conformity with those of Elkashif *et al.* (2005) who reported that for a firm pulp texture, good colour and flavor development, the fruit must be ripened at a temperature of 20 – 22 °C.

Fruit total soluble solids (TSS):

The effects of banana clones on fruit total soluble solids were highly significant (Table 12). The clones Zelig and Bio significantly resulted in higher TSS contents as compared to the locally grown DC, which significantly resulted in the lowest TSS contents in the three ratoons. Elsiddig *et al.* (2009) reported similar results for the plant crop of these introduced banana clones.

The effects of plant spacing on TSS content were significant (Table 12). The wider spacing (3x3m) resulted in significantly higher TSS content than the closer spacing (2x2m) in all ratoons. This was because the wider spacing resulted in the production of heavy bunches with large sized fingers, which were more likely to ripen with excellent quality standards (Robinson, 1996; Mahmoud *et al.*, 2011).

The interaction effects of banana clones and spacing on total soluble solids were highly significant (Table 13). Regardless of clones, the wider spacing always resulted in significantly higher TSS contents than the closer one. The clones Zelig and Bio planted at the wider spacing resulted in the highest TSS values than the other clones.

Fruit taste:

Results showed highly significant differences between the different banana clones in the fruit taste of all three ratoons. Generally, the clones Zelig and Bio scored the best taste values as compared to the others (Table 14).

Plant spacing had significant effects on the fruit taste of all three ratoon crops (Table 14). The wider spacing (3x3m) resulted in significantly better taste than the closer one (2x2m).

Table 11. Firmness of fruits of banana clones at the ripe stage.

Banana clones	Fruit firmness		
	R1	R2	R3
WH1	4.3	4.2	4.1
WH2	4.2	4.3	4.2

GN1	4.0	4.0	4.0
GN2	4.8	4.0	4.3
Zelig	4.0	4.8	4.2
Bio	4.8	4.4	4.1
DC	4.3	4.7	4.6
CV (%)	5.2	5.6	4.7
Sig. level	NS	NS	NS

WH1= Williams hybrid clone 1, WH2= Williams hybrid clone 2, GN1= Grand Nain clone 1, GN2= Grand Nain clone 2, DC= Dwarf Cavendish.

NS indicates not significant.

R₁, R₂ and R₃ indicate first, second and third ratoons, respectively.

Means in columns followed by the same letter(s) are not significantly different according to Duncan's Multiple Range Test.

Table 12. Main effects of banana clones and spacing on fruit total soluble solids (%).

Clone	Total soluble solids (%)		
	R ₁	R ₂	R ₃
WH1	20.8 b	21.0 a	20.5 b
WH2	19.0 c	18.5 b	19.8 c
GN1	19.5 c	20.3 a	20.3 b
GN2	20.3 b	20.8 a	20.2 b
Zelig	22.2 a	21.0 a	21.2 a
Bio	21.7 a	20.5 a	21.7 a
DC	19.5 c	19.7 b	19.8 c
CV%	3.4	3.3	3.1
Sig. level	***	***	***
Spacing (m)			
3x3	22.7	22.9	22.9
2x2	21.4	21.6	21.8
Sig. level	*	*	*

WH1= Williams hybrid clone 1, WH2= Williams hybrid clone 2, GN1= Grand Nain clone 1, GN2= Grand Nain clone 2, DC= Dwarf Cavendish.

*and*** indicate significance at 5% and 0.1% level, respectively.

R₁, R₂ and R₃ indicate first, second and third ratoons, respectively.

Means in columns followed by the same letter(s) are not significantly different according to Duncan's Multiple Range Test.

Table 13. Interaction effects of banana clones and spacing on fruit total soluble solids (%).

Clone	Spacing (m)	R ₁	R ₂	R ₃
WH1	3x3	21.0 b	22.6 a	21.3 b
	2x2	20.7 c	20.0 c	19.7 d
WH2	3x3	20.1 c	19.2 d	20.6 c
	2x2	19.0 d	18.3 e	19.4 d
GN1	3x3	19.7 d	21.5 b	20.8 c
	2x2	19.3 d	20.1 c	19.2 d
GN2	3x3	20.3 c	21.7 b	21.8 b
	2x2	20.2 c	20.4 c	20.5 c
Zelig	3x3	21.8 b	22.2 a	22.6 a
	2x2	20.7 c	20.0 c	20.1 c
Bio	3x3	22.7 a	21.8 b	21.9 b
	2x2	20.6 c	20.3 c	20.5 c
DC	3x3	19.3 d	19.6 d	19.3 d
	2x2	19.2 d	19.2 d	19.0 d
Sig. level		**	**	**

WH1= Williams hybrid clone 1, WH2= Williams hybrid clone 2, GN1= Grand Nain clone 1, GN2= Grand Nain clone 2, DC= Dwarf Cavendish.

