Utah Science

Volume 39 | Number 2 Article 1

6-1978

Utah Science Vol. 39 No. 2, June 1978

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Recommended Citation

(1978) "Utah Science Vol. 39 No. 2, June 1978," *Utah Science*: Vol. 39 : No. 2 , Article 1.
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UTAH SCIENCE

Agricultural Experiment Station
Volume 39 Number 2
June 1978

UTAH SCIENCE

JUNE 1978

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Cover photo by Carol Grundmann

A quarterly devoted to research in agriculture, land and water resources, home and community life, human nutrition and development, and other wide-ranging research conducted at Utah State University. Published by the Agricultural Experiment Station, Utah State University, Logan, Utah 84322.

The magazine will be sent free on request.

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The Self-Rejuvenation of Gunnison Valley, Utah

Craig L. Mangus
Paul R. Grimshaw
and Leon C. Michaelsen

Gunnison Valley, Utah, was dying economically in the 1960's. Young people seeking jobs were forced to leave the area to find work because of the valley's stagnant economy. Once thriving celery and sugar beet industries had faded due to marginal yields, plant diseases, and high costs. To try to stimulate the local economy and provide jobs, local citizens (with the help of Utah State University Extension workers) organized the Gunnison Valley Economic Development Committee (GVEDC).

The GVEDC initiated a study into the feasibility of growing row crops other than sugar beets in the area. The results indicated that row crop emphasis would not produce the desired economic development.[2]

Subsequent investigations of other agricultural development alternatives pointed toward the development of a large dairy unit as especially promising. The proposed dairy would use locally grown alfalfa hay and corn silage as its major feed input. Milk sales were expected to bring thousands of dollars of "new money" to the area annually, while the dairy would directly provide some 20 to 30 jobs for community members.

Ingenuity and resourcefulness create dairy and $1.4 million "new" dollars

The Process

The GVEDC therefore acted to acquire 104 hectares (260 ac) of land on the southeast bench area of the valley. The committee next built a milking parlor, feeding corrals, and the other physical facilities needed for a dairy operation and leased them to the newly formed Gunnison Valley Dairy Association, the GVDA. Several members of the GVDA are experts in dairy operation, and Utah State University Extension specialists helped provide financial planning and organizational expertise.

The facilities and equipment were financed as follows:

1) Ten percent of the total investment was raised from within the ranks of the GVDA membership.

2) Thirty percent was borrowed from the Gunnison Valley Bank.

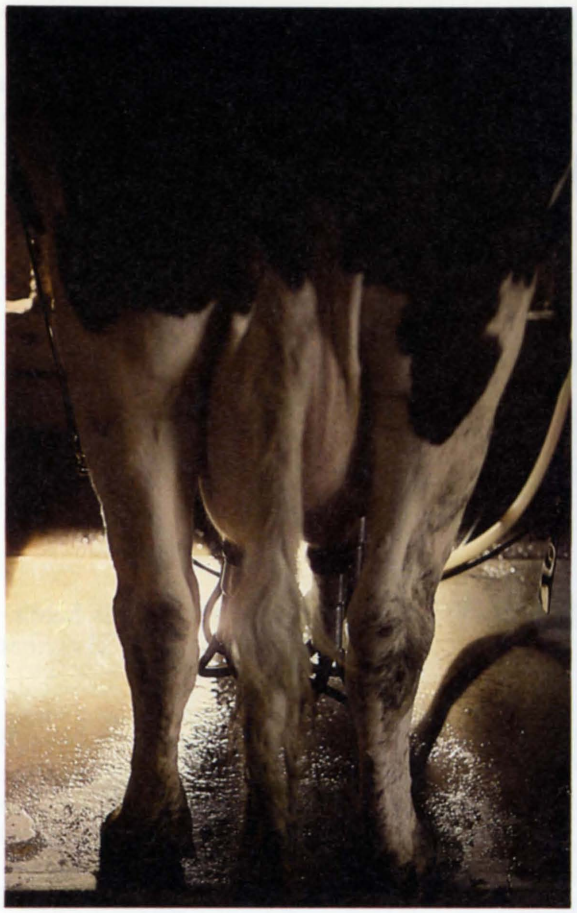
3) Sixty percent was financed through the Small Business Administration.

The GVDA originally consisted of 23 members in a cooperative arrangement. Later, due to adverse tax rulings by the Internal Revenue Service, the organization changed to a general limited partnership. The GVDA now has 6 managing partners who act as a board of directors. Day-to-day decisions are executed through a full-time hired manager.

In 1971, members of GVDA bought 1400 dairy heifers. The heifers and their feed for the first year cost about $400 per head. Each member's financial inputs were arranged for on an individual basis.

In 1975 and 1976, an average of 1200 cows were being milked twice daily. The milking process went on around the clock in a ten-on-a-side double-herringbone type milking parlor of the most modern design. Twenty-two people work at the dairy full or part time to satisfy the daily requirements of the milking herd plus 1200 heifers, 250 calves, and 15 bulls.

The total cost of feeding the animals was almost one million



Carol Grundmann

dollars ($960,000) in 1976. All feed inputs, except the grain, come from local feed producers. Both alfalfa hay and corn for silage are grown extensively in Gunnison Valley.

Feed production has filled the gap created by the loss of the celery and sugar beet industries. The GVDA feed purchasing policy calls for buying from the feed producing partners first, other local producers second, and outside the valley as a final feed source. Many marginal farms became profitable when the price of feed increased, which occurred, at least partially, because the GVDA became a major feed buyer in the valley. The announcement of the GVDA construction alone caused the feed prices to rise in November of 1971. Theoretically, the feed producers had the option of increasing the price of feed in the valley to just equal that of out-of-valley feed plus transportation costs.

