MEMORIA
DE LA
28ª REUNION ANUAL

Agosto 9-15, 1992
Santo Domingo, República Dominicana

Publicado por:

Sociedad Caribeña de Cultivos Alimenticios y
Fundación de Desarrollo Agropecuario

Santo Domingo, República Dominicana

FUNDACION
DE DESARROLLO
AGROPECUARIO, INC.

INVESTIGATIONS ON THE EFFECTS OF REDUCED INTRA-ROW SPACING, FERTILIZER RATES AND CULTIVATION SYSTEMS ON EDDOES (*Colocasia antiquorum* L) PRODUCTION[1]

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ABSTRACT

The effects of reduced tillage, spacing and rates of fertilizer on yield and yield components of Eddoes (*Colocasia antiquorum*) were investigated in two Experiments. In Experiment 1 the response of yield and yield components to fertilizer rates and systems of cultivation were studied. Marketable yield increased significantly with reduced tillage and high rates of fertilizer applications compared to the traditional method of ploughing and banking. The reduced tillage operations, in addition to conserving the soil, was less labour intensive and reduced the cost of production. In Experiment 2 the effects of closer intra-row spacing and system of cultivation on marketable yield and yield components were evaluated. The results showed that reduced intra-row spacing from 90cm to 15cm significantly increased marketable yields in eddoe without affecting cormel size or quality. Validation of the results on larger plots with economic analysis showed that closer intra-row spacing of 30cm established with minimum tillage and using fertilizer rates of 1.6 t ha^{-1} improved productivity (32t ha^{-1}) compared to traditional prodluction systems (17t ha^{-1}). Cost of production was reduced by E.C. \$0.25 kg^{-1}

Introduction

During the period 1984 to 1990 the total export of eddoes (*Colocasia antiquorum*) from St. Vincent and the Grenadines declined from 23 thousand to under 3 thousand tonnes. Further, the data from the

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Central Statistical Office in St Vincent showed that the commodity is still the second largest earner of foreign exchange among non-banana agricultural exports (Figure l). Most of the product is exported to Trinidad and Tobago (Figure 2). Farmers produce the eddoe on small holdings on sloping hill- sides. The soils are of relatively recent volcanic origin and are characterized by good fertility but low water holding capacity (Watson et al., 1958).

Farmers prepare the land for eddoe production by 'Banking'. This involves ploughing the land with a hoe, pulverizing the soil and drawing it into rows of mounds. The mounds are 1 to 1.5m between rows and 0.75 to 1 metre along the row. Planting holes are then opened using a hoe in the top of the banks for planting. Over the years, this system has resulted in a progressive downward movement of soil from the top to the base of the hillsides.

As an alternative to this practice, a system known as 'Ranging' was introduced. It Involves removing just sufficient weeds to enable planting holes to be prepared in rows along the contour. The weed debris is laid along the contour and the planting holes are then made in front of the debris. Spacing is 30 cm along the rows and 75cm between rows which means that the plant population can be two to three times that achieved with Banking.

As far as productivity is concerned, yields have been increased from 3.2 to 10.1 t ha^{-1} during the period 1972 to 1983 (Gunsam, 1985). However, the potential yield is in excess of 20 t ha^{-1} (O'Hair and Asokam, 1961). Therefore, this gap represents an opportunity for increasing productivity and exports.

In the light of the above, studies were carried out in St. Vincent and the Grenadines during 1989 to 1992 to investigate and validate technologies to increase yield, productivity, reduce the cost of production and prevent soil loss through modifying the existing system of cultivation.

Materials and Methods.

The rainy season in St. Vincent and the Grenadines begins in June and is the main planting season for eddoes . The rainfall and

temperature data are presented in Figure 3 from the E.T. Joshua airport, the closest station to the experimental site. It should be noted that eddoes can be grown all year in Ecological Zones where the annual ralnfall distribution is relatively uniform and in excess of 1800 mm. The experiments were carried out on a soil series known as Greggs Loam (Watson et al., 1958).

Experiment 1

In this Experiment the response of yield and yield components to two land preparation systems (ranging and banking) and four rates (0.4, 0.8, 1.2 and 1.6 t ha^{-1}) of NPK fertilizer (15-08-24) were applied in three split applications (at planting, six and twelve weeks after planting) were examined. Farmers cultivated eddoes by using the banking system and applied fertilizer rates between 1.2 to 1.6 t ha^{-1} and hereafter refers to as "the existing System". The experiment was laid down at Fenton on May 1990 and harvested on November 1990. The split plot design was utilized to facilitate land preparation. The main plot consisted of two land preparation systems, Ranging and Banking with the four fertilizer rates of 0.4 to 1.6 t ha^{-1} with increments of 0.4 as the sub plot. There were two blocks and the main plots were replicated twice in each block. Data measured were marketable, unmarketable and main corm (head) weight and numbers. Data were subjected Analysis of Variance using the Genstat V package.