** indicates significance at 1% level.

R₁, R₂ and R₃ indicate first, second and third ratoons, respectively.

Means in columns followed by the same letter(s) are not significantly different according to Duncan's Multiple Range Test.

Table 14. Main effects of banana clones and spacing on fruit taste.

Clone	R ₁	R ₂	R ₃
WH1	4.7 a	5.0 a	4.5 b
WH2	4.2 b	4.2 b	4.3 b
GN1	4.0 b	5.0 a	4.3 b
GN2	4.7 a	5.0 a	4.5 b
Zelig	5.0 a	5.0 a	5.0 a
Bio	5.0 a	5.0 a	5.0 a
DC	3.3 c	3.2 c	3.4 c
CV (%)	7.1	3.4	7.2
Sig. level	***	**	***
Spacing (m)			
3x3	4.8	4.9	4.6
2x2	3.8	3.7	3.2
Sig. level	*	*	*

WH1= Williams hybrid clone 1, WH2= Williams hybrid clone 2, GN1= Grand Nain clone 1, GN2= Grand Nain clone 2, DC= Dwarf Cavendish.

*, ** and *** indicate significance at 5%, 1% and 0.1% level, respectively.

R₁, R₂ and R₃ indicate first, second and third ratoons, respectively.

Means in columns followed by the same letter(s) are not significantly different according to Duncan's Multiple Range Test.

The interaction effects of banana clone and spacing on fruit taste were highly significant (Table 15). The best taste scores were recorded for the clones Bio and Zelig grown at the wider spacing. Generally, there was a direct relationship between TSS and taste. Banana clones which scored high TSS values had the best taste and *vice versa*. Similar results were reported by Seymour *et al*, (1987) and Mahmoud and Elkishif (2003).

In conclusion, the introduced banana clones Bio and Zelig grown at the spacing of 3x3m showed an outstanding performance with respect to vegetative growth, total and exportable yields, fruit green life and quality, which makes them good candidates to replace the local clone DC.

Table 15. Interaction effects of banana clones and spacing on fruit taste.

Clone	Spacing(m)	R ₁	R ₂	R ₃
WH1	3x3	4.7 b	5.0 a	4.7 b
	2x2	4.5 c	4.3 c	4.2 d
WH2	3x3	4.3 c	4.0 d	4.4 c
	2x2	4.0 d	3.8 e	4.1 d
GN1	3x3	4.2 d	4.8 b	4.5 c
	2x2	4.1 d	4.3 c	4.0 d
GN2	3x3	4.4 c	4.8 b	4.8 b
	2x2	4.4 c	4.3 c	4.4 c
Zelig	3x3	4.8 b	5.0 a	5.0 a
	2x2	4.5 c	4.3 c	4.3 c
Bio	3x3	5.0 a	4.9 a	4.9 a
	2x2	4.4 c	4.4 c	4.4 c
DC	3x3	4.1 d	4.4 c	4.2 d
	2x2	4.0 d	4.3 c	4.0 d
Sig. level		**	**	**

WH1= Williams hybrid clone 1, WH2= Williams hybrid clone 2, GN1= Grand Nain clone 1, GN2= Grand Nain clone 2, DC= Dwarf Cavendish.

** indicates significance at 1% level.

R₁, R₂ and R₃ indicate first, second and third ratoons, respectively.

Means in columns followed by the same letter(s) are not significantly different according to Duncan's Multiple Range Test.

