Union Sugar Company's Random Stand Reduction to Predetermined Row Population

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California will probably harvest 80 to 85% of its sugar beet crop with machines in 1949. A 100% mechanical harvest with a higher yield in tons of beets and sugar than any hand harvest or combination of hand and machines and at less cost is possible. It could be an accomplished fact except for the vagaries of a small element of the human factor involved. The transition from a hand to a mechanical harvest has occurred over a period of about six years. Wartime labor shortages and productivity made this a dire necessity. The alternative was a serious detraction from the war effort and a huge financial loss.

Mechanization of the spring work has not been faced with the critical urgency which was the motivating factor in the harvesting of the sugar beet crop. The type of effort necessary to thin, hoe and weed was recruited among a labor force which was incapable of the hard physical labor that hand harvesting demands. A limited and often insufficient supply of hand labor has since been available. Segmented seed, light rates of seeding and partial mechanization have been stop gap practices toward spring mechanization. A field which could not be cared for properly could be worked over and replanted or planted to another crop without too serious a financial loss. A consistently good return from sugar beets afforded a cushion for a small increase in cost. As a consequence full mechanization of the spring work will probably not be with us as early as it would if the spur of necessity were applied as it was with the harvest.

The experience and facts recorded here have been gained and assembled in the coastal valleys and the Imperial valley of California. Much of it would apply to the great inland valleys, the Sacramento and the San Joaquin, but there are some differences such as method of planting and type and supply of field labor. In the coastal and Imperial valleys the planting is practically all ridge or bed planting. Two rows twelve to fourteen inches apart are planted on beds ridged up to thirty-eight to forty-two inch centers, leaving the rows of beets from twenty-six to thirty inches apart across a furrow from four to ten inches deep. This method of planting precludes any across the row[7] blocking, thinning or weeding operations with any of the present mechanical equipment. We are confined to down the row operations. Some good equipment for down the row blocking, thinning and weeding has appeared from many different sources and there has been some adaptation of equipment not specially designed for that purpose. Some of it is designed to do a part of the job followed by hand work and some equipment designed for follow-up operations. One type of equipment is

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intended to do a finished job, including subsequent hoeing. None of it has been accepted readily by the growers at this writing. The average grower still has *in* his mind a thinned stand of single plants eight, nine or ten inches apart as the case may be, with all the weeds removed, as a thinning job well done.

In trying to accomplish this end much experimental blocking has been done, that is, cutting out a section of row and leaving a section on certain centers. After five or six years of experiments there is still not a single grower who has adopted it as a regular practice. Many outstanding demonstrations have been made of the possibilities of blocking. Most notable was a field in which grower stated he wanted one hundred twenty beets per 100 feet of row. Several beds were blocked which showed an average of 135 beet-containing blocks per 100 feet of which 87 were singles. But it did not satisfy the grower. There are several reasons for this. Too often in blocking the tool seems to remove the largest and thriftiest plant with the weak one remaining and also removes the single beet which would fill a gap if left standing. Secondly, our plantings are in the winter and early spring with weeds a major factor. The cost of cleaning out the weeds and removing the multiples almost equals the cost of hand thinning. When the option of selection is taken away from the laborer by predetermined spacing efficiency seems to fall off tremendously.

During the thinning season of 1949 we attacked spring mechanization from the angle of stand reduction with equipment designed to obtain the same results as the bean or pencil weeder used across the row; also by blocking to extremely small blocks such as 1" cut 1" block. Milton, Eversman, Winpower and Dixie equipment was used. The Dixie beet thinner seemed best adapted to experimentation because different cutters could be built and bolted on the working head and variable speeds could be obtained by changing sprocket ratio between the driving wheels and the working head. A plate was made to bolt on the working head of the Dixie which embodied eight small cutting knives designed to make from a 1" to 1½" cut. A weeding head of side delivery rake teeth was built holding twelve teeth evenly spaced. Another was built consisting of four pairs of double rake teeth quartering on the circle. The latter proved impractical on account of difficult timing and its hopping and jerking performance.