The Analysis

The Gunnison Valley experience has now been studied by personnel of the Utah State University Agricultural Experiment Station and the Department of Economics. Managers of 8 dairy operations in Gunnison Valley, among them the GVDA, were interviewed as a way to obtain information on costs of dairy operations in the area and the impact of the GVDA on the community. Revenue information for each dairy was gleaned from state Dairy Herd Improvement Association (DHIA) records and industry price information on milk and butterfat differentials paid for the years of 1974 and 1975.

Results of this study showed that milk receipts alone injected 1.4 million "new" dollars into the Gunnison Valley economy. Nearly one million of these dollars went to pay for local feed inputs, local labor, and veterinary services. The multiplier effect of these new moneys in the Gunnison Valley economy was not defined, but even if it were small, the overall stimulus to the local economy has been substantial.

The dairies analyzed were compared by a coefficient of return on dairy capital (Table I). The coefficient is defined as the quotient of the total net profit of each dairy divided by the amount of capital involved in its operation. Many dairy operations in Gunnison Valley are associated with a family farm. Such farms incorporate many nondairy-related capital items. Special care was taken to maintain homogeneity in this comparison by computing

these relative coefficients using only dairy profits and capital. The dairies are represented by randomly assigned letter designations to preserve the anonymity of the owners.

Dairy capital utilization was also analyzed. The right column of Table 1 shows the capital invested per cow for the 8 dairies within the valley. The GVDA milks cows around the clock and, therefore, more effectively uses the fixed cost capital that it owns relative to the other dairies in the area.

To test the physical economies of size among the dairy operations in Gunnison Valley, we used the basic equation:

$$Y = a + bX,$$

where

Y = the average amount of milk produced per cow per day

a = a constant term

b = the change in Y as per a unit change in X

X = the average number of cows milked per day

Results showed that within the dairy operations of Gunnison Valley the average amount of milk produced per cow per day decreased as the number of cows milked per day increased.

The GVDA employs 22 people. Many other people are indirectly employed because of the dairy. Examples include the farmers who were able to continue farming as feed prices and demand increased. Also to be considered are the families of the 22 employees of the GVDA dairy who buy food, clothing, cars, medical services, and all kinds of other goods and services associated with living. The providers of these goods and services indirectly are employed because of the GVDA. In this way the "new money" brought into the area by the GVDA recirculates through the local economy.

In Brief

The rejuvenation of Gunnison Valley, Utah was thoroughly planned and investigated before it was started. Based on the available data, the GVEDC chose to capitalize on the valley's comparative advantage in dairy feed production. The necessary resources (labor and farm land suited to alfalfa hay and corn silage growth) were in abundance in the valley and simply needed development incentive.

No attempt was made in this study to estimate the multiplier effect of the new dollars in milk receipts brought into the valley. But dollars went out among members as payments for feed and labor inputs to production and certainly were recirculated in the valley, creating a multiplier effect. Other studies have indicated that, for this type of development dollars, a reasonable multiplier is between 1.9 and 2.2.

Capital utilization and tax advantages in the valley have been more efficient and favorable, respectively, as dairy herd size increased. Milk production per cow, however, has decreased as herd size increased.

Other planning and development groups can use the GVEDC experience as a model as they seek to promote successful economic development by using resources that offer their areas special comparative advantages.

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[1]Craig L. Mangus, Graduate Student, Economics, Texas A&M University. Paul R. Grimshaw, Professor, Economics, and Associate Dean, College of Agriculture, Utah State University.

[2]Andersen, J. C., Thomas, B. E. and Van Epps, G. A. "The feasibility of growing and freezing vegetables in Gunnison, Utah," 1971, Four Corners Regional Commission Report.

Leon C. Michaelsen, Professor, Economics, and Area Coordinator, Utah State University Extension Services.

Table I. The dairies of Gunnison Valley, Utah, showing return to dairy capital coefficients and capital investment per cow, 1975.

Dairy	Coefficient Return on Capital*	Capital Investment per Cow
A	.314163581	1,485.50
B	.662247408	1,232.61
C	.092531265	1,900.00
D	.223825892	1,377.78
E	.121836464	1,860.00
F	.429057039	1,161.56
G	.182003732	727.08
H	.555149633	1,138.88

*To express these coefficients as a percent return on dairy capital the decimal point must be moved two places to the right.

That "Ultimate" Bull

K. W. Hill

A Utah Agricultural Experiment Station bull, Utag Ivanhoe Ultimate (1477381) has sired over 200,000 calves in the last eight years. His daughters now represent nearly one percent of all the milking cows (11,000,000) in the United States. National Dairy Herd Improvement records have established that these daughters produce significantly more milk than their herd mates. In addition, thousands of his granddaughters are in production, and he has exerted a significant leavening effect through his sons and grandsons, several of whom have become outstanding, proven sires in their own rights.

A Story of Success

The breeding of such superior sires is a success story based on many years of wholehearted cooperation between the Utah Agricultural Experiment Station (UAES) and USDA. In 1938 UAES entered into a cooperative agreement with the Agricultural Research Service (ARS) of USDA to develop a superior Holstein herd at Logan. Seventeen purebred cows and 4 proven bulls were transferred to Logan from the ARS station at Huntley, Montana. This about doubled the size of the Station purebred herd.

The Utah Agricultural Experiment Station creates a superior Holstein

In 1961 an additional group of some 60 milking cows and their offspring were transferred to Logan from Huntley—again, about doubling the numbers in the Station herd. At this time also, 2 dairy research scientist positions were established at Logan by ARS; these have continued and the incumbents have worked hand-in-glove with Station scientists in the signal accomplishments that have taken place.

Between 1940-1960, the quality of the UAES dairy herd was upgraded significantly. Females with promising germ plasm were added to the herd and then mated to superior sires by artificial insemination. In the 1960s the herd included several outstanding daughters of the bull Sevens Burke Skylark (1239242). Charles H. Mickelsen, the Chief Herdsman, suggested combining this high producing line with the Ivanhoe line, which was superior in conformation as well as milk and fat production. Accordingly, Utag Skylark Ablest Ardie (4745926) was inseminated with semen from Osborndale Ivanhoe (1189870).