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Ethics Reflexivity in Documentary Film (An i-doc as a model)

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Abstract

This article highlights the ethics of documentary filmmaking. It focuses on filmmakers' task to consider these ethics based on the ethical philosophy of Emmanuel Levinas in exploring the dilemmas of representation in documentaries adopted by Nash (2011), who notes that stories and ethics always go hand in hand. Determining the ethics of regulating documentary filmmaking is not easy and has been controversial over time. It is possible to define the ethics of a filmmaker academically. However, in practice, the matter is different as conditions and reality are imposed on the filmmaker, which makes his experience and expertise different from the ethics of theoretical filmmaking. This paper aims to show how an increasing number of academic scholars and filmmakers' industry stakeholders working for one goal can help improve the arguments on documentary filmmaking ethics to capitalise in the subsequent films. The method is to review published reports and articles on the ethics in documentary film and reflexivity, further including observed data about the experiences of others to help understand the ethics that guide documentary filmmaking, including my experience as a filmmaker in producing the interactive documentary *Eden Again* (2017) as a model.

The problem discussed in this paper relates to what kills the documentary: the conflict between professional ethics and ideological biases. Some agendas negate professionalism and credibility by promoting or seeking to serve particular interests that push those behind the film to hide the truth instead of being completely open to exploring the participants' matters and following filmmaking's ethics. Documentary filmmakers are recommended that if they have ideological biases and solid feelings or preconceived ideas, set them aside and ethically interact with the facts they encounter while working on a documentary.

Keywords: Ethics, Documentary filmmaking, Reflexivity, Interactive documentary.

1. Introduction

Sanders (2010) argues that the responsibility of filmmakers in the first place is towards their participants, the film and the audience; they are among the primary things that must be considered when talking about the ethics of documentary film. Therefore, I argue that it is essential to consider all ethical, psychological and behavioural considerations, raising credibility towards what is presented. Sanders (2010) focuses on documentary films between theory, application, and concepts of documentary film. She suggests including filmmakers' experiences data to help understand the ethics as a directory for documentary filmmaking.

On the other hand, Nash (2011) identifies some principles that boost documentary ethics, like 'Respect for autonomy', through the signing of a consent form and a release form which are the legal agreement between the filmmaker and participants that determine the way of the use of the materials of the participants and the process of conducting interviews. 'Honesty' is the main principle governing the relationship between the documentary maker and the audience and has implications for the relationship with the participant'. 'Non-maleficence' is a principle requiring that the documentary maker works to eliminate harm resulting from documentary practice' (Cited in Alamouti 2020, p. 108).

Nash (2011) writes an optimistic message about her conclusion about Levinas's ethics by challenging assumptions about the other and the possibility of knowledge through the profound reflexivity and ethics reshaped; she calls to focus on filmmaking practices and respect the difference for the sake of showing the truth. As Nash puts it, "It is a philosophy of power, a philosophy that transforms the Other into an object of knowledge. The totality of Western thinking is a violent response to the Other, a response that suppresses and possesses" (ibid, P. 231). As for Levinas, Nash summarises that an ethical relationship has been created (2011). On the other hand, hand (1996) argues about Levinas's view that I should not reach the point of melting each of us with others because the communication, in this case, is a non-positive communication because both of us cancel the Other.

1.1. The Purpose of study

This paper aims to show how an increasing number of academic scholars and documentary filmmakers' industry stakeholders working for one goal can help improve the arguments on documentary filmmaking ethics to capitalise in the subsequent films.

1.2. The importance

Seeing the experiences of a few documentary filmmakers who failed to delve into the ethics of documentary filmmaking, these standards should be avoided by a filmmaker, but most importantly, benefit from the successful experiences of other filmmakers in adopting the industry's ethics in all its strictness and without any biases.

1.3. The problem

What kills the documentary is the conflict between professional ethics and ideological biases. Some agendas negate professionalism and credibility by promoting or seeking to serve particular interests that push those behind the film to hide the truth instead of being completely open to exploring the participants' matters and following filmmaking's ethics.

2. The Methodology

The method is to review published reports and articles on the ethics in documentary film and reflexivity, further including observed data about the experiences of others to help understand the ethics that guide documentary filmmaking, including my experience as a filmmaker in producing the interactive documentary *Eden Again* (2017) as a model.

