Forage Production With Limited Water

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Thousands of acres of cleared floodways and abandoned agricultural land presently lie fallow in Arizona because their uncertain or high cost water supply, topography or location makes them inefficient for annual cash crop production. A perennial crop, capable of production when low cost water was available, and survival when it was not, could transform this waste of potential into productive and beneficial use.

The perennial forage grasses and legumes are most promising as means of transformation and provide additional values in terms of soil conservation and erosion control. To evaluate this unexploited agricultural potential, an experiment was initiated at the Mesa Experiment Station in 1957. Eight forage species (Table 1) drill planted at one foot and three foot drill widths were compared over the 6-year period 1958-1963 under three levels of irrigation.

Table 1. Forage Species Investigated

COMMON NAME	*SCIENTIFIC NAME*
Alfalfa (Moapa variety)	*Medicago sativa L.*
Kleingrass	*Panicum coloratum*
Blue panic	*Panicum antidotale*
Boer lovegrass	*Eragrostis chlorameles*
Wilman's lovegrass	*Eragrostis superba*
Pima pappusgrass	*Pappophorum mucronatum*
Sideoats grama	*Bouteloua curtipendula*
Turkestan bluestem	*Andropogan ischaemum*

Table 2. Stand estimates in percentage of ground covered. Mesa, Arizona 1957-1964

Species	*Number of Irrigations Applied 1958-1963*								
	3			2			1		
	1957	1962	1964	1957	1962	1964	1957	1962	1964
Moapa alfalfa	100	95	50	100	78	30	100	38	20
Kleingrass	88	98	100	94	94	80	92	74	40
Blue panic	66	60	60	69	50	10	75	40	20
Boer lovegrass	36	80	70	60	93	50	49	64	60
Wilman's lovegrass	73	91	60	85	95	80	83	68	50
Pima pappusgrass	3	78	80	7	80	60	18	45	50
Sideoats grama	49	89	70	71	89	50	64	58	30
Turkestan bluestem	36	89	70	45	90	50	46	55	30
Average	56	85	70	66	84	51	66	55	38

Five Inches Per Irrigation

The plots were flooded with approximately five inches of water per irrigation in three schedules. One series was irrigated once a year, in April. Another series was irrigated in April and in July. The third series was irrigated three times, in April, July, and October. Production was measured by cutting and weighing the green forage whenever there was a weighable amount for harvest. This procedure was followed in each of the six years 1958-1963. In 1964, the last year of the experiment, all plots were irrigated in April and in July.

Table 3. Average Green Forage Yields at Mesa, Arizona 1958-1963 under Three Irrigation Levels*

Species	*Green Weights in Tons per Acre* Number of Irrigations		
	3	2	1
Moapa alfalfa	9.2	4.5	2.8
Kleingrass	4.4	3.6	1.3
Blue panic	3.6	3.7	1.8
Boer lovegrass	3.7	3.0	1.7
Wilman's lovegrass	3.1	3.4	1.4
Pima pappusgrass	3.1	2.8	1.4
Sideoats grama	2.6	2.5	.8
Turkestan bluestem	2.0	1.6	.3

Species

* 3-April-July-October 2-April-July
1-April only

No fertilizer was applied until 1960 when signs of nitrogen deficiency appeared on the early growth of grass plots receiving two and three irrigations. In that year 15 pounds of nitrogen per acre was applied to all plots prior to the July and October irrigations. After 1960, 15 pounds of nitrogen was applied to all plots prior to each irrigation.

Initial stands varied from less than 10 percent for Pima pappusgrass to 100 percent for the Moapa alfalfa (Table 2). By 1962 the thinner stands had increased and stands of all species, with the exception of the blue panic and alfalfa, were at somewhat similar levels within each irrigation treatment.

July Irrigation Important

October irrigations had little effect on stand maintenance over that of the April and July applications. The July irrigation, however, made an appreciable difference in stand survival over the single irrigation in April, and it is probable that without supplemental water most stands would have been lost. Average rainfall at Mesa during the years of this test was seven inches per year. Minimum annual requirements for long term survival of the species tested probably range from 8-15 inches.

Average annual green weight production for six years is shown in Table 3. Drill row spacing made no

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Table 4. Average Dry Forage Yields at Mesa, Arizona 1958-1963 under Three Irrigation Levels

Species	*Estimated Dry Matter in Tons per Acre** Number of Irrigations		
	3	2	1
Moapa alfalfa	3.3	1.6	1.0
Kleingrass	1.7	1.4	.5
Blue panic	1.4	1.5	.7
Boer lovegrass	2.0	1.5	.8
Wilman's lovegrass	1.4	1.6	.7
Pima Pappusgrass	1.5	1.4	.7
Sideoats grama	1.5	1.4	.4
Turkestan bluestem	.9	.7	.1

* Estimates based on average green weight yields 1958-63 average dry matter percentages in 1963 crop.

