

# Effects of no Tillage and Various Tillage Methods on Yields of Maize, Field Beans and Pepper Grown on a Mollisol in Southern Puerto Rico<sup>1</sup>

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## ABSTRACT

Corn, field beans and peppers were planted in a Mollisol at the Fortuna Research Center in 14 × 6 m plots that were either not plowed, plowed twice or plowed four times at 15 or 45 cm depths, the same day or every 7 days. There were no statistical differences in corn and field bean yields between plowed or non-tilled plots. A similar response pattern was observed when the same test crops were planted in the same plots without disturbing the soil (residual effect). However, peppers showed a positive response when planted in plots that were plowed 4 times at 45 cm depth once every 7 days. These results indicate that corn, field beans and even peppers can be grown without tillage under the conditions prevailing at the Fortuna Research Center.

## INTRODUCTION

In fiscal year 1981–82 the value of vegetables harvested in Puerto Rico amounted to \$18.9 million, whereas the value of the imported vegetables amounted to \$30.8 million (13). Therefore it is imperative that production levels be increased and that the traditionally high cost of production of these crops be reduced.

Since land preparation could account for 25% of total production costs and in view of current high costs of fuel and labor, it is necessary to carefully evaluate land preparation techniques (4, 6). Negative results of excessive tillage practices have also shown the need for innovation in regard to land preparation (5). The fact that tillage response varies with both crops and soils has been demonstrated by different researchers (1, 7, 9, 10, 15).

Recent experiments at the Isabela and Corozal Substations showed that taniens responded positively to tillage (9). However, soil management trials in the mountain region, with and without tillage, revealed that taniens yield equally well under both treatments (1). Plantain seems to respond in a similar fashion, that is, a significant yield increase was obtained when the soil was tilled at Corozal whereas no significant differences were obtained when plowed and non-plowed plots were compared in Humatas, Quebrada and Los Guineos soils (7). Vicente-Chandler et al. (15), working with tobacco, sugarcane, plantains, taniens, yams,

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corn, and beans grown in clay soils of the mountain region of Puerto Rico, obtained good yields with no-tillage techniques. They concluded that in soils with excellent structure and good drainage it is not necessary to till. Likewise Lal (8), who compared tillage versus no tillage with crops such as corn, soybeans, cassava, pigeon peas and chick peas in Nigeria, obtained the best results in nonplowed plots. Moschler et al. (11) in Virginia, Triplett and Van-Doren (14) in Ohio, and Blevins (3) in Kentucky obtained better corn yields when the soils were not tilled than when they were plowed conventionally.

Subsoiling trials in Puerto Rico have produced different responses according to the crops and soils used. However, a positive response generally has been associated with subsoiling and the use of fertilizers or lime applications (10, 12).

It is well known that the frequency and intensity of land preparation depends largely on soil properties such as texture, structure, type of clay minerals, and soil compaction as well as on the crop to be grown. It is necessary, then, to critically examine tillage practices such as depth and frequency of plowing on the soil types prevalent in Puerto Rico.

## MATERIALS AND METHODS

### 1979 EXPERIMENT

An experiment was established November 1979 at the Fortuna Research and Development Center in which plots of  $14 \times 6$  m were either plowed twice or four times at 15 and 45 cm depths. Some plots were plowed the same day, whereas other plots were plowed every 7 days. Conventionally plowed plots were plowed once, left undisturbed for 2 weeks and plowed again before planting. An undisturbed (no tillage) plot was used as a control. The test crops, corn (Pioneer brand hybrid  $\times$  304 C), peppers (cv. Blanco del País) and field beans (cv. Bonita) were planted in  $6 \times 4$  m sub-plots in a San Antón soil (Cumulic Haplustolls, fine-loamy, mixed, isohyperthermic) with a pH of 7.4 and a CEC of 25 meq/100 g of soil. The experimental design was a split-plot arrangement of randomized complete blocks, replicated four times, with land preparation methods assigned to main plots and test crops to subplots.