The result was a bull calf, born November 14, 1964. By chance, but prophetically, he was named "Ultimate" (Utag Ivanhoe Ultimate—1477381). From the day of his birth, the Station started turning down offers to purchase him or even a part interest in him for several thousand dollars.

His confirmation gave promise of his being a show-ring bull as well as a breeder. He was never defeated in his class as a bull calf. His only defeat as a Senior Yearling was at the International Dairy Show in Chicago where he placed third in very strong competition.

As a yearling he was mated to females in several herds in Utah. In 1966 arrangements were made to place "Ultimate" in the artificial insemination stud of American Breeders Service (ABS) in Madison, Wisconsin.

Here he became a premium sire. The UAES and ARS animal scientists and ABS officials exercised a good deal of skill and vision in properly sampling the bull and developing a demand for his use. By 1970, "Ultimate" was in the Number One (out of 100 bulls) stall at the ABS barns, indicating that the sales of his semen exceeded those of any other bull in the barn.

The ABS barns have also housed "Ultimate's" 3/4 brother "Sizzler" (Utag Ivanhoe Sizzler—1495135), and another UAES bull who has sired over 100,000 calves. Earlier, two widely known AI sires from the UAES herd, Sevens Burke Skylark (1239242) and H-10 (Burkegou Inka Dekol (1038509)), each sired more than 50,000 calves. Burkegou Inka Dekol was in such demand that some of the last ampules of his semen sold for as much as $1,000.00 each.

These glamorous sires deserve their acclaim, but their very existence depended upon the infrastructure of an outstanding dairy herd. And such a herd must rest firmly on a base of scientific breeding and management. This is the achievement of which the Station is justifiably proud.

Nearly a Century of Service

The Utah Agricultural Experiment Station has had a dairy herd for 90 years. For the first 50 years (1888-1938) a grade herd was maintained. A bulletin published in 1895 entitled, "Five Years' Study with Dairy Cattle," indicates an average annual milk production of about 6,000 pounds per cow. Butterfat production was 300 pounds. The progress we have made is indicated by the fact that a demonstration herd of the Experiment Station recently has maintained a production average of 20,000 pounds per cow per year.

The Impact of the Program

One objective of the Experiment Station dairy program has been to help upgrade the quality of dairy cattle locally, as well as nationally. The Station herd certainly has had an ameliorating influence. As a matter of policy, the Station personnel have exhibited some of their best stock at local, regional and sometimes national shows. They have won more than their share of ribbons and have drawn the attention of premium breeders. Utag Benedict Warrior (1497985) was Grand Champion Sire at the National Holstein Exhibition in Pennsylvania in 1968.

During the past 25 years, more than 100 young bulls from the Station herd have been loaned to commercial dairymen in Utah and other states. These bulls have been used extensively by these dairymen (and their neighbors) on their best cows to upgrade their replacement heifers. In addition, hundreds of males and females have been sold outright as breeding stock.

A Nationally Acclaimed Achievement

In a recent study (1977), personnel of the Virginia Polytechnic Institute found that the Utah Station had provided 19 bulls to major artificial insemination centers. This is more than any other Experiment Station in the nation. Furthermore, the average predicted differences (increases above contemporary herd mates) of these sires were higher than those for sires from any other Holstein breeders in the country. Seven of these bulls have received Gold Medal recognition from the Holstein-Friesian Association of America, indicating that they have improved both the production and the body conformation of their daughters.

K. W. Hill is Professor of Plant Science at Utah State University

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Property Tax Equity Problems in Utah: Part I

W. Cris Lewis

Property taxes are the largest single revenue source for local governments; nationally, they account for about 85 percent of local tax revenue and 40 percent of all local general revenue. Their relative importance in Utah is comparable. The level of the tax does vary considerably among states, however. As measured by property taxes per capita, California ($296) is the highest in the United States, while Alabama ($41)[1] is the lowest. The 1971 per capita tax in Utah was $140, which was some 24 percent below the national average of $184. These summary data are included in Table 1.

Consider the following: In Trenton, New Jersey, the median tax rate is 6.4 percent of market value. This implies the annual property tax on a $50,000 home would be $3,200. For one-fourth of the residential properties in that city the tax rate was in excess of 9.7 percent. In Jackson, Mississippi, the median tax rate is 0.1 percent of market value. There, the tax on a $50,000 home would be only $50 per year.

Because the magnitude of the tax is not insignificant, it is worthwhile to review how the tax is administered and to identify some serious equity problems. Virtually, all taxes involve questions of fairness; invariably, someone can document "unfair" treatment.

A penetrating and analytical look at the inequities of our property tax system

Problems of this kind are probably more common and more severe with regard to property taxes than with any other. This article focuses on property tax inequities both within and among Utah counties; a second article (in the September *Utah Science*) will propose changes in property tax administration.

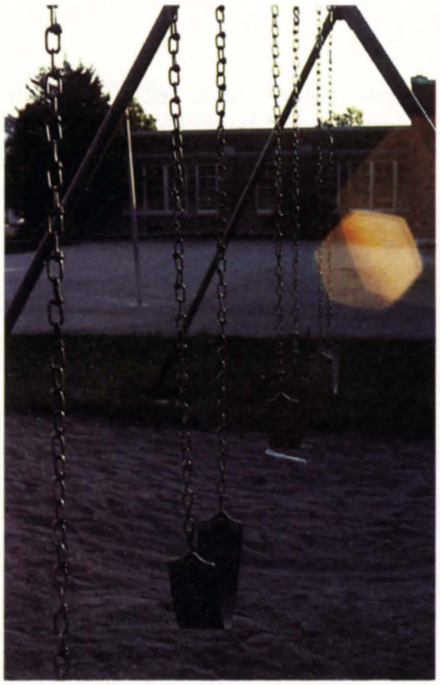
Comparative Tax Burdens

Per capita property taxes in Utah are below the national average, but this does not mean Utah is a low-tax area. An evaluation of the overall tax burden must consider the range of state and local taxes (e.g., income, sales, inventory, etc.). The limited available data suggest that Utah is about average or possibly a little below. Tax burden data for selected cities are grouped into "high" and "low" tax categories to show the relative position of Salt Lake City residents (Table 2).