Filmmaking's ethical issues

However, the filmmaker might lure the participants into revealing events and information that may cause them to harm in the future, whether legal or social. Therefore, participants must choose their terms carefully not to affect them in the future. Sanders (2010) writes that 'inviting the participants to view the material and give provisional consent is more realistic' (p. 542). However, some filmmakers might exploit the participants by playing their feelings and emotions to enter a psychological conflict. As such, the filmmaker works hard to show to arouse this sympathy. The exploitation of individuals, especially those belonging to poor classes; To obtain statements from them that are not fact and events that have not occurred; The filmmaker gives them an amount of money this is considered against the ethics of media work. Submitting false images and statistics; Such as offering personal pictures of individuals through the use of computer programs that have been produced by modern technology. Falsification of historical facts and documents in documentaries. It would contribute to the distortion of history for society; this is considered a violation of media ethics. Interviewing people who do not speak the native language of the participants or have a simple native language causes a problem.

Cut off participants' speech, words or sentences that may appear with sarcasm and irony. Also, the same when correct to do dubbing or translation of the participants' speech. It is unethical if the filming process occurs without the participants knowing what is happening. People perform various natural activities spontaneously, so filming people in public places without understanding the process is generally considered unethical. Further, violating the agreement between the filmmaker and participants will cause harm and problems to the participants and their society.

Although the filmmaker's commitment to reservations about the future possibilities of participants. Aufderheide et al. (2009) showed that filmmakers take ad hoc decisions about moral issues they face and employ situational ethics in doing so (cited in Sanders 2010, p. 543). Hence, the filmmaker might set unrealistic expectations that the character could not achieve through the narrative structure. In this instance, the filmmaker becomes guilty due to the freeze of participants' lives. Therefore, the filmmaker's ethical attitude focuses on the reflexivity approach during the production and editing of participants' stories.

To be a subject in the filmmaking process indicates a high level of trust between the filmmaker and participants and the familiarity with conversational filmmaking where the participants experience. Since the documentary film's goal is to represent authenticity, this results in some self-contradiction; therefore, some filmmakers sometimes hide the modes and means of production to give us a sense of non-meditating reality. MacDougall (1998) writes that most filmmakers argue that documentary touches within themselves and others something more transient and valuable and a way of representing reality. Another important thing that the filmmaker should practice is screenings to a private audience for comments. I consider it a refreshing and vital touch because it cultivates honesty. When watching the rough cut, some peer reactions might be a long or short sequence or could be the filmmaker's self-indulgence to a high degree. Therefore, omitting and editing must be considered. According to the peer review's comments, a filmmaker should make appropriate choices to provide different stories/events. Making final decisions requires degrees of waiver and morality.

Regarding technical issues related to the story itself, if one needs to delete part of one of the participants' stories, the ethical duty is to make an independent short film for this participant. If so, the filmmaker and the participant will be sensory interns for each other.

Also, if there is a shortage of available imagery, the filmmaker might use dips to black where necessary because they represent more reflexive than cutaways. Dips to black will provide a consistent aesthetic approach and be more transparent. However, the most important thing is to serve the narrative requirements, such as stories and film editing structure.

The filmmaker might experience some reflexive moments from rushes during editing. It will be many visual, intuitive moments from the previous experiences of the filmmaker, such as glancing at the camera at some participants. Likewise, ethical principles must adhere to the commitment to the participants on the screen and the soundtrack during editing. Similarly, filmmakers sometimes combine imagery and written comments to form an automatic and declarative device, and the sequences must show the influence of ethics on the aesthetics of the scene. From the beginning, the participants agree and determine the frame's boundaries. Therefore, unfold sequences stratify with Levinas' theory approach that ethics starts with philosophy.

In his discussion about a reflexive approach to documentary, Ruby argues that the filmmakers must be objective and avoid explaining their methods on the screen to avoid indulging. They must admit that neutrality is a myth because it shows us their view of the world, with or without intent, revealing regards reflexive situation, the overall three components of 'PRODUCER-PROCESS-PRODUCT' (1977, p. 3). A complex and critical understanding of the product is impossible if the public does not recognise these three significant elements. Moreover, since the filmmakers are reflexive, they fully reveal some basic knowledge assumptions that promote them to formulate questions, search for answers, and present what they reach from the results (ibid). Equally important, Pink (2009) indicates the concepts of the mason of venue and the filmmaker's embodied place. In this regard, Pink asks how researchers intertwine to participate in a specific production, power relations, and materialism.

