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WATER-HARVESTING AGRISYSTEM TO GROW JOJOBA ON DEVELOPED IDLE FARMLANDS

by

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and

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INTRODUCTION

A water-harvesting agrisystem to rehabilitate abandoned farmlands in the arid Southwest has been developed by the University of Arizona Office of Arid Lands Studies (OALS) and the Water Resources Research Center (WRRC).

For descriptive purposes the agrisystem has been applied to Avra Valley idle farmland conditons with jojoba as the cash crop and vegetative dust control. Jojoba, Simmondsia chinensis, is a shrub native to the Sonoran Desert and requires little water once it is established. It bears a bean containing a liquid wax with chemical properties similar to oil derived from the sperm whale, an endangered species. Liquid wax extracted from jojoba beans can be used in hair oil, shampoo, machinery lubricants, paper coatings, and de-foaming agents in manufacturing pharmaceuticals. In its solid, or hydrogenated, form jojoba wax substitutes for beeswax and the expensive carnauba wax.

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The system is designed to operate without groundwater, which is being overdrafted in most Arizona basins. Groundwater is the principal source of irrigation water and of ever-increasing municipal water demands in Arizona. As a result of these escalating demands, water tables are dropping rapidly. Central Arizona Project waters and reuse of treated municipal waste waters will reduce, but not eliminate, the need to shift water from agricultural uses to muncipal uses as the State population continues to grow.

The Tucson area is entirely dependent on groundwater. About 11,000 acres of previously irrigated farmlands in Avra Valley, west of the Tucson Mountains, have been purchased and retired from use by the City of Tucson to secure water rights. Retired or abandoned farmlands present several problems which must be resolved.

Semiarid fragile ecosystems such as those in Avra Valley present serious rehabilitation challenges once they have been disturbed and abandoned. These lands do not revert to aesthetically pleasing desert growth without considerable passage of time, if at all, and weeds and dust become problems. Usually the dominant new growth is tumbleweed, *Salsola kali*, which has no proven economic value and is troublesome. Range grasses are established with difficulty in relatively low annual rainfall regions (11 inches or less) where evapotranspiration is relatively high. Studies indicate these grasses do not survive prolonged drought without auxiliary water, even after being established.

Sufficient commercial demand for jojoba products is developing to support establishing sizable plantations of the shrub. Maximum jojoba bean production can be maintained using harvested water from natural precipitation which offers a commercially viable solution for rehabilitating the 11,000 acres of abandoned farmland without use of groundwater.

THE SYSTEM

The water-harvesting agrisystem for growing jojoba on abandoned farmland was developed by WRRC in cooperation with personnel from the University of Arizona College of Agriculture Department of Soils, Water and Engineering, and Plant Sciences. OALS has practical experience in raising jojoba and WRRC has experience in designing and constructing the Compacted Earth Sodium Treated (CEST) water-harvesting and the compartmented-reservoir systems.

Field establishment of the system assumes availability of 40 acres in the Avra Valley area where there is existing but unused "pumpback" capacity to recharge the reservoir with rainwater harvested by the CEST.

A road grader could shape abandoned farmland into the intial ridge and runoff configuration shown in Figure 1. The ridged area is treated with common table salt, sodium chloride, to increase runoff and reduce weed and dust control costs. The drainage would be reshaped to form a double drainage after three or four years to