Of the areas studied, Milwaukee, Wisconsin, had the highest state and local tax burden. Those taxes accounted for about 15 percent of income at both the $10,000 and $25,000 levels. New Orleans was the lowest with effective tax rates of 4.6 and 3.7 on those income levels. Salt Lake City was about average (8.1 percent) at the higher income level and below average at the $10,000 level. It is significant that in most cities the effective tax rate declines as income rises. This regressive tax structure is at variance with the usual notion of fairness that dictates tax rates should rise, not fall, as income increases.

Property Tax Inequity: The "Among County" Problem

The Utah school finance program is designed to redistribute tax revenues from the "wealthy" school districts to the "less wealthy" districts. Because the measure of wealth is the amount of assessed value of real property per student, the assessment phase of the property tax program is critical to an "equitable" or fair redistribution of those tax revenues. Residents of a county where property is under-assessed will receive more than their "fair" share of state revenues. In contrast, counties where property assessments are above the state average will receive less than an "equitable" share and may have to remit locally collected property taxes to the state.



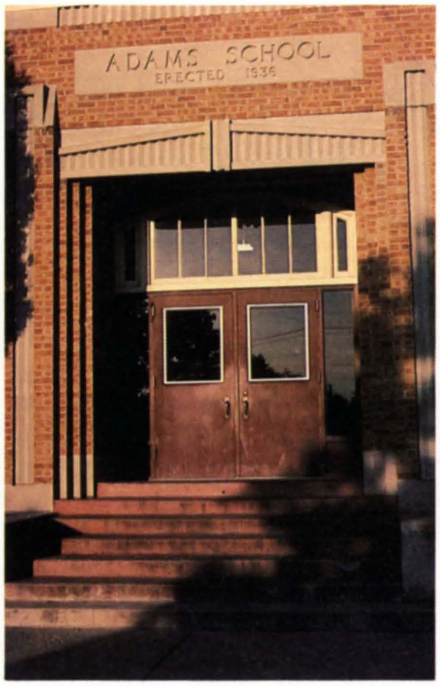


Table 1. Property Tax Revenues of State and Local Governments, 1971

	Amount (millions)			Total Per $1,000 of Personal Income	Amount per Capita	Amount as a Percent of State and Local General Revenue
	Total	State	Local			
						%
UNITED STATES	$37,852	$1,126	$36,726	$47.37	$183.51	26.1
Regions:						
Northeast	11,408	114	11,293	52.49	230.03	29.4
North Central	11,260	269	10,992	50.01	196.62	29.5
South	6,605	263	6,342	31.19	103.35	17.6
West	8,579	480	8,099	59.28	241.80	28.2
High Property Tax States:[a]						
South Dakota	160.9	b	160.9	76.32	240.14	33.3
Montana	166.4	8.6	157.8	70.84	235.04	31.6
California	5,992	244	5,748	67.45	296.27	32.3
Massachusetts	1,647	——	1,647	66.28	286.08	38.0
Wyoming	78	9	69	65.74	228.35	23.8
Low Property Tax States:[a]						
Alabama	142	24	118	14.46	40.87	7.3
Delaware	49	——	49	20.54	87.74	11.1
South Carolina	173	2	171	22.77	66.01	13.5
Kentucky	231	27	204	23.31	70.35	12.0
Louisiana	265	28	237	23.79	71.95	11.0
Utah	154	13	141	44.95	139.74	20.4

[a]Based on total property tax per $1,000 of personal income.
Source: U.S. Bureau of the Census, *Census of Governments, 1972.*

To fully understand why inter-county variation in the ratio of assessed value to market value (i.e., the assessment ratio) can be a problem, it is necessary to understand the complexities of the Utah school finance program.

Basically, the program functions as follows. Each school district must levy at least a 28 mill tax on all real property in the district. If a district sets a lower mill levy, it could not receive state funds. If the total tax raised from that levy fails to meet a legislated minimum amount per student ($792 for the 1978-79 year), the state will provide the difference from the general fund. For some districts this can amount to $400-$500 per student. If the assessed value per student exceeds the minimum standard, the local district must remit the difference to the general fund. Duchesne County, with a large oil and gas recovery industry, has been the only county in this position. It has been returning about $2 million in local property taxes to the state general fund each year.

As an example, consider a district having 2,000 elementary and high school students and a total assessed valuation of real property of $35.7 million. A 28 mill tax levy will raise $1,000,000 (i.e., 0.028 x $35.7 million) or $500 per student. Because this is below the guaranteed minimum of $792, the district will receive $292 per student, or $584,000, from the state general fund. Clearly, the rational county government would want to minimize the level of assessed valuation in order to maximize the state contribution to the local school district. The mill levy for other nonschool operations can always be adjusted to raise whatever revenue is required. Thus, the combination of a low assessment ratio and high mill levy would be preferred because it would result in an increase in the level of state funding. If this hypothetical county had assessed its real property at $25 million instead of $35 million, it would receive an additional $300,000 from the state general fund.

To preclude a contest among the several Utah counties to see which could set the lowest assessment ratio, the state legislated that property must be assessed at 30 percent of market value. An administrative decision was made that set 20 percent as the prescribed ratio for an interim period. In 1969, the state embarked on a massive property revaluation program designed to reduce if not eliminate the wide variation in assessment ratios among counties. This program was to be completed by 1977.