Part of the entanglement concept denotes continuous dynamic and active relationships with the participants; this has to do with Nash's notes about the filmmaker's power relations. I argue that documentary films seek to transfer the facts of society and contribute to acculturation. The inspiration for folk customs, rituals, and ways of living to document and spread human memory is among the ethnographic data that constitute a fatty substance that enriches the interactive documentary film visualisation.

The ethnographic film reveals peoples' culture or flicks over others due to creative and theoretical practices. Perhaps the ethnographic film allows researchers and filmmakers space to study and document, through what is allowed by interactive documentary techniques from the possibilities of dealing with anthropological topics as a human product for Informative and indicative purposes. As far as it is concerned ethnographic, MacDougall writes that ethnographic film is a record of the filmmaker's participation with the community represented by his opinion. It is not a record of this community only (1995).

For ethical obligation and focusing the creative energies in the interest of a documentary, there are some standards to be avoided by a filmmaker, for instance, not luring or pushing the interviewees to reveal events and information that may cause him to harm in the future, whether legal or social. Editing the interviewee's speech/answers and not dividing the sentences/words to cut the context. Further, do not exploit the interviewee by entering them into a state of psychological or emotional conflict, which they work hard to show in front of the screen to arouse sympathy in the audience. The exploitation of individuals, especially those belonging to poor classes; To obtain statements from them that are not fact and events that have not occurred; So that the filmmaker gives them an amount of money is considered against the ethics of media work.; Submitting false images and statistics, such as submitting personal photos of individuals through software like photoshop.

Falsifying historical facts and documents in documentaries contribute to the distortion of history for society. Also, it is considered a violation of media ethics when film people in public places without their knowledge of the filming process. Ethically, the filmmakers should protect their source and all the participants, even if they do not care about protecting themselves, as professional honesty morality requires them to protect them. Also, some practices are less ethically straightforward, like re-enactment technology. However, such use is not confusing to viewers; they can usually distinguish the experience from its symbolic embodiment, which cause controversy around falsehood overlaps with truth without allowing viewers to discern.

In the documentary *Mighty Times-The Children's March* (2004), about the history of human rights, scenes are mixed with archival material, and archival material from time and place is also used to indicate another place and time, which also sparks controversy because of this blending. Further, the documentary *The Secret Plot to Kill Hitler* (2004), directed by David McNab, was also part of an experiment in "virtual history",

In which the actors re-enact a moment in history drawn from archival scenes. Still, some believe that the method of mixing actors with archival images might cross an ethical line and might confuse the audience.

Moreover, docudrama films that use actors and scripts to retell actual events, including films such as *Gandhi* (1982), the TV series *Roots* (1977), and the 2006 drama-documentary *The Road to 9/11*, could generally overlook subtlety to dramatise reality, leading to ethical issues. Likewise, some documentary filmmakers mix fictional elements and claim that these are documentaries like *The Perfumed Nightmare* (1977), where the director Kidlat Tahimek re-uses documentary scenes to tell a fictional story about a third-world naive who travelled to the West. Still, the disgruntled other filmmakers and viewers did not like such repudiation and distortion of the documentary ethics.

Case study: the interactive documentary *Eden Again* (2017)

The interactive documentary *Eden Again* represents Arabs/Muslims___ the Middle East; this i-doc reflects the authentic daily lives, which are often negatively portrayed as the 'Other' (Said, 1978). Moreover, Edward Said (1997) has critical of academic orientalists and blamed intellectual and political rhetoric for building negative images of the East and its various cultures. Levinas' philosophy is of relevance, as indicated by Hand (1996), who argues: in Levinas' view, the structure of philosophy is fundamentally ethics, and that morality is achieved on the ground only through the relationship of the self to the Other, and that this relationship based on kindness, compassion, love, and altruism between us. We cannot ignore others or abandon the responsibility for Others' misery. However, in a relationship with the other, we must distance ourselves.

Through *Eden Again* experience with the residents of the Marsh area in the south of Iraq to represent them and their area, I acknowledge the right of 'Others' to talk and reveal their potential through an interactive relationship. (Aufderheide et al.), argue about the role of the filmmakers, "they routinely found themselves in situations where they needed to balance ethical responsibilities against practical considerations" (2009, p. 1). Furthermore, Nash puts it, "Situationism has come to designate an approach to documentary ethics characterised by a focus on context. Ethical frameworks, while not necessarily inconsistent with a situationist approach, must be applied flexibly" (Nash 2012b, P. 321).