It has been proven and is generally conceded that equal production of both tonnage and sucrose can be obtained from harvested stands of beets which exceed the conventional 100, 120 or 130, etc., per 100 feet of row. Stands in excess of this within reasonable bounds produce equal tons per acre and tend to produce more sucrose per acre. Our local University Extension Service has developed a rule over a period of years which sums up as follows:

> A soil type which will normally produce fifteen tons per acre will mature to marketable size (marketable size being considered beets larger than $1^1/_4$ inch diameter) one hundred fifty beets per 100' of row in twenty-inch rows. Progressing further, a soil which can be expected to produce twenty tons per acre will mature about 200 marketable beets per 100' of row and soils more fertile

will stand a slight increase above 200 beets per 100' of row. Any particular increase above these points does not produce any more marketable beets and if increased materially quickly results in less marketable beets. To further evaluate the above theory our farm advisor conducted population experiments in fifteen grower's fields in 1949. Two records were lost. The summary is the result of thirteen trials under regular field conditions using the grower's whole field and crop as a check. Trial records are based on a 100' length of row harvested by hand three different places in the plot. In harvesting the trial plots, beets 11/4" in diameter and less were discarded. Stand reduction was by machine, using various cuts and blocks as the situation seemed to justify to obtain an average of the aforementioned populations. Population per 100' after machine stand reduction varied from 160 to 422. Hand thinning check fields varied from 100 to 150.

A detailed tabulation is given in Table 1. The average result was as follows:

Beet Per 100' Row	Beets Harv. 100' Row		Yield Tons Per Acre		Sugar Cont. Percent		Sugar Per Acre	
Mach. Thin.	Mach. Thin.	Hand Thin.	Mach. Thin.	Hand Thin.	Mach. Thin.	Hand Thin.	Mach. Thin.	Hand Thin.
251	191	123	21.9	22.3	17.2	17.2	7,612	7,735

Of the thirteen trials two showed no significant difference. Five showed results in favor of machine thinning. Six showed results in favor of hand thinning. The difference i11/4" in diameter or less. These were discarded and not computed in total weights and averaged approximately 400 pounds per acre, tops included.

We conducted an experiment along the above lines thru the center of a fifty-five acre field. It comprised twelve beds 1,835 feet long. Four beds were planted by a John Deere No. 66 planter 11.6 cells per foot. Four were planted with the same planter 4.5 cells per foot and four were planted with a Planet Jr. unit attempting to plant ten pounds per acre. Very fine emergence was obtained from the John Deere planting but the Planet Jr. planting was too deep and emergence was very irregular. Only the very strong thrifty seedlings emerged together with some groups of seedlings which happened to be in a partially closed portion of the seed furrow or otherwise shallow spot of planting. It was a freak stand altho it appeared to be normal on a 100" count. The field was judged capable of producing twenty-five tons per acre and we were attempting to leave from 250 to 300 beets per 100' of row. This grower was high-population minded and his thinning averaged 158 beets per 100' of row and the yield for the whole field averaged 27.68 tons per acre, 18.1 sugar. The trials yielded less than the check. The difference in tons per acre was 1.31 for J. D. 11.6 cells per ft.; 2.05 for 4.5 cells per ft. and 4.14 tons less for the Planet Jr. planting. The average was 2.5 tons per acre less than the grower's field. All of the

Table 1.—Results of Machine Thinned Versus Hand Thinned Sugar Beets, 1949 Season[1]

	1	2	3	4	5	6	7	8	9	10	11
	Beets 100 ft. Row After	Beets Harvested 100 ft. Row		Yield Tons per Acre		Percent Sugar		Sugar per Acre		Plus or Minus Yield	
	Machine Thinning	Machine Thinned	Hand Thinned	Machine Thinned	Hand Thinned	Machine Thinned	Hand Thinned	Machine Thinned	Hand Thinned	Compared to Hand Thinned	Comments
1	185	150	97	21.45	21.82	20.6	20.4	8,837	8,902	Same	
2	231	175	129	15.47	14.95	19.6	20.0	6,033	5,980	+	Nematode
3	230	146	108	8.58	9.42	20.1	19.85	3,603	3,738	Same	Nematode
4	308	214	132	18.85	23.33	16.58	15.83	6,215	7,386	—	Soil compacted by machine
5	368	308	124	28.8	28.8	18.00	17.3	10,576	10,165	+	
6	160	151	126	24.0	25.8	16.37	17.1	7,853	8,825	—	Poor stands
7	170	129	126	17.94	19.4	17.1	17.83	6,135	6,860	—	
8	235	196	120	32.51	30.0	17.9	17.66	11,642	10,596	+	Check—field ave. Test double fert'd.
9	272	202	118	15.19	16.71	14.96	13.2	4,622	5,079	—	Sand; lack of moisture
10	214	178	114	26.78	23.40	15.2	14.65	8,141	6,856	+	
11	422	247	140	25.58	25.81	15.6	15.59	8,772	9,596	—	Check—field ave.
12	225	201	146	29.51	26.78	16.3	16.6	9,620	8,890	+	
13				22.6	24.5	15.3	15.7	6,915	7,693	—	
Average	251	191	123	21.9	22.3	17.2	17.2	7,612	7,735	2 — no significant diff.	
										5 — favor of machine t	
										6 — favor of hand thin	

[x]The difierence between the number of beets after thinning (column 1) and beets harvested (column 2) represents beets not harvestable under *Wi* inches in diameter. These were discarded and not computed in total weights. The total weight per acre of such beets averaged approximately 400 lbs. per acre.