Table 2. State and Local Tax Burdens, Selected Cities, 1975

	$10,000 Income			$25,000 Income		
	Taxes	% of Income	Rank	Taxes	% of Income	Rank
NATIONAL AVERAGE	$ 889	10.01	——	$2,031	8.12	——
Salt Lake City, Utah	815	8.15	29	2,027	8.11	27
"High" Tax Cities:						
Milwaukee, Wisconsin	1,476	14.76	1	3,672	14.69	1
Newark, New Jersey	1,443	14.43	2	2,905	11.62	5
Boston, Massachusetts	1,391	13.91	3	3,258	13.03	2
Baltimore, Maryland	1,282	12.82	4	2,985	11.94	4
"Low" Tax Cities:						
New Orleans, Louisiana	462	4.62	48	932	3.73	47
Jacksonville, Florida	492	4.92	47	863	3.45	48
Las Vegas, Nevada	551	5.51	46	1,007	4.03	46
Huntington, West Virginia	563	5.63	45	1,220	4.88	41

Source: *Changing Times, the Kiplinger Magazine*, July, 1976.

Unfortunately,

> Although Utah's property revaluation program has done much to reduce property inequalities among individual properties and property classes within the same county, inflation and rapidly changing property values have made it difficult to achieve balance and equity among counties. Consequently, the disparity among counties is as great today as it was seven years ago when the present revaluation program was begun.[3]

1977 assessment ratios for all Utah counties are reported in Table 3. Excluding the four counties which had not had reassessments at the time these data were prepared (i.e., Carbon, Salt Lake, Sanpete, and Sevier), the ratio varied from 8.3 in Wayne County to 19.0 in Juab County. The overall state average, 12.9, is far short of the 20 percent ratio prescribed by law; this is partially explained by inflation, which keeps upward pressure on property values.

The point is that Wayne County residents (and others in counties where the assessment ratio is below average) are benefitting at the expense of Juab County residents and those in above-average assessment areas. The Utah Foundation estimates that the total "overcontribution" by the high-ratio counties (equivalently, the undercontribution by the low-ratio counties) in 1976 was $3.2 million. In absolute terms, the Ogden School District was the largest "overcontributor" and the Granite School District the largest "undercontributor."[4]

That this problem exists is well known, but little has been done to rectify it. Legislation exists that would allow adjustments to be made in the state allocation to districts where the assessment ratio is below average, but no effort has been made to enforce this provision of the law.

Within-County Inequity

The inequity problem within counties is essentially the same as the among-county problem (i.e., a highly variable assessment ratio among individual properties), but has an important additional implication. When the property tax on otherwise comparable parcels of property in a taxing jurisdiction varies significantly, the differences are likely to be capitalized in the market value of the properties. Within one taxing-public service jurisdiction, the tax is best viewed as an annual cost of owning property, not as payment for services. Taxes vary considerably among homes, but the same level of public services (e.g., education, police, fire protection, etc.) is available to all.

Table 3. Assessment Ratios for Utah Counties, 1976

County	Year of Revaluation	Assessment Ratio[a]	County	Year of Revaluation	Assessment Ratio[a]
		%			%
Beaver	1974	13.20	Piute	1976	16.03
Box Elder	1974	13.53	Rich	1972	10.83
Cache	1975	14.80	Salt Lake	b	10.99
Carbon	b	7.03	San Juan	1974	15.06
Daggett	1972	10.68	Sanpete	b	5.63
Davis	1975	15.86	Sevier	b	6.81
Duchesne	1972	8.46	Summit	1972	9.98
Emery	1972	10.15	Tooele	1974	14.06
Garfield	1972	8.24	Uintah	1973	11.93
Grand	1975	15.58	Utah	1976	18.45
Iron	1976	16.97	Wasatch	1972	8.44
Juab	1976	18.95	Washington	1973	12.96
Kane	1972	9.80	Wayne	1972	8.29
Millard	1973	12.59	Weber	1975	14.29
Morgan	1972	10.11			

[a]Ratio of assessed value to market value.

[b]Reassessment had not been made when these data were compiled.
Source: Utah Foundation, "Property Assessment Levels in Utah—1977," *Research Briefs*, January 30, 1978.

Carol Grundmann

For example, consider two similar residential properties, A and B, which would both have a market value of $50,000 if the property tax was the same on each. But the annual tax on A is $600 and only $400 on B. Clearly, B is the preferred property in that the annual ownership cost is $200 less than for A; the rational buyer obviously will bid less for A than for B. The question is, how much less? If the difference is expected to be maintained for ten years and if the buyer's opportunity cost on money is r, the present value (PV) of that stream of $200 payments is given by:

$$PV = \sum_{i=1}^{10} \frac{200}{(1+r)^i}$$

Bids on A should be lower than on B by the amount of the present value. This assumes, of course, that buyers are rational and have the necessary tax information to make judgments of this kind. The empirical evidence suggests that buyers generally are well aware of tax differentials. What might be the magnitude of that present value? If the time horizon is ten years and the appropriate discount rate is nine percent, the difference in bids would be $1,284. Thus, if property tax is not levied in an equitable manner among properties, it can cause immediate and rather large capital gains and losses for owners of real property.

Two measures can be used to determine the equity or "fairness" in actual assessment procedures.

- **The coefficient of intra-area dispersion** measures the average difference of individual assessment ratios from the median of those ratios. So that comparisons can be easily made, the average difference is expressed as a percent of the median ratio, i.e.,

$$C_d = \frac{(\Sigma|R_i - R|)/n}{R} \times 100$$

where R is the median assessment ratio, R_i the assessment ratio for the eighth property, and n the number of properties under study. The larger the value of this coefficient, the more variation there is in assessment ratios; if all property was assessed at the same percentage of market value, the coefficient would be zero.

The following example will help clarify the concept. Consider five properties, A through E, with the assessment ratios as shown. The median assessment ratio is 20.

Property	Assessment Ratio (R_i)	$\lvert R_i - R \rvert$
A	13	7
B	17	3
C	20	0
D	23	3
E	27	7
	Median ratio = 20	$\Sigma\lvert R_i - R\rvert = 20$

$$C_d = \frac{(\Sigma|R_i - R|)/n}{R} \times 100 =$$

$$\frac{20/5}{20} \times 100 = 20\%$$

In this example, the average deviation from the median ratio is 20 percent. Probably all would agree this variation is excessive and unfair, yet it is about the national average. Note that if these properties had the same market value, the annual tax on E would be more than twice that on A.