Experiment 2

In experiment 2 four methods of land preparation six intra-row spacings were evaluated for yield and it's components in eddoes. The methods of cultivation were (1) banking,(2) ranging (3) cutlassing and making a hole using a fork and (4) spraying with paraquat and making a hole with a fork. The six intrarow spacings were 15, 30, 45,60, 75 and 90 cm, with a spacing of 75 cm between the rows. The experiment was laid down in a split-plot design in two replicates. The main plot was land preparation with spacing being the subplot. Data collection and analysis were similar to Experiment 1. The Experiment was established on May 22, 1990 on a Greggs Loam soil at Queen's Drive close to Fenton and harvested on January 1, 1991.

Technology validation

From the results of Experiments 1 and 2, validation plots were established to determine the economics of closer spacing, system of land preparation and fertilizer rates to be used on farmers holdings. This is referred to as the Alternative System or Technology II. The alternate technology consisted of a combination of the fertilizer rate of 1.6 t ha^{-1} , ranging as the method of land preparation and spacing of 30 cm intra-row and 75 cm inter-row spacing. This was compared to the existing system or Technology 1 is as previously described. The plots showing the recommended and the existing practices were established in the major eddoe producing areas of St. Vincent at Spring Village on 25/04/91, Vermont on 08/07/91 and Fenton on 14/12/90. Marketable tuber yield was used to compare the two systems. The cost of inputs used and labour requirements were monitored and used for economic analyses.

Results and Discussion

Experiment 1

There was a significant linear effect (p= 0.01) for the interaction of land preparation and fertilizer rates for both marketable and unmarketable yields. These effects are presented in Table 1. The fertilizer rate of 1.6 t ha^{-1} on ranged lands gave the best results (30.72 t ha^{-1}). However, poor results of 12.40 t ha^{-1} were obtained at the rate of 0.4 t ha^{-1} on ranged lands. Banking showed no significant response to increased fertilizer rates. Plucknett and De La Pena (1977) showed that Nitrogen, Phosphorus and Potassium at 560 kg ha^{-1} respectively, were beneficial to growth and development of *C. esculenta.*

The significantly high yield observed for marketable cormels from 'ranging' and 1.6 t ha^{-1} fertilizer might be attributed to the conservation of nutrients coupled with improved plant water relations in this system. The increased yield of marketable cormels were due to the high number of cormels per unit area and not mean cormel weight. In addition, the zone where the plants are grown when ranged is less porous than when the area is banked, and therefore could retain fertilizer and moisture for longer periods thus improving growth. The

banking process loosens the soil that made the soil prone to the loss of nutrients and moisture (Watson, 1958). The results indicate that farmers should prepare their land by ranging. This system requires less labour for land preparation, more 'soil friendly' and seems to use fertilizer more efficiently. If farmers anticipate that funds may not be available for fertilizers and continues to bank, then the lower fertilizer rate should be used to prevent leaching into the water ways. It is important to note that ranging with low fertilizer rates resulted in poor yields.

Table 1. The effect of System of Cultivation and fertilizer rates on yield and yield components at Fenton.

	Marketable		Unmarketable		Heads	
	Weight t ha^{-1}	Mean weihgt /cormel(g)	Weight t ha^{-1}	Mean weihgt /cormel(g)	Weight t ha-1	Mean weihgt /cormel(g)
			Ranging			
Fertilizer rates						
0.4 t/ha	18.78 (2.93)	95.27 (4.56)	4.24	44.19	6.88	227.1
0.8 t/ha	21.36 (3.06)	105.36 (4.66)	4.80	48.48	8.48	221.4
1.2 t/ha	21.80 (3.08)	101.70 (4.62)	4.78	57.79	9.23	256.3
1.6 t/ha	24.58 (3.20)	99.90 (4.60)	4.78	43.19	8.66	221.4
			Ranging			
Fertilizer rates						
0.4 t/ha +	12.40 (2.52)	86.40 (4.46)	5.16	47.11	7.90	227.2
0.8 t/ha	15.40 (2.73)	94.97 (4.55)	7.10	55.29	7.47	244.7
1.2 t/ha	24.10 (3.18)	103.43 (4.64)	5.22	48.70	8.71	233.0
1.6 t/ha	30.72 (3.42)	105.81 (4.66)	5.30	50.00	10.03	279.6
S.E.D.	0.52	0.39	N.S.	N.S.	N.S.	N.S.

Transformed data by logarithms are in parentheses.

Experiment 2

A significant linear effect (p=0.01) of intra-row spacing to marketable yield was observed. The yields increased from 15 t ha^{-1} to 27 t ha^{-1} as intra-row was reduced from 90 to 15cm. There were no significant differences among systems of cultivation or for the interaction of systems by spacing. These effects are presented in Table 2. The increase in yield with closer spacing was due to the increase in number of cormels and not to mean cormel weight. Unmarketable yields followed a similar trend to marketable yields, increasing with closer intra-row spacing.

