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INTERCROPPING OF YOUNG IRRIGATED ORCHARDS

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More California orchards were intercropped during 1917 than ever before. The desire to produce more actual food during the present war emergency, and the added desire to share in the prevailing high prices contributed to this result. An exhaustive survey, made through the agencies of the various marketing associations, the County Horticultural Commissioners, and Farm Advisors, indicates that where normally only about 25 per cent of the irrigated orchards under six years of age are intercropped; this year, 1917, at least 45 per cent have been so handled. Going more into detail, the percentage of orchards, three years old and under, intercropped has increased from 33 per cent to 50 per cent, while the percentage of intercropped orchards from three to six years of age has increased from 20 per cent to 40 per cent.

The survey indicates that out of some 77,000 orchard acres of young citrus in southern California 30,000 acres have been planted to beans, 3000 to grain sorghums, 1000 to corn, 2000 to potatoes, and one or two thousand to miscellaneous crops. About the same percentage holds for the irrigated deciduous orchards of southern California and very nearly the same ratio of crops used. In the San Joaquin Valley the amount of intercropping is not so large and grain sorghums occupy almost an equal place with beans.

This paper is based on a field study of, first, the results obtained with the increase in intercropping, and second, the possibilities of even further extension in the future. Young orchards only are considered. The intercropping of bearing orchards is a practice which has been dismissed in the past as being both agriculturally unsound and

financially unprofitable, under the ordinary California orchard conditions. The evidence seems conclusive that there is nothing in the present situation to justify a change in this general attitude.

The intercropping of unirrigated orchards is too hazardous for consideration, both agriculturally and financially, except in a few locations where the minimum rainfall is sufficient to insure satisfaction to both crops.

ECONOMIC ADVANTAGES

The man who is intercropping an irrigated orchard has certain very definite economic advantages over the man who is raising a crop in an open field; namely:

1. The orchard pays the land rental charges including interest and taxes; the intercrop does not have to meet that expense.

2. The usual practice in irrigated orchards that are not intercropped is to work up the land thoroughly in the spring and keep it cultivated during the summer; thus the intercrop need not pay the expense of preparing the land for planting.

3. The arrangement of many irrigation projects provides for the delivery of sufficient water to support full bearing orchard trees; there is no saving in cash payments for water in certain cases if less than the total amount is used; it takes no more water to care for young trees and an intercrop than it does for full bearing trees; therefore, in these cases the water for irrigating the intercrop is not properly chargeable to that crop.

4. Very often orchardists have unused time of both themselves and their teams, which can be turned to good service in the planting and care of the intercrop; in which case the entire labor cost is not properly chargeable to the intercrop.

In other words, the additional expenditures connected with intercropping orchards, are mainly reduced to the cost of seed, a possible slight charge for cultivation during the growing season, the harvesting costs and, sometimes, a charge for additional water.

LIMITING FACTORS

On the other hand, intercropping is by no means a "get rich quick" scheme. Success with intercropping depends upon how and under what conditions it is done. No crop, whether an intercrop or one in the open field, can be better than that allowed by the weakest of several factors necessary to its production, namely: the farmer; the soil; the climate; the moisture supply. The first requirement,

therefore, is to choose that crop which the farmer himself knows something about. As a secondary consideration, this crop must be adapted to the soil and climatic conditions under which he is working; and an abundant moisture supply both for the intercrop and the trees must be assured. An off season may even then result in partial or total crop loss.

The point which most often leads to failure with intercropping is the fact that the grower overlooks the necessity of caring for each of the two crops just as religiously as though it were growing alone. If this is not done, one or the other crop is sure to suffer.

Certain crops, particularly the cereals, are notably hard in their effects on soil productivity. When they are used as intercrops, therefore, more than the usual amends must be made. With grain hays the soil is frequently allowed to become excessively dry just at the time of ripening of the hay. Orchards are very apt to suffer because of this factor. Grain stubble left standing in the field during the hot weather of early summer is liable to cause severe sunburning of orchard trees, apparently through the intense heat reflected, as well as because of excessive drying out of the soil.