- **The intra-area price-related differential** is computed by dividing the average assessment ratio (R) by the ratio of the total assessed value divided by total market value, i.e.,

$$D = \frac{R}{\Sigma A_i / \Sigma V_i} \times 100$$

where A_i and V_i represent, respectively, the assessed and market values for the ith property. A differential of more than 100 indicates that assessment ratios for higher value properties are lower than for lower value properties. A differential of less than 100 means the converse.

Consider the calculation of D for the following five hypothetical properties.

Property	Market Value	Assessed Value	Assessment Ratio
A	10,000	2,000	20
B	20,000	3,600	18
C	30,000	4,800	16
D	40,000	5,600	14
E	50,000	6,000	12
	$\Sigma V_i = 150{,}000$	$\Sigma A_i = 22{,}00$	Mean (R) = 16

$$D = \frac{16}{22{,}000/150{,}000} \times 100 = 109$$

The differential exceeds 100 because the assessment ratio falls as property value rises.

1971 data on the dispersion coefficient for the United States and selected states are reported in Table 4. The median coefficient (the average percentage deviation of an assessment ratio from the median) for the nation was 20.2; the median for Utah in that year was 24.1. This represents a substantial and perhaps unacceptable level of variation in assessment ratios. Of course, these data represent observations before the major reassessment program began in Utah; presumably that program has resulted in the reduction of those coefficients. For example, based on all single family homes sold in one Utah county in 1976 one year after the property reassessment, the coefficient was 16.1, which is significantly below the 1971 state average. Still, Kentucky, Nevada, and Michigan have coefficients in the 12-14 range, suggesting there is still room for improvement in Utah.

The dispersion coefficient will tend to increase as the time since the last revaluation increases. Continuing inflation will have differential effects on real property. Assessments on newly constructed properties often are not

Table 4. Distribution of Intra-Area Dispersion Coefficients for Single Family Houses, United States and Selected States, 1971

	Number of Areas	Median Coefficient	Percent of Areas Having a Coefficient of			
			Less Than 10.0	10.0-19.9	20.0-39.9	40.0 And Over
UNITED STATES	1,571	20.2	6.7	42.2	42.0	9.1
Utah	8	24.1	— —	25.0	50.0	25.0
Low Coefficient States:						
Kentucky	27	12.5	22.5	59.3	18.5	— —
Nevada	6	13.4	— —	83.3	16.7	— —
Michigan	190	14.6	10.0	43.7	41.6	4.7
High Coefficient States:						
Pennsylvania	44	30.0	18.2	59.1	20.5	24.6
Arkansas	22	30.2	— —	4.5	81.8	13.6
Idaho	13	31.6	— —	15.4	61.5	23.1

Source: Same as Table 1.

consistent with those appraised earlier. The result probably is increased variation among assessment ratios over time. All of this suggests the need for a more-or-less continual revaluation process.

With regard to the price-related differential (Table 5), the Utah data are comparable to those for the nation. The 1971 estimated average for Utah in 1971 exceeded 110, implying that higher value properties tended to have lower assessment ratios. Using the 1976 data for one county in Utah resulted in an estimated differential of 98.7. Whether this reflects an overall improvement due to the revaluation program or simply better assessment procedures in that county is not clear. In any event, there has been a tendency nationwide and in Utah to underassess higher-valued properties. Hopefully, this tendency has been or is being eliminated in Utah. Ideally, the differential coefficient should be 100; the law is clear in stating that all properties, regardless of value, should have approximately the same assessment ratio.

Summary

That there are significant equity problems associated with property tax administration in Utah is easily documented. Residents of some counties are paying more than a "fair" share of the state school finance program, while residents of other counties are paying less. Within a county the property tax on two properties of equal market value can differ greatly. Because the difference in the tax is capitalized in the market value, the property tax system confers random capital gains on some property owners and losses on others. Empirical studies indicate that other states have significantly more equitable property tax systems than does Utah. This suggests that improvements can be made in the way we levy this tax.

In the September article, various alternatives to the current assessment procedures will be outlined and evaluated. It is submitted that the biggest problem in improving the situation is not in developing better practices, but in overcoming the political and institutional inertia that perpetuates the *status quo* in local property tax procedures.

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[1]These data are for 1971 as reported in the *1972 Census of Governments*. Given the inflationary trends since that year, the current level of per capita taxes is probably much higher.

[2]Although the tax burden on Salt Lake City residents will differ from that on individuals in other parts of Utah, the comparisons to other US cities are probably indicative of the relative tax burdens faced by non-Salt Lake City residents of Utah.

[3]Utah Foundation, "Utah's Reappraisal Program—1977," *Research Report No. 364*, February, 1977.

[4]Utah Foundation, Ibid.

This article represents part of the research being carried out under Project #016 of the Utah Agricultural Experiment Station.

Table 5. Distribution of Selected Local Areas According to Price-Related Differentials in Assessment Ratios, 1971

		Percent of Areas Having Price-Related Differentials of			
	Number of Areas	Less Than 95.0	95.0-104.9	105.0-119.9	120.0 Or More
UNITED STATES	1,571	2	58	31	9
Utah	8	— —	50	38	13
High Differential Areas:					
North Dakota	10	— —	10	30	60
Kansas	25	— —	20	44	36
Alabama	27	— —	22	56	22
Low Differential Areas:					
Wisconsin	92	— —	83	12	4
California	38	— —	74	24	3
Oregon	19	— —	84	11	5

Source: Same as Table 1.