Table 2.—Result of Machine Thinned Versus Hand Thinned Sugar Beets, 1949 Season.

[1]Pre-Thinning Stand Per 100" Rule					[2] Harvest Count per 100'					Yield per Acre Clean Weight		
Total Beets	Beet Inches	Singles	Doubles	Multiples	Total Beets	Marketable Beets	Singles	Doubles	Within Multiples	Tons	% Sugar	Pounds Sugar
John Deere No. 66 Planting 11.6 Cells per Foot												
67.6	37.6	20.5	9.1	8.0	418.5	197.6	53.6	53.6	90.3	25.37	18.3	9,651
John Deere No. 66 4.5 Cells per Foot												
26.4	16.0	8.6	5.2	2.2	237.5	121.6	60.0	29.3	32.3	25.63	18.2	9,329
Planet Jr. Planting—10 lb. per Acre												
38.4	25.4	17.2	5.8	2.4	239.6	98.5	22.5	22.2	53.8	23.54	18.9	8,898
Total and Averages												
132.4	79.0	46.3	20.1	12.6	895.6	417.7	136.1	105.1	176.4	75.54	55.4	27,878
44.13	[3]26.33	15.43	6.7	4.2	298.53	139.2	45.4	35.0	58.8	25.18	18.46	9,293
						Grower 55 Ac. Field Check Hand Thinned				27.68	18.1	10,020
						Difference Favor Hand Thinning				2.50-		722
						Value Difference at $6.50 Net				$29.02		
						Grower Thinning Cost				34.21	Trial	8.24
						Grower First Hoeing				19.89	Trial	7.06
						Totals				54.10		15.30
						Difference in Cost in Favor of Trial					38.80	

[1] All counts are an average of six. [2] Harvest count not by conventional 100" method. A *single* was a marketable beet standing alone; *Doubles*, only-two in a group; *Among Multiples*, a marketable beet or beets among groups of three or more non-marketable beets. [3] It should be noted that although the grower's field exceeded the mechanically thinned trial plot by 2.50 tons per acre, the grower's cost for thinning and weeding exceeded the trial by $38.80 per acre, which was more than the value of the increased production.

beets were harvested by the grower with a Marbeet harvester and were handled, hauled, sampled and tared in the same manner.

A detailed tabulation is given in Table 2. Average results follow:

Yield Per Acre									
Total Beets		Marketable Beets + $1^{1}/_{4}$" Dia.		Tons Clean Wt.		Percent Sugar		Pounds Sugar	
Trial	Check	Trial	Check	Trial	Check	Trial	Check	Trial	Check
298.5	158	139.2	148	25.18	27.68	18.5	18.1	9,293	10,020

In studying the detailed statistics it was noted that the Planet Jr. planting showed a much higher proportion of marketable beets among multiple groups. These were necessarily smaller beets than singles or doubles. This planting could not be reduced too severely without getting too low a population. The difference in yield in our judgment was due to poor distribution. If the Planet Jr. record were eliminated the other plantings would average 1.68 tons less than the grower's field. There was a remarkable difference in the weed crop between the hand and machine-thinned in favor of the machine-thinned at the first hoeing. No counts were made but it was judged that there were only ten percent as many weeds at first hoeing in machine-thinned beets as compared with hand-thinned.

In summarizing we realize that we did not have sufficient replications to establish any fixed conclusions but we believe we are pioneering a field which merits further study. This principle may find better acceptance by growers because it attacks both thinning and weeding mechanically.

We believe we have learned that a sugar beet crop can be produced by mechanical thinning only which will compare in net returns to a hand-thinned crop. We believe that the stand reduction principle and the use of small cuts and small blocks is superior to wide cuts and blocking, but a good full stand well distributed in the row is essential in obtaining a successful result. The better the stand to start with the more severe the work on the row may be. The more work on the row to reduce to a predetermined population the better the distribution of beets left for harvest and the fewer the weeds.