Corn and peppers were planted in rows 75 cm apart and 30 cm within the row; field beans were spaced 2.5 cm between plants and 75 cm between rows. Initially, all three crops were fertilized at a rate of 1,100 kg/ha of a 10-10-8 fertilizer. Corn was sidedressed with urea at a rate of 50 kg/ha at tasseling. Lasso (alachlor)<sup>3</sup> at a rate of 2.4 L/ha and Dacthal

<sup>3</sup> Trade names in this publication are used only to provide specific information. Mention of a trade name does not constitute a warranty of equipment or materials by the Agricultural Experiment Station of the University of Puerto Rico, nor is this mention a statement of preference over other equipment or materials.

80W at 11 kg/ha were used for corn and beans, respectively as preemergence herbicides. Insects and fungi were controlled with Diazinon AG 500 and Dithane M 45 at a rate of 1.25 l/ha and 2.5 kg/ha respectively, when needed. The experiment was overhead irrigated as needed.

At harvest a recording penetrometer with a cone area of 0.04 cm<sup>2</sup> was employed for resistance measurements in each plot. A soil sample from each plot was taken at the end of the experiment for moisture, pH, Ca, Mg, K and P analysis as well as for organic matter and particle size determination as described by Black (2).

### 1980-81 EXPERIMENTS

In November 1980, a second experiment was established at the same research site in which the same test crops (corn, field beans and peppers) were planted with varying tillage practices. The initial and residual effects of four soil treatments replicated four times were compared. A split-plot arrangement of randomized complete blocks was used. The soil treatments (main plots) were: undisturbed (no-tillage); plowed and harrowed 4 times at a 7-day interval and 45 cm depth; plowed and harrowed 4 times at a 7-day interval and 15 cm depth; and plowed conventionally. This experiment (initial) was harvested in the spring of 1981. In October 1981, the same crops were planted in the same plots without further land preparation in order to measure the residual effect. Cultural practices were followed as stated above for the 1979 experiment. The residual effect experiment was harvested February 1982. Yields and chemical and physical analyses of the soil were recorded and statistically analyzed.

## RESULTS AND DISCUSSION

### 1979 EXPERIMENT

Table 1 shows yield data for beans, corn and pepper as a function of different land preparation methods. There were no differences in bean and corn yields from plots plowed in different manners or left undisturbed (no tillage). These results are in partial agreement with observations by Vicente-Chandler (15), Lal (8), Moschler (11), and others (3, 14). These researchers obtained equal or better yields when the soils were not tilled as when the soils were plowed conventionally. The absence of response to tillage correlates well with no differences in the penetrometer resistance measurements, and chemical analysis among the plowed and not plowed plots as shown in table 2.

The response of peppers was somewhat similar to that of corn and beans, with the exception of the yield from plots plowed four times at 45 cm depth and at a 7 day interval, which yielded at a rate of 57,324 kg/ha, whereas the no-tillage plots yielded significantly less, 37,709 kg/ha. The 57,324 kg/ha yield was significantly higher than those from other

treatments. The pepper response is in agreement with data reported by Lugo and Badillo (9) with taniers (*Xanthosoma* spp.), an annual root crop. They obtained the highest yield when an Oxisol was plowed four times at a weekly interval. It appears that the longer the crop stays in the field the greater the sensitivity of the crop to the physical condition of the soil.