Soil Moisture: The Life Blood of Aldicarb and Its Control of the Sugarbeet Cyst Nematode

G. D. Griffin

Nematicidal activity of aldicarb (Temik) was first reported in 1966. Since then, it has successfully controlled plant-parasitic nematodes on several important crops. In the intermountain area of the western United States, a prime aldicarb target is the sugarbeet cyst nematode, *Heterodera schachtii*. However, effective control and maximum sugarbeet yields are realized only when optimum soil moisture is maintained. With high nematode populations, soil moisture must be closely controlled to obtain adequate crop protection.

It isn't known whether aldicarb controls nematodes by killing them. Control may result from indirect effects on vital body functions of the nematode such as inhibition of hatching, impairment of migration of larvae to invasion sites, and disorientation of males that prevents fertilization. Whatever the control mechanism, however, an effective amount of active material must be in contact with nematode eggs, larvae, or males. Whether this occurs is determined by how much aldicarb goes into solution and is subsequently degraded to sulfoxide and sulfone.

A single severe dry soil period destroys nematicide potential for sugar beets

Various soil moisture levels in aldicarb-treated soil produce significant differences in infection of sugarbeet seedlings by *H. schachtii* larvae. We have shown in laboratory and greenhouse studies that larval infection is least in treated soil and greatest in nontreated soil at soil moisture levels of 80-100 percent field capacity (FC). One greenhouse study showed that after 14 days, 120 times more sugarbeet nematode larvae were infecting sugarbeet seedlings in nontreated, wet soil than in treated wet soil (Table 1). The lesser infection of sugarbeet seedlings in treated soil at 80-100 percent FC than at 20-30 percent FC reflected the greater concentration of aldicarb and/or its derivatives, sulfoxide and sulfone, that was in solution in soil kept at the higher moisture levels. Both treated and untreated soil at 80-100 percent FC produced higher sugarbeet yields and plant weights than did the soils at 20-30 percent FC. These results further substantiate the greater nematicidal activity of the chemicals at 80-100 percent FC (Table 2).

Our field studies have also demonstrated a direct relationship between sugarbeet yields and available soil moisture in soil treated with aldicarb. Good-to-excellent nematode control with increased plant growth resulted when soil moisture was maintained at or above 80 percent FC (Table 3). Although sugarbeet yields from aldicarb-treated soil at 20 percent FC exceeded those from control (nontreated soil) plots, they were much lower than those from aldicarb-treated soil at 80 percent FC.

Sugarbeet yields were inversely related to numbers of nematode cysts per plant. In aldicarb-treated soil, the number of female nematodes and cysts per plant was highest in soil at 20 percent FC and lowest in soil at 80 percent FC. In nontreated soil, the numbers of female nematodes and cysts were

highest at 80 percent FC because these optimal moisture conditions for plant growth also favored nematode infection and development.

Sugarbeet growth was affected as much by soil moisture as by nematodes; yields in both treated and nontreated soil were less at 20 percent FC than at 50 and 80 percent FC (Table 4).

The level of achievable control is lessened as the soil population of nematodes increases. A low nematode population (1.8 larvae/gm soil)* has little or no effect on sugarbeet yields in either aldicarb-treated or nontreated soil. In northern Utah and southern Idaho sugarbeet-producing areas, nematode densities below 2 larvae/gm soil usually do not warrant a chemical control application. As the nematode population density (nematodes/gm soil) increases, the effects of soil moisture level on aldicarb control of nematodes become more critical.

Sugarbeet yields were not significantly increased in aldicarb-treated soil at 20 percent FC over those taken from nontreated plots when the respective initial nematode population densities were 3.5 and 6.2 larvae/gm of soil. Plants from both aldicarb-treated and nontreated soil were stunted throughout the growing season, roots were sprangled (showing nematode damage), and yields were low. At a 50 percent FC soil moisture level, sugarbeet yields from treated soil were increased over those from nontreated plots. But at this FC, sugarbeet yields were less at a nematode population density of 6.2 than at 3.5 larvae/gm soil.

Sugarbeet yields in soil treated with aldicarb, maintained at 80 percent FC, and having

Table 1. Effect of soil moisture on aldicarb control of *Heterodera schachtii*

Soil Treatment	Soil moisture and Nematodes per root[a]	
	80-100% FC	20-30% FC
Aldicarb	0.3	9.1
Nontreated	35.8	25.3

[a]Plants harvested after 14 days growth
[b]30 kg/ha (27 lb/ac) 15G formulation

Table 2. Effect of soil moisture on aldicarb control of *Heterodera schachtii*

Soil Treatment	Soil moisture levels Plant Weight (gm)[a]	
	80-100% FC	20-30% FC
Aldicarb[b]	8.0	2.0
Nontreated	3.80	2.4

[a]Plants harvested after 40 days growth
[b]30 kg/ha (27 lb/ac) 15G formulation

Table 3. Effect of soil moisture and aldicarb on sugarbeet yield and control of *Heterodera schachtii*

Soil (% field capacity)	Yield[a] metric ton/ha (ton/ac)		Nematodes per plant[b]	
	Aldicarb[c]	Nontreated	Aldicarb[c]	Nontreated
20	11(5)	7(3)	17	28
40	20(9)	9(4)	8	33
60	25(11)	9(4)	4	42
80	29(13)	13(6)	3	45

[a]Yield data collected 100 days after planting
[b]Nematode data collected 40 days after planting.
[c]4.49 kg(a.i.)/ha [4 lb (a.i.)/ac] of aldicarb

*A pound of soil equals 454 grams (gm).