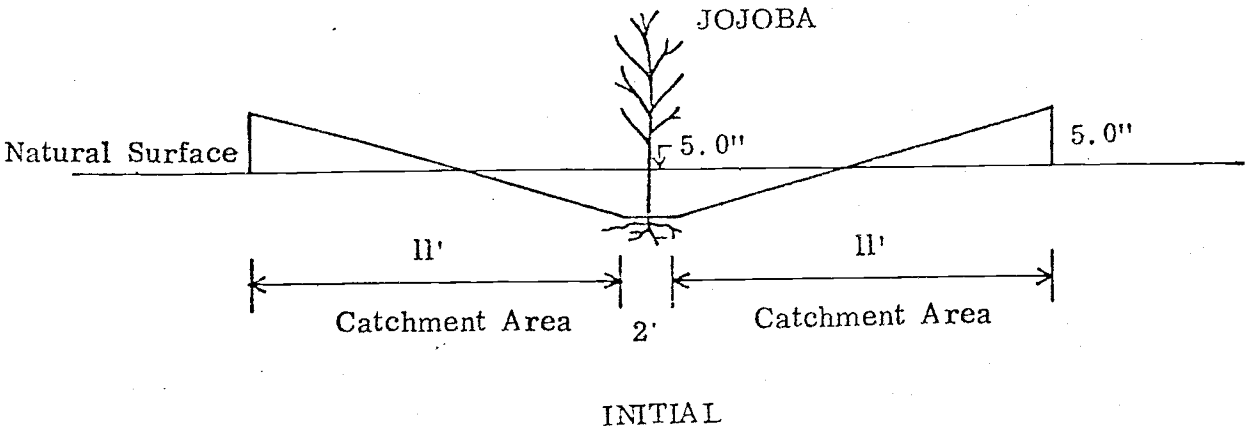
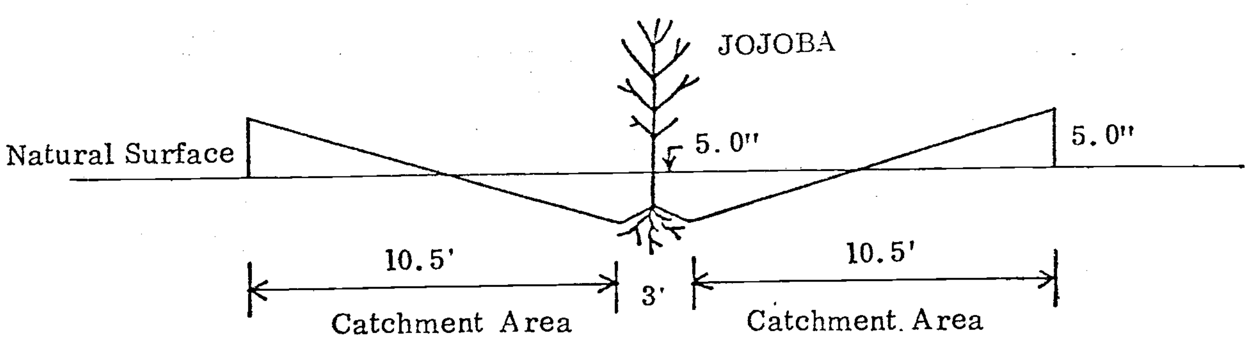

JOJOBA
Natural Surface
5.0"
5.0"
11'
11'
Catchment Area
2'
Catchment Area
INITIAL

Figure 1

increase infiltration area as plants grow and extend roots (See Figure 2). Rainwater would run from the ridged portion into adjacent drainages planted with jojoba (See Figure 3). Excess runoff would be collected and pumped to the compartmented reservoir for plant use as needed to maintain peak production during prolonged periods of scant precipitation and during winter months. A compartmented reservoir is proposed to reduce evaporation losses (Cluff, 1977). A reservoir is compartmented and water concentrated by pumping from one compartment to another to reduce the surface area. This method has been shown to reduce evaporation up to 45 percent. The use of the pump makes it possible to go to deeper above-ground compartments. When this is combined with the compartmented method savings can approach 80 percent (Cluff, 1978). It is proposed that each catchment would be 20 to 24 feet wide to provide sufficient runoff and adequate space for moving cultivating and harvesting equipment in the rows.