TABLE 1.—*Field beans, corn and pepper yields for the 1979 experiment as affected by land preparation methods*

Treatments	Yield		
	Field Beans	Corn	Peppers
	<i>kg/ha</i>		
1.—Undisturbed	2127 a <sup>1</sup>	5133 a	37709 a
2.—Conventionally plowed	2032 a	6199 a	46307 ab
3.—Plowed 2 times, same day, 15 cm depth	2127 a	5474 a	46301 ab
4.—Plowed 2 times, same day, 45 cm depth	2500 a	6275 a	39552 a
5.—Plowed 2 times, 7-day interval, 15 cm depth	2013 a	5701 a	41944 a
6.—Plowed 2 times, 7-day interval, 45 cm depth	2419 a	5227 a	46672 ab
7.—Plowed 4 times, same day, 15 cm depth	2089 a	5449 a	35328 a
8.—Plowed 4 times, same day, 45 cm depth	2216 a	4778 a	36445 a
9.—Plowed 4 times, 7-day interval, 15 cm depth	1983 a	5152 a	34369 a
10.—Plowed 4 times, 7-day interval, 45 cm depth	2229 a	6585 a	57324 b

<sup>1</sup> Means followed by the same letter do not differ statistically.

TABLE 2.—*A comparison of some physical and chemical properties among treatments for the 1980-81 (residual effect) experiments*

Treatments	pH	Organic matter	Resist- ance <sup>1</sup> to penetra- tion	Nutrients in the soil			
				Ca	Mg	P <sup>2</sup>	K
		%	<i>kg/cm</i>	<i>p/m</i>			
Undisturbed	7.48	1.82	9.60	2514	498	25	382
Plowed 4 times to 15 cm	7.54	1.72	9.57	2580	504	27	373
Plowed 4 times to 45 cm	7.70	1.77	7.29	2459	499	24	386
Conventionally plowed	7.36	1.74	7.30	2484	496	30	358
	NS <sup>3</sup>	NS	NS	NS	NS	NS	NS

<sup>1</sup> Average of 3 determinations per plot at 15 cm depth.

<sup>2</sup> Olsen method.

<sup>3</sup> Not significant at the 5% probability level.

### 1980-81 EXPERIMENTS

Table 3 shows corn, field beans and pepper yields for the initial (first crop) and residual effect (second crop) experiments. There were no significant differences among treatments in either experiment. However, it is evident that for the second pepper crop (residual effect experiment) the plowed plots outyielded the nontilled plots especially those plowed

four times to 45 cm depth. This is in agreement with the results of the first crop and the data for the 1979 experiment (table 1). The observed lack of response to tillage by corn and beans reflects the good physical condition of the San Antón soil, as evidenced by low penetrometer readings, its relative high fertility (table 2) and the fact that the soil was irrigated weekly.

The above results clearly indicated that corn, field beans and even peppers can be grown in soils similar to San Antón without tillage and without reducing yield. Less tillage may permit the commercial production of corn, field beans and peppers because of reduced production costs.

TABLE 3.—*Initial (1st. crop) and residual (2nd. crop) land preparation effect on corn, field bean and pepper yields for the 1980–81 experiments*

Treatments	Yield (kg/ha)					
	Corn		Beans		Peppers <sup>1</sup>	
	1st. Crop	2nd. Crop	1st. Crop	2nd. Crop	1st. Crop	2nd. Crop
Plowed 4 times to 15 cm	7463	9920	2998	2236	53,196	60,000
Plowed 4 times to 45 cm	7236	9301	3305	2372	61,014	66,000
Conventionally plowed	6249	9961	2992	2406	51,643	61,500
Undisturbed	7358	9985	2786	1967	48,341	37,800

<sup>1</sup> Yield calculated from per plant basis assuming 30,000 plants/ha.

### RESUMEN

Se estudió el efecto de la preparación del suelo sobre el rendimiento de maíz, habichuela y pimienta en un suelo Mollisol, de la serie San Antón. Se comparó el efecto de arar dos o cuatro veces a profundidades de 15 ó 45 cm el mismo día o cada 7 días. Se utilizaron parcelas sin arar como control. Se comprobó que cultivos de corta duración en el campo, como maíz y habichuela, pueden sembrarse en este suelo sin que tenga que ararse previamente. Por otro lado, los rendimientos máximos de pimienta se obtuvieron cuando el suelo se aró cuatro veces a intervalo de 7 días a 45 cm de profundidad.

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