Harvesting of various crops is apt to interfere with orchard work, both in point of time and by enforced tramping of wet ground.

At present the market will hardly be a limiting factor except in case of less than car lots of perishables. Non-perishables and car lot shipments can always be disposed of at better than pre-war prices.

IMPORTANT CONSIDERATIONS

There are three especially important considerations in the intercropping of young orchards; namely:

1. The maintenance of the productive condition of the soil;
2. The financial returns from the crop;
3. The distribution of labor between the orchard work and the intercrop.

MAINTENANCE OF THE PRODUCTIVE CONDITION OF THE SOIL

In considering these points it is necessary to keep in mind the fact that all of our semi-arid irrigated land is confronted by the very serious problem of maintaining the organic matter of soils. Just at present, there is a rapid decrease in the available supply of barnyard manure, and also a growing tendency on the part of bean growers to utilize bean straw directly on their own land. The value of alfalfa hay and even cereal straw for feeding purposes is so high now as to

be almost prohibitive for soil improvement purposes. Therefore, it seems particularly desirable that leguminous green manure crops be used in all orchards. In other words, intercropping should not interfere with the common practice of raising a winter green manure crop which may be plowed under in the early spring. Summer green manure crops may occasionally be substituted in cases where winter crops such as cabbage are distinctly the most profitable cash crops which could be grown on the land. Ample water for the summer green manure crop would need to be assured in such cases.

The organic matter problem immediately suggests the possibility of growing a strip of alfalfa between the young trees for a period of years, a part of which may be used for soil improvement around the trees. This is entirely feasible on well drained soils where ample water is available. Ample water in this conection will usually mean irrigation once every two weeks through the growing season, with a total of at least 50 per cent more water than would be used on the same soil for the trees and an intercrop of beans. Trees growing on heavy, poorly drained soil have frequently shown injury from the large applications of water used on the alfalfa and therefore, great caution must be exercised with this combination planting.

Beans, corn, sorghum, potatoes, and many of the short seasoned vegetable crops may be raised during the summer without interfering with winter green manuring.

The immediate effect of intercropping on the growth and appearance of orchard trees may be taken as indicative of the effect on soil conditions. This effect may appear as an actual improvement in the trees, showing that the practice need in no way interfere with the yield or development of the orchard, provided the proper crop and the proper system of management are undertaken. Out of several hundred inquiries, no one was found who felt that beans, for instance, injured young trees when grown as an intercrop. Several felt that they would not plant beans, particularly in the San Joaquin Valley, because they felt there was too small a margin of profit in the undertaking, not because of interference with tree growth. In fact the experience of years in commercial bean growing in California indicates that the soil is not noticeably injured for a long period of time, particularly if the bean straw is returned to the soil and many growers feel that the land is actually improved by the cultural methods necessary for good bean production.

Numerous instances were found where other crops than beans showed an immediate effect upon tree appearance and growth. A

study of such cases indicates three principal factors contributing to this effect; namely, competition for nitrogen; competition for moisture; and puddling of the soil. The evidence seems perfectly clear that the first two of these factors can be overcome by avoiding planting too close to the trees and by maintaining an ample moisture supply in the uncropped strip near the trees. The exact distance at which it is safe to plant cannot be given. Local experience and the best judgment of the farmer must dictate that. Give the benefit to the tree rather than to the intercrop, when in doubt. The third factor may be avoided by not planting crops which require tramping of the ground when it is wet.

FINANCIAL RETURNS

It is impossible to discuss the question of cash returns without presupposing a definite yield. The yield will vary with the condition under which the crop is grown. For certain sections of the state, potatoes will give the largest cash return, while in other cases it will be beans and in a few cases, corn or grain sorghum. It is even more difficult to consider the cash returns that might come from vegetable growing, because in that particular case the skill of the farmer is of importance out of all proportion to any other factor.