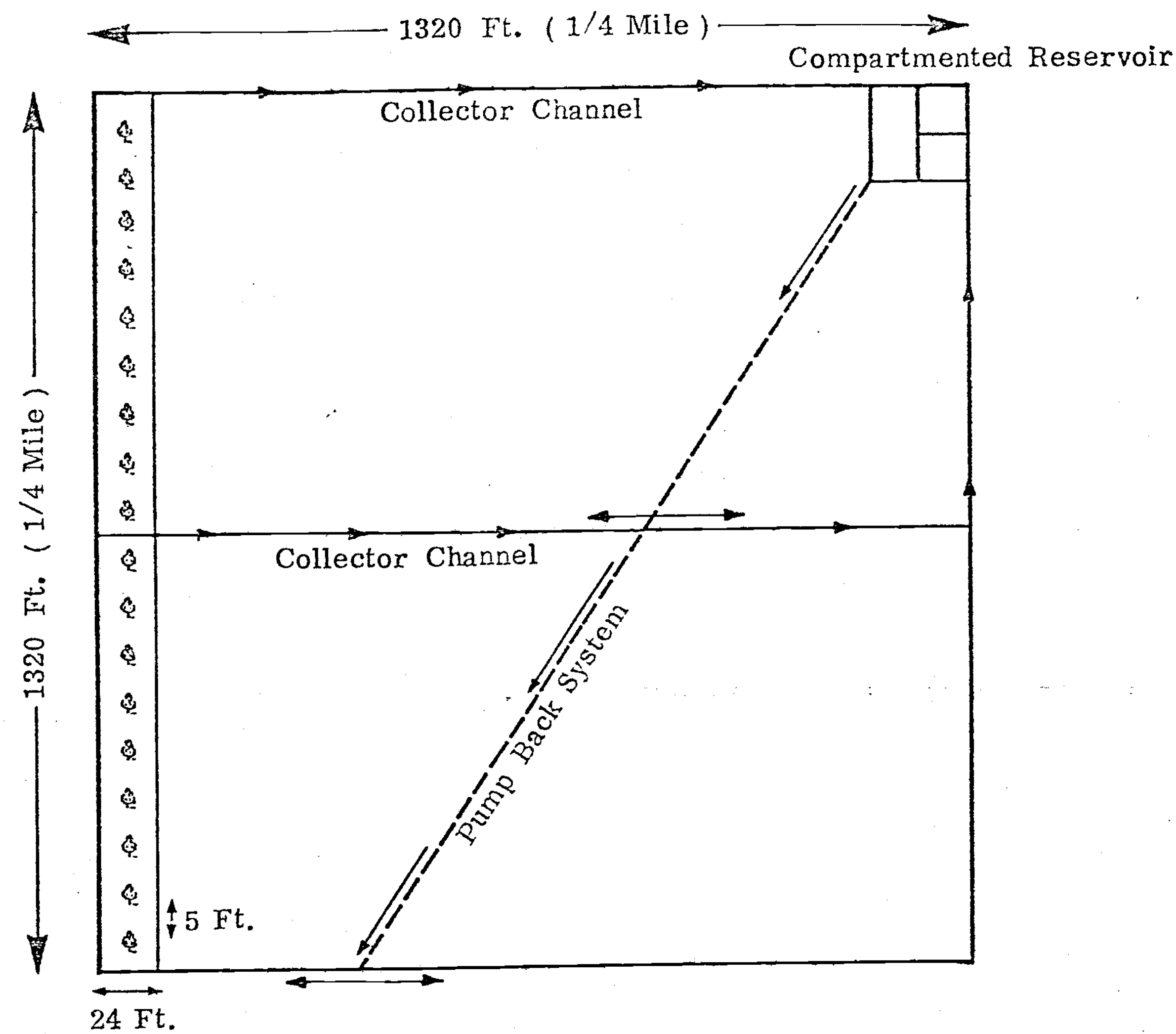
The runoff efficiency of the CEST catchment is about 50 to 60 percent, thereby greatly increasing water availability to the plants. This means that water available to the plants in Avra Valley would increase from about 11 inches annually to about 16.5 inches. Even more important, water harvesting with surface storage would provide water to plants during the December-April period to maximize bean production.

Soil salt treatment will not degrade runoff water quality significantly, as illustrated at Page Ranch where a one-acre system



FINAL

Figure 2



1320 Ft. (1/4 Mile)
Compartmented Reservoir
Collector Channel
1320 Ft. (1/4 Mile)
Collector Channel
Pump Back System
5 Ft.
24 Ft.