The ethnographic film discovers what is hidden and mysterious from human groups and the artistic construction through which humans express themselves and their existence. In the i-doc *Eden Again*, I ordered one of the participants to point the microphone at the person speaking; it was technically risky because it might harm the sound quality. It was a spontaneous moment that the audience does not know about; this harmony between bodies and interests when the two sides of the relationship learn from each other; Pink (2009) describes it as a sensory apprenticeship. Another example while filming the i-doc *Eden Again*: someone entered one of the interviewees' workplaces without knowing a camera's presence. Therefore, the scene was spontaneous. This coincidence also occurred during the fisherman's interview. One of his customers entered the fish store without their knowledge of filming; the fisherman asked whether we continue filming or turn the camera off. Then, he requested permission from the customer to appear with him in the shoot, and the customer wondered what was going on.

It is an exact reflexive moment that emerges the film's intention and stylistic approach, and the fisherman indulges and understands this approach. Thus, it is a profoundly intuitive sequence highlighting the stylistic approach to an i-doc and its intentions. Moreover, the filmmaker's voice can be heard during the conversation or off-camera to create a critical stylistic assignment to reveal him as a filmmaker, interviewer, and narrator in the i-doc. Even after the customer leaves, as it happened with *Eden Again*, the fisherman interacts; he takes the initiative to ask whether his behaviour with the customer was satisfactory or not. I deliberately kept the camera on him without adding any visual objects to give the participants an impression of ethical cooperation between them and the filmmaker.

Accordingly, this indicates the cooperative relationship (level of sympathy between the fisherman and me); the collaborative fisherman's position is ethical because he requests the customer to film. This implicit relationship is an example of deep reflexivity because it has involved and subtle in its conclusions. When reflecting, as emphasised by (Aufderheide et al., 2009) that some documentary filmmakers fear intimidating their participants; they deliberately underestimate what they do. Therefore, I think the customer's generous and desired response to filming with the fisherman does not change, even if I explain in full detail.

As far as McDougall's ideas are concerned, a question arises and leads me to McDougall's ideas: How can an interactive documentary use reflexivity to become more ethical- without giving up

the necessity of social participation? MacDougall (2005), the ethnographic filmmaker, who discusses reflexivity, argues that since the film is a group work, it is considered a field for creating everyday awareness. Documentary filmmaking can frame as a shape of stretching oneself to others instead of seizure or reception to help others with our realisation and senses as a kind of verification. We understand and feel them through what we contain ourselves because the ultimate purpose is to contact our subjects. As for deep reflexivity, McDougall says we must read the author's position in building the work itself, whatever external interpretations. We must understand the book as including the author (1995).

Likewise, Ruby's (2005) ethics concerns led him to this question: Should the documentary artist dispel the construction's ambiguity? However, McDougall (1998) argues about expectations; an ethnographic film comprehensively reveals that the filmmaker's bias that may interfere in representing reality is futile. McDougall argues that relying on this type of external reflection is the filmmaker's involvement. Their opinions reveal the details and nuances of fact because the essential things are the ones in which the author is strongly involved. He affirms that the intention is to read the work at this high level of meaning and accuracy, reflecting its profound reflection. McDougall's (1982) point of view is judging his film through his good towards others, understanding their impressions, and presenting and clarifying the apparent issues. I agree with McDougall's position when thinking about my own experience, as though the filmmaking process and the interest in taking the reflexive approach and transparency. The filmmaker's point of view prefers when completing the film.

In the same way, Sanders (2012) writes that those ethical decisions taken during the filmmaking process, whether real or false, sometimes not be recognised. If reflexivity is related to deep thinking regarding consciousness, we cannot free ourselves from ourselves; therefore, we cannot exit from our practice. Continuous self-reflection leads to a change; it affects ethics. As Sanders continues, these ethical issues are determined through the potential of informed consent as an ethical ground; about privacy and freedom of expression, there may be a conflict between moral and legal rights, ownership and use of images and release forms, and its effects representation (ibid).

The critical question here is, what does cooperation mean at this stage? As mentioned earlier, the participants were present during the filming/recording videos in my i-doc *Eden Again*.