A few illustrations may be taken from this year's experience with intercropping of young orchards which will indicate the possibilities. A certain farmer in the Yucaipa Valley who was an experienced potato grower intercropped a considerable acreage of young apple orchards with potatoes. He had one-half to three-eighths of the land in potatoes, thus leaving a considerable strip along the tree rows as a protection against injury to the trees. He harvested an average of 110 sacks per orchard acre, which he sold at $3.00 a sack. His extra water cost was $1.00 per acre. His only other extra costs were seeding, cultivation of the potatoes and the harvesting, which were, of course, not higher than similar costs would be on open ground. A certain farmer in the cabbage section in Orange County grew last winter five tons of winter cabbage to the orchard acre. Following the harvesting of the cabbage, he planted Black Eye beans in late June and harvested twelve sacks per orchard acre. His gross returns were approximately $150 per acre. The owner of a young walnut orchard in Ventura County has for the past two years raised 3000 pounds of Henderson bush limas per orchard acre. This year he sold his beans for 12c a pound, or a gross return of $360 per orchard acre. A walnut grower

in El Monte turned under a green manure crop in February, 1917. In June, he harvested seventy-five sacks of potatoes and in October he threshed twelve sacks of Black Eye beans to the orchard acre. Total gross returns about $260 per acre. In a two-year-old citrus orchard near Santa Ana, the owner raised sweet potatoes which he sold for $400 per orchard acre yield. These followed a winter green manure crop, but they were matured early so as to take advantage of high prices. These are, of course, the results obtained by particularly good farmers working under favorable conditions.

A summary of the records of yields of intercropped citrus land, covering several hundred individual instances, shows that one should expect from an orchard acre of three-year-old trees or younger, 60 per cent of the yield which he would get from an open field acre under like soil and climatic conditions, and 50 per cent of a normal open field yield in orchards from four to six years of age, inclusive. Walnut groves will do better than this because of the great distance between the slow growing trees. A 50 per cent yield may often be obtained in a ten-year-old orchard where the trees are sixty feet apart. Plantings in apricot orchards, on the other hand, will not do so well as those in citrus. In fact, intercropping probably will not be profitable after the apricot trees are four years old.

RESULTS AT CITRUS EXPERIMENT STATION FARM

The following statement of the results with intercropping sixty acres of the Citrus Experiment Station property at Riverside with Black Eye beans many be taken as typical of what may be accomplished even when conditions are below normal to begin with.

The land in question had been cropped to grain hay for many years. So far as known, it had never been planted to any other crop prior to this year, nor had it ever been irrigated. In 1915, one ton of oats per acre was harvested from a part of the tract, the remainder being untilled that season. Following this crop, all the land was deeply plowed and nothing was planted during 1916.

The property was planted to citrus trees during the months of May and June, 1917, with the trees placed 20 × 24 feet apart. A narrow strip of land in the tree row was plowed at the time of planting. The rest of the ground was unworked until preparation for bean planting was commenced.

For bean growing, the land was double-disced with tractor and 12-inch disc two ways and harrowed; four and one-half acre inches of water was applied in furrows fourteen inches apart; the land was double-disced again and seed planted. The seed was planted with bean planter, rows being thirty-six inches apart, with six rows between the trees, occupying three-fourths of the ground. The dates of planting were from June 7 to 26.

Two irrigations were necessary after planting, one, July 23, and one, August 15. Cultivation was done with a modified Planet Jr. cultivator, having two sweeps to the row and cultivating two rows at a time.