Table 5. Average Dry Forage Yields at Mesa, Arizona in 1964, with two irrigations (April and July) on all plots

Species	*Estimated Dry Matter In Tons per Acre** Number of Irrigations During Previous Six Years		
	3	2	1
Moapa alfalfa	3.3	1.6	1.9
Kleingrass	3.3	2.6	3.7
Blue panic	1.6	1.8	3.4
Boer lovegrass	2.5	2.1	2.8
Wilman's lovegrass	2.1	2.2	2.7
Pima pappusgrass	2.3	2.4	3.5
Sideoats grama	1.9	2.0	1.9
Turkestan bluestem	1.7	2.3	2.2

* Estimates based on 1964 green weights and average dry matter percentages in 1963 crop.

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difference in yield per acre. All yields given are averages of both spacings. Moapa alfalfa gave the highest production (in part because of its deep-rooted habit and deep sub-irrigation from nearby irrigated plots). Kleingrass, blue panic, Boer lovegrass and Wilman's lovegrass fell into the next group. Pima pappusgrass and sideoats grama gave equivalent production on a somewhat lower level and Turkestan bluestem was least productive.

Average dry matter production over the six years of the experiment is shown in Table 4. On a dry weight basis, alfalfa yield was no better under the two irrigation regime than that of the top producers among the grasses. The extra irrigation in October favored the alfalfa and the Boer lovegrass, both capable of growth later in the season than the other species.

Show Excellent Recovery

In 1964 all plots were irrigated in April and July to measure possible stand and yield recovery. Dry matter production figures are shown in Table 5. All yields were higher than the longtime averages, with least change on the plots irrigated three times per year. Excellent yields were obtained on the plots previously receiving only one irrigation per year, eloquent testimony to the survival and recovery potential of the species tested.

Data from this study suggest that many areas now fallow which might not have sufficient water available for cash cropping, yet could receive one or two irrigations per year, could produce usable forage with those irrigations and maintain a soil conserving stand of grass.

Some estimates of costs for forage harvested as hay following two irrigations per year are given in Table 6. Forage produced with limited water might be more valuable and could be more economically handled as pasture in many farming operations. In addition, the expected life of the stand is somewhat more than the seven years of this experiment, further reducing annual establishment charges.

Ton and Half of Hay

The average production under two irrigations of 1.5 tons dry matter would be equivalent to 1.7 tons of hay at 10 percent moisture. This amount of hay valued at $20 per ton should cover the normal direct additional costs incurred and provide a small margin toward fixed expenses which ownership of the land imposes, whether productive or not.

Putting perennial forage in place of tumbleweeds should receive serious consideration from owners of land no longer capable of sustained crop production because of water difficulties, but still having some water available.

Further studies with additional species and additional systems of management will continue. They should clarify further the possibilities for more efficient use of lands marginal because of water limitations.

The authors are professor of Agronomy and research associate in Agronomy, respectively. This project was planned and established by D. D. Rubis and was headed, 1960-63, by A. A. Baltensperger.

Table 6. Estimated Annual Costs Per Acre to Produce Forage With Two Irrigations Per Year

Establishment Expense	
Disc	2.00
Float	2.00
Drill	2.00
Seed	2.50
1½ acre feet water @ 12.00	18.00
	26.50
1 year interest @ 6%	1.59
Total Establishment Expense	28.09
Annual cost per acre amortized over 7 years	4.01
Annual Production Expense	
Water 10 inches @ 12.00 acre foot	10.00
Nitrogen 30 lbs. @ .12 lb.	3.60
2 Applications of Nitrogen @ 1.25	2.50
Mowing, raking, 3 cuttings @ 2.00	6.00
Baling 1.7 tons 10% DM hay @ 4.00	6.68
	28.78
Establishment charge	4.01
Total Annual Production Expense	32.79

FARMERS THANK A BUG

A memorial to an insect has been unveiled in the town of Dalby in Australia. The insect is the cactoblastis moth which was responsible for ridding 65 million acres of Australian land from prickly pear.

Prickly pear cactus was introduced into Australia by the first European settlers in 1788. By 1925 it covered 65 million acres, mostly in Queensland.

The infestation was particularly heavy on the Darling Downs, one of the richest areas in Queensland. Control of the pest seemed economically impossible. A Prickly Pear Board hit on the idea of experimenting with cactoblastis cactorum, a cactus-eating moth from South America.

The first cactoblastis eggs were released in Queensland in 1926. In seven years the caterpillars had wiped out the main primary growth of prickly pear. By 1940 Australia was virtually free of prickly pear.

This victory of the moth over the pear has been described as the most outstanding example ever recorded of the control of pests by biological means.