It was easy to discuss their feelings and what was appropriate for them. During this collaborative process, the participants must be consulted, focusing their skills on telling their stories so that the filmmaker's skill remains in conveying their information to the screen. Suppose the documentary deals with an important and sensitive issue. The filmmaker should not engage in a simple process. As the camera is an incentive, it should use for excitement. MacDougall's concept of discernment is that the film, by its nature, bears the imprint of the parties involved (1995). At the same time, Pink (2009) emphasises that the camera must be essential to a researcher's identity. The research participants' conscious minds share a conscious-mind relationship. As she continues, sensory ethnography expanded to feel the camera as part of the ethnographers' social participation to demonstrate how they embodied. Therefore, the sensory environment and substance suggest additional importance to visual methods. Similarly, some ethical standards in post-production must consider as the filmmaker works alone in the edit house without the participants. Any participants must not participate in the editing decisions about other participants or ask the filmmaker to exclude another participant.

3. Conclusion

This article highlighted the ethics in documentary film and how documentary filmmakers have always been required to utilise ethics; they work according to ethics regarding the participants, the film, and the audience. Sanders (2010) writes that scholars focused on linking many concepts to ethics in documentary filmmaking in addition to mentioning the circumstances that may be relevant and identifying inadequate practices to these ethical issues. Filmmakers might fail to think about moral theories and how to inform each other about the right thing to do. Nevertheless, the end of what matters is that 'the ethics of documentary filmmaking should reflect the practice of documentary filmmaking. It is not about judging individual actions or describing the right thing to do in a given situation. Instead, it is about the principles that inform deliberations and decisions about the right thing to do as a documentary filmmaker. Morals in documentary filmmaking concern those norms and values filmmakers decide about right and wrong. These morals may be related to the filmmaker's cultural background, [...] religion or ideas about their profession. Moral issues are issues with a moral component: issues that relate to the filmmaker's responsibility toward others or to themselves' (Sanders 2010, p. 531).

Eden Again interactive documentary (2017) uses the underpinned ethics principles in filmmaking. In addition to signing the approval between the filmmaker and participants, the filmmaker or the producer can conduct a thorough study of the participants and their places, analysing all possibilities before starting the film to ward off risks before they occur that can have real and unfortunate consequences. As such, not only considering the specific ethical positions in the various documentary productions requires research and analysis. However, it is essential to consider all ethical, psychological and behavioural considerations of the target audience; This contributes to raising the credibility of what is presented.

4. Findings

- Ethics risks in documentary films lie in four main determinants: the participant, the degree of social bias, the place, and the audience.
- Using the underpinned ethics principles in filmmaking and signing the approval between the filmmaker and participants can help the filmmaker to conduct a thorough study of the participants and their places. Further, analysing all possibilities before starting the film to ward off risks before they occur that can have real and unfortunate consequences.
- Not only considering the specific ethical positions in the various documentary productions requires research and analysis. However, it is essential to consider all ethical, psychological and behavioural considerations of the target audience; This contributes to raising the credibility of what is presented.
- Although the examples highlighted in this paper show how a few documentary filmmakers did not commit the filmmaking ethics, other examples show how to get benefits from the experience of other filmmakers.

5. Recommendations

For the ethical obligation of a documentary, there are some standards to be avoided by a filmmaker, for instance:

- It is not luring or pushing the interviewees to reveal events and information that may cause them harm in the future, whether legal or social.
- Editing the interviewee's speech/answers and not dividing the sentences/words to cut the context.

- Do not exploit the interviewee by entering them into a state of psychological or emotional conflict. Ethically, the filmmakers should protect their source and all the participants, even if they do not care about protecting themselves, as professional honesty morality requires them to protect them.
- The exploitation of individuals, especially those belonging to poor classes; To obtain statements from them that are not fact and events that have not occurred; So that the filmmaker gives them an amount of money is considered against the ethics of media work.
- They were submitting false images and statistics, such as offering personal photos of individuals through software like photoshop and filming people in public places without their knowledge of the filming process.
- Avoid falsifying historical facts and documents in documentaries because it will contribute to the distortion of history for society. Further, avoid any ideological biases and ethically interact with the points you will encounter while working on a documentary.
- Some practices are less ethically straightforward, like re-enactment technology, which causes controversy around falsehood overlaps with truth without allowing viewers to discern.

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