In addition to the beans, a single row of dwarf milo was grown in the tree rows. The heads have been harvested and the stalks used to tie up the trees as a prevention of frost injury during the winter. The grain produced will easily pay for the cost of growing the sorghum and tieing the trees

COST OF RAISING CROP OF BLACK EYE BEANS AT CITRUS EXPERIMENT STATION, 1917

		Orchard acre ($\frac{3}{4}$ of an acre)	Full acre
Preparing Land			
Double-disced and harrowed two ways (tractor)		$ .68	$ .90
Seed			
18 pounds @ 12½c		2.25	3.00
Planting			
Two row bean planter		.27	.36
Irrigations			
4½ acre inches—one full acre @ 30c per acre inch	$1.35		
Labor of irrigating	.37		
Cost of one irrigation, per acre	$1.72		
Total of three irrigations, one before and two after planting		3.87	5.16
Cultivation			
Furrowing for irrigations (three), 32c per acre		.96	1.26
Cultivations (three) @ 36c		1.08	1.44
Hoeing			
One hoeing @ 10c		.08	.10
Cutting			
Twelve orchard acres per day, one man, two horses, $4.00		.33	.44
Bunching Beans			
Three men, twelve acres per day, @ $7.50		.63	.84
Hauling to stack		.80	1.07
Feeding from stack to thresher		.31	.41
Threshing			
7½ sacks per acre @ 35c per sack		2.63	3.51
Cleaning charges			
New sacks and stencilling, 7½ sacks per acre @ 15c per sack		1.12	1.50
Cleaning @ 11c per 100 lbs.—595 lbs		.65	.87

	Orchard acre (¾ of an acre)	Full acre
Freight to cleaning house		
595 lbs. @ $2.15 per ton	.07	.09
Total cost	$15.73	$20.95
Credit, 540 lbs. beans @ 8½c	45.90	61.20
19 lbs. split beans @ 1½	.29	.39
	$46.19	$61.59
Less cost	15.73	20.95
Net profit	$30.46	$40.64

The only orchard costs for the period June 7 to September 17, not charged directly to the bean crop, were as follows:

Water for the trees, 8 acre inches @ 30c	$2.40
Cultivation for trees, including furrowing out, one horse work	1.65
Total per acre	$4.05

It should be borne in mind that had these beans sold for 4c (a good pre-war price for Black Eye beans) the gross returns would have been only $21.60, and the net profit $5.87. Even this would have paid all the other orchard costs for the summer and left $1.87 per orchard acre as a margin of net profit. On the other hand, the cost of $4.05 per acre, charged against the trees might have been increased somewhat had the grove been clean cultivated.

ADJUSTMENT OF LABOR REQUIREMENTS

Choice of intercrops should be made with due consideration to the labor requirements of both the orchard and the intercrop. For instance, the planting of the intercrop should be so planned that the supply of man and horse power at hand may be turned directly from the rush of spring orchard work to the preparation of land and planting. Similarly, the time for harvesting the intercrop should be planned to avoid the stress of fruit harvest so far as possible. Much of the work connected with the intercrop may be handled by the regular labor supply in time which might not otherwise be gainfully employed, unless such coördination is worked out. Black Eye beans may be planted, in the interior localities at least, any time from the middle of May to the first of July, with every reason to expect a satisfactory harvest. The time of maturing in the interior is about ninety days on the average. The following table gives the planting and harvesting dates of Black Eye beans on the Citrus Experiment Station farm at Riverside, 1917 season.

Effect of Different Dates of Planting on Growing Days of Black Eye Beans

Planting date	Cutting date	Days growing	First irrigation	Dates irrigated
May 12–14	Aug. 20	100	Early in July	----------
June 7–8	Sept. 3	88	July 25–28	Aug. 15, 16
June 22	Sept. 16	86	July 23–28	Aug. 22–24
June 26	Sept. 19	85	July 29	Aug. 27
June 28	Sept. 21	85	Aug. 1–2	Aug. 30–31
July 10	Oct. 2	84	Aug. 10	Sept. 5
July 19	Oct. 9	82	Aug. 3	

Average of season's planting, 87 days.

Potatoes, if planted for the spring crop, should be in the ground before the 10th of March, and may then be harvested by the middle of June. This means a rush of work following the turning under of the cover crop. Fall potatoes are apt to compete in point of time with the proper planting of a winter cover crop following their harvest.