Figure 3

has been used for the past several years to grow grapes (See Figure 4. Note the difference between the untested area in the foreground and the salt-treated catchment). In addition, the salt-treated catchment was one of three treatments used on an acre water-harvesting agrisystem for growing jojoba at Sells, Arizona (See Figure 5). Jojoba growth in the salt-treated catchment has been more vigorous than in those treated with Asphalt Plastic Asphalt Chipcoated or wax.

Five tons of salt per acre would be applied. This amount would not exceed the total dissolved solids in five acre-feet of treated municipal sewage effluent. Salt use would not prevent the treated land from being used for other purposes at a later time; the land can be reclaimed easily. Granulated salt would be applied using conventional seed drills. A large tractor-drawn roller should be used to compact catchments after the first rain of at least an inch.

The agrisystem design was fed into a computer program (Cluff, 1977) having 31 years' daily rainfall data to simulate runoff. Findings were compressed into a weekly array. With these data the size of the compartmented reservoir was optimized so that adequate soil moisture could be maintained. The simulation indicated that a three-compartment reservoir with a surface area of about one acre and holding 11.35 acre-feet of water would assure water for maximum jojoba growth and production for the 40-acre system. The simulation also indicated that a cover would be needed on the "last" compartment to increase evaporation control efficiency beginning in the third or fourth year of use. The "last" compartment is the one containing

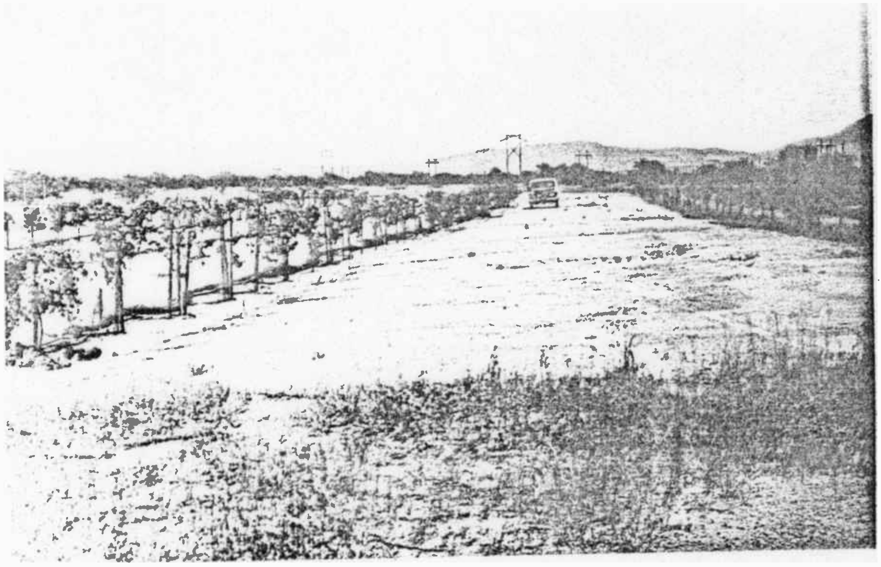


Figure 4

Salt-Treated Grape Water-Harvesting Agrisystem, Page Ranch, near Tucson, Arizona.

Figure 5

Salt-Treated Jojoba Water-Harvesting Agrisystem, Sells, Arizona.

water all the time thus it makes effective use of a floating cover. This cover would be constructed out of wax impregnated foam also developed at the University of Arizona (Cluff, 1977b).

Three simulations were made using different root-depth and infiltration-width data. The analysis showed that as jojoba plants grow, larger amounts of water can be stored in the soil and lesser amounts in the compartmented reservoir. However, the reservoir appears to be essential to maximize production. Jojoba shrubs cannot grow where water ponding around the base of the plant occurs. Thus, the pumpback and reservoir system is essential to capture excess runoff and move the water to the plants as needed.

Approximately 42,000 jojoba seedlings would be needed to plant a 40-acre area. Usually each seedling is grown in a test-tube container. These would be transplanted in late April, with each seedling cluster of three-plants placed in hills five feet apart in the row. The hills would be thinned as the plants mature.