Table 2. The effect of systems of cultivation and intra-row spacing on yields and yield components of Eddoe.

	Marketable		Unmarketable	
	Weight t ha^{-1}	Mean Weight /cormel	Weight t ha^{-1}	Mean Weight /cormel
15	27.07 (5.20)	95.56	5.74 (2.40)[1]	33.44
30	24.57 (4.96)	98.80	4.52 (2.13)	34.00
45	19.31 (4.39)	99.96	4.16 (2.04)	38.40
60	16.51 (4.06)	95.64	3.91 (1.98)	32.04
75	17.02 (4.13)	88.72	3.56 (1.89)	32.48
90	15.48 (3.93)	99.72	2.25 (1.50)	28.08
S.E.D.	0.24	NS	0.34	NS

[1] The data transformed using square root are in parentheses.

Gooding and Campbell (1961) reported increased yields for dasheen with high density. Yields of 60 t ha^{-1} for wetland production of ***Colocasia esculenta*** and with high density cultivation, 123 t ha^{-1} has been recorded under experimental conditions. Since there were no significant differences in yields from the present experiment among the systems of cultivation at constant fertilization rates of 0.8 t ha^{-1}, farmers should use the most convenient and cheapest method such as ranging or forkhole to conserve soil and water.

Technology Validation

The proposed technology (Technology II) showed higher marketable yields of 31.8 t ha^{-1} than the existing technology (Technology I) which

gave 17.4 t ha^{-1}. Table 4 shows a partial budget of the cost of production for one hectare of eddoes grown under the two systems. The agency in St. Vincent (The Caribbean Agricultural Trading Company CATCO through the Organization for Rural Development, ORD) responsible for extra regional export graded and sorted the produce into marketable and unmarketable grades.

Table 4. Partial budget for eddoe production comparing existing (I) and an improved technology operating costs of labour, materials and fertilizer.

Activity/ Description	Units	Unit Price ($EC)	Technological alternatives	
			I	II
Marketable yield	Tonnes (t)		17.4	31.8
(A) Gross benefit		$600 t-1	10.440	19.080
Operating cost				
Field preparation (Man day)		@20.00	2,740	1,200
Land clearing	"			
Pest/Weed control	"		320	320
Fertilizing	"		280	840
Weeding (Moulding)	"		920	920
Planting	"		460	860
Fertilizer	kg		600	1,800
Herbicide	l			
Planting Material	kg (saved from previous crop)	(Free)	(400)	(1,200)
Contingency			200	200
Transport			400	400
Interest				
Other			60	60
Harvesting Operations			1.500	2,400
Harvest, wash&grade	"		200	400
Transport to market	"		120	480
Total cost			7,800	9,980
Net benefit			2,640	9,100

All costs are in East Caribbean Dollar US $1.00 = $2.70

The Alternate Technology gave a higher net return per dollar invested for operating cost of labour, materials and for fertilizer of E.C. $1.10 compared to E.C.$0.34 for the existing system of cultivation. Productivity of the farm was increased giving higher profits for the farmer of E.C.$6,500.00. The alternate technology could increase production, farm incomes and save foreign exchange in fertilizer purchase by optimising usage. In addition, it might have implications for soil and water conservation.

Acknowledgements

The Author gratefully acknowledges the support and collaboration provided by the Caribbean Agricultural Research and Development Institute professional and support staff from St Vincent and other member states; the Ministry of Agriculture, Industry and Labour, Extension Services, St. Vincent and the Grenadines; The University of the West Indies, Extension department, St Augustine; The Organization for Rural Development; The National Farmers Union. Special gratitude is extended to cooperation of the farmers Nola Miller, Ivy Edwards and Elise Jessop for- volunteering their lands for this work. Special thanks are due to The United States Agency for International Development for funding this project.

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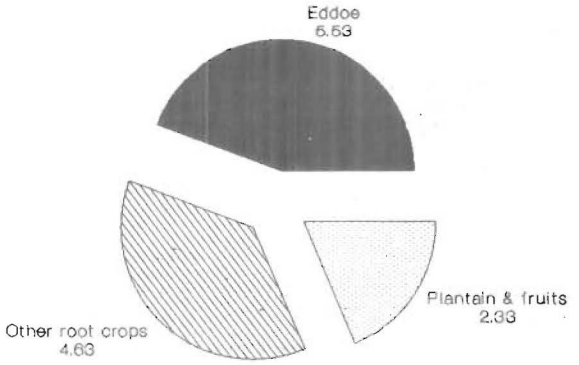
Figure 1 **Earnings from eddoe compared to non-banana agricultural exports for 1990**



Statistical Office, St Vincent, 1992.

Figure 2 **EDDOE EXPORT FROM ST VINCENT 1991 TARGET COUNTRIES (thousand tonnes)**

SOURCE: STATISTICAL OFFICE ST VINCENT 1992