DISCUSSION OF CROPS

As mentioned in the introduction, beans, grain sorghum and potatoes have been the principal intercrops used during the past season, with beans easily the favorite. Some of the advantages and requirements of these crops have been mentioned in illustration of various points relative to intercropping. The reason for the predominance of beans may be summed up briefly as follows: they are not hard on the soil and may even be a benefit to the orchard; the water requirements are easily met without interference with orchard irrigation; the product is non-perishable, of high food value, and can be shipped anywhere; varieties may be found adapted to almost every condition and the cultural requirements are, in general, well understood.

Spring potatoes follow a winter cover crop admirably, provided the labor requirements can be adjusted. Usually no extra water is required for this crop, beyond what would normally be used for the orchard. As an illustration, American Wonder potatoes were planted on the Citrus Experiment Station farm at Riverside in late February, following the plowing down of a Melilotus crop. They were irrigated twice and harvested in June, yielding 125 sacks per solid acre. A crop of early amber sorghum followed the potatoes and was harvested for hay to make way for another winter crop of Melilotus. Fall potatoes, on the other hand, require irrigation at least once every two weeks for the first six weeks after planting.

Grain sorghums give good promise in the interior sections, although they are not of equal cash value per acre to either beans or potatoes. The labor requirements are relatively low, but the growing season is long compared to that for Black Eye beans.

MISCELLANEOUS CROPS

There are certain other crops which are occasionally used as intercrops. A few of these will be briefly mentioned.

Tomatoes are desirable if the marketing facilities are good. Frequently, however, unless there is a cannery to absorb the surplus, the market conditions are such that no profit is realized from this crop. There is the injurious factor with tomatoes of constantly tramping the ground during the picking.

Cantaloupes may be raised, but in most cases it is impossible to compete with the Imperial Valley and the Fresno cantaloupe sections.

Casabas give a fair market return but are very frequently ruined by aphis.

Winter peas if grown for the December trade are always at a premium price. They have a very high labor requirement at the time of picking. This, however, comes at a time when orchard labor requirements are relatively low. There is the disadvantage with this crop of tramping the ground while it is wet during the picking season. There is the advantage that the vines themselves form the winter green manure crop following the harvesting of the pods. The growing of peas for the canneries is not a feasible proposition except where canneries are equipped for handling peas through the viner method. Peas are subject to attacks of aphis and damage by mildew.

Sweet potatoes fit in nicely with orchard requirements where the soil is adapted to sweet potato culture. This is one of the most profitable crops in the whole list of annuals in California, but it is adapted to a comparatively small range of soil conditions. Sweet potatoes are difficult to keep in storage.

Vegetable growing is a specialized art and only those familiar with it are apt to succeed. Market conditions are often uncertain although some things may be sold on contract in advance of growing. This applies particularly to such crops as spinach, peppers, and tomatoes for the canners. The opinion of one very practical orchardist on this point of vegetable growing is quoted as follows: "The list of possible vegetables is produced by the regular gardeners to the

extent of barely remunerative prices. The average man, unskilled in the growing of these things, working with conditions not the best, I fear, would discredit the whole thing. Satisfactory crops of vegetables as a rule need enriched soil all to themselves. It seems that the constant going over the land with irrigation and tramping over it gathering vegetables, does not leave the land in good physical condition."

SUMMARY

Remember, in intercropping, that two crops are being raised and that each one needs the same sort of attention as if it were growing separately.

Rely on the most successful general farming practice of the community for choice of crops and cultural methods. Crops which are not successful in open field farming in the district will be failures as intercrops.

Arrange for the upkeep of the organic matter content of the soil through the use of legumes to be turned under and the use of other forms of organic matter.

Avoid crops which necessitate tramping of wet ground or which call for excessive irrigations.

Plant orchards to beans (unless some other crop is definitely better adapted) wherever there is a reasonable expectation that the crop will pay for the *additional expenditures.*

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