It should be noted that at least two irrigations supplemental to rainfall will be required when the plants are transplanted to assure seedling survival. And additional watering may be necessary during July if precipitation is negligible. After the first year water held in storage in the compartmented reservoir will be adequate for supplemental irrigation.

AGRONOMIC POTENTIAL

Estimated 1978 costs to establish and maintain one plantation-acre of jojoba for three years before bean yield are shown in Table 1 (Wright and Foster, 1978). Total costs of $1,608 per acre are assumed amortized over a 10-year period beginning in the fourth year when production begins.

Estimated 1978 costs to produce jojoba using mechanical harvest methods beginning in the fourth year are shown in Table 2. The yearly break-even price incorporates cost of paying off the first three-year crop establishment expenses, prorated over the next 10 years, plus yearly production costs during the fourth through the tenth years.

When a hydraulic expeller is used for extraction, liquid wax yield from jojoba beans is about 40 percent and costs $.25 per pound. If it costs $ .67 to produce a pound of beans and liquid wax yield is about 40 percent, the break-even price for liquid wax is $1.97 per pound. Liquid jojoba wax currently sells for between $5.50 and $8.00 per pound.

Several budget details should be noted. Layout and planting costs are $142 per acre, including materials and labor for seedling production and transportation to the site. Supervision and management costs of $365 per acre include all salary and fringe benefits. For a 1,000-acre plantation, management costs would drop to $20 per acre, assuming an annual salary of $20,000.

TABLE 1

ESTIMATED 1978 COSTS FOR ESTABLISHING ONE ACRE OF JOJOBA ON RETIRED AGRICULTURAL LANDS: YEARS ONE - THREE

Operation	First Year	Second Year	Third Year
Land Preparation (shaping, salt, etc.)	$403	---	---
Grow, Layout and Plant (seedlings)	142	---	---
Chemical Weed Control @ $5/application	10	10	10
Cultivation @ $5/cultivation	15	10	10
Fertilizer and Application ($.25/Unit of N)	12	12	12
Plant Replacement	10	5	5
Roguing-Pruning-Disposal	---	45	45
Supervision and Management	365	227	230
Variable Farm Overhead	10	10	10
Subtotal	967	319	322
Accumulated Subtotal		967	1,286
Total Establishing Costs	967	1,286	1,608
Costs to be Carried Forward	967	1,286	

Establishing costs are to be allocated equally over a ten-year period = $1,608/10 = $161/year.

TABLE 2

ESTIMATED 1978 COSTS FOR PRODUCING ONE ACRE OF JOJOBA ON RETIRED AGRICULTURAL LANDS: YEARS FOUR - TEN

Operation	4th yr.	5th yr.	6th yr.	7th yr.	8th yr.	9th yr.	10th yr.
Chemical Weed Control @ $5/app.	$ 10	10	10	10	10	10	10
Cultivation @ $5/cultivation	10	10	10	10	10	10	10
Fertilizer & App. @ $.25/Unit of N	12	12	12	12	12	12	12
Plant Replacement @ $.75/plant	10	10	10	10	10	10	10
Roguing-Pruning-Disposal	50	50	50	50	50	50	50
Supervision & Management	90	91	92	93	94	95	96
Variable Farm Overhead	12	12	12	12	12	12	12
Subtotal	194	195	196	197	198	199	200
Machine Harvest @ $200/acre	200	200	200	200	200	200	200
Clean Seed Harvested (lbs)	225	360	720	900	900	900	900
Clean & Handle Seed @ $.05/lb	10	18	37	45	45	45	45
Subtotal	404	413	433	442	443	444	445
Establishing Stand Costs (Prorated over 10 years)	161	161	161	161	161	161	161
Total Producing Costs	565	574	594	603	604	605	606
Break-even Price/lb seed	2.51	1.59	.82	.67	.67	.67	.68

(300 Producing Plants - Machine Pick - 900 lbs/acre - Idle Land)

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