Table 4. Effect of soil moisture and nematode population density on aldicarb control of *H. schachtii*

Initial Nematode population (larvae/gm soil)	Sugarbeet yields[a] metric ton/ha (ton/ac)					
	20% FC		50% FC		80% FC	
	Aldicarb[b]	Nontreated	Aldicarb[b]	Nontreated	Aldicarb[b]	Nontreated
0.0	——	27(12)	——	34(15)	——	34(15)
1.8	27(12)	25(11)	34(15)	31(14)	36(16)	34(15)
3.5	20(9)	18(8)	29(13)	22(10)	36(16)	22(10)
6.2	9(4)	7(3)	22(10)	11(5)	34(15)	13(6)

[a]Yield data taken 120 days after planting.
[b]30 kg/ha (27 lb/ac) 15G formulation.

nematode populations of either 3.5 or 6.2 larvae/gm soil, were greater than sugarbeet yields in similarly treated soil held at 50 percent FC. Yields from aldicarb-treated soil were increased by 108 percent and 171 percent in plots held at 50 percent and 80 percent FC, respectively, over those of nontreated plots when all test soils had nematode population levels of 6.2 larvae/gm of soil. Yield increases when the population level was 3.5 larvae/gm soil were less spectacular, being 29 and 56 percent over those of the nontreated plots, at 50 and 80 percent FC, respectively.

With increasingly high nematode population densities, a longer period of chemical activation is obviously required to achieve an adequate level of control. Sugarbeet yields from nontreated plots with the same nematode density, but kept at either 50 or 80 percent FC moisture levels, did not differ significantly. This indicates less importance between the 2 soil moisture levels as related to plant growth alone.

Infections of sugarbeets by *H. schachtii* in both greenhouse and field studies were associated with soil moisture. The especially high infection in nontreated soil (80-100 percent FC) can be attributed to such moisture equating with relatively optimum plant growth conditions. Root growth was good (resulting in a greater chance for nematode-root proximity in these soils) and migration of the larvae to the area of root infection was favored by adequate soil moisture.

Thus, optimum aldicarb control of *H. schachtii* in sugarbeets requires proper placement of the chemical and continued activation of its toxicant in the rhizosphere by appropriate moisture levels. This continued activity is obtained only when soil moisture is sufficient to release the material from granules and transport it to the rhizosphere where control is needed. The required duration of control depends upon the initial nematode population density.

Aldicarb can effectively control nematodes and thus encourage economic sugarbeet yields. However, its use should be discouraged in sugarbeet-growing areas where soil is allowed to become dry, and/or where the first irrigation water is not applied until after the plants have wilted. Such conditions cause precipitaion of the chemical onto the soil, poor nematode control, and loss of feeder roots, resulting in poor plant growth and small yields. Even though subsequent watering will reactivate the chemical and reinitiate its control potentials, the loss in plant growth during the dry period cannot be recovered. This becomes more critical as the nematode population density become greater.

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Land Prices and Zoning on the Urban Fringe

Suzanne Dean
and C.M. (Cy) McKell

It happens regularly in dozens of Utah communities. A developer appears before a local planning and zoning commission to ask a community to annex an 80-acre parcel just outside city limits. The parcel is zoned for agricultural use, but the developer wants it rezoned for 1-acre residential parcels. "At this present price, which is typical of land prices in this whole area, this land simply can't be bought for agricultural use," the developer pleads. "A farmer could never make enough from crops to justify paying such an amount. The only way this land is going to be developed at all is for single family residences."

Developers' arguments that land prices often make zoning, which should be based on a master plan, are unrealistic and can't be simply shrugged off. If price-zoning inconsistencies really exist over a large area, results can only be negative. "Overpriced" sites may simply remain vacant. Development may then "leap-frog" the sites, creating costly, noncontinuous growth and impair the ability of adjacent agricultural uses to continue. More often, perhaps, zoning commissions will succumb to developer pressure and approve more intense development. The result can be a variety of "land use abberations;" for instance, "garden apartments surrounded by farms."[1]

For our farmers:
a new crop of
garden apartments

The Study

In 1976 a study was conducted to determine if serious disequilibrium existed between land prices and zoning in Salt Lake County. The study sought to compare the "developer's feasible price" for land—the price a developer could pay and still develop according to present zoning—with actual prices on 10 developable sites in the county.

Next, the average percent disparity between feasible and actual prices on the 10 parcels was calculated. This calculation represented a view of valley-wide trends. The calculation was expected to help identify types and locations of parcels most susceptible to, and general causes of, "overpricing." Finally, the results were expected to suggest how Salt Lake County and municipalities within the county might act to consider unwarranted land price escalation and preserve their master plans. The example should also be instructive to planning officials wrestling with growth problems on urban fringes.

The study was conducted in the spring of 1976. Since then, the status of some parcels has changed. Land price figures are higher now. But since overall land trends have not changed particularly since 1976, the results still seem to be valid.

The Sample Parcels

The 10 parcels studied were selected from want ads and realtors' listings. All were either for sale at the time or had been sold within the previous 3 months. Except for one two-thirds acre apartment site, all parcels were one acre or larger. Moreover, all had been vacant and non-income-producing for at least 5 years (Table 1).

The sites were selected so they would be well distributed through the Salt Lake Valley. To this end, concentric circles were drawn on a county map (Figure 1). Land in the center circle was mostly inside Salt Lake City. The second ring mostly contained the valley's mature suburbs and the third its developing fringe.

Table 1.
NARRATIVE DESCRIPTION OF PARCELS

Parcel 1

This 280-acre parcel, located west of the Salt Lake City limits at 5600 West, is now developable because an adjacent industrial developer has paid to extend sewer and other services to the area. The land is flat, dry, and presently unzoned. It would have to be annexed and zoned by Salt Lake City to be developed.

Parcel 2

This two-thirds acre parcel at the corner of 5th South and 11th East is in a prime location for apartments. Its city zoning classifications, R-7 and R-6, allow high rise apartments—up to 70 units per acre are permitted with underground parking. It has been vacant several years.

Parcel 3

Once a huge brick yard, Parcel 3, about a mile south of Sugarhouse, contains 57 acres. It is possibly the largest vacant, developable tract so close to Salt Lake's urban center. The plot's future has been discussed widely. Salt Lake County's Big Cottonwood Master Plan, dealing with a 50 square mile area of the valley, gave special consideration to the property. The plan said the county should resist attempts to create a major shopping center there but that a mixture of light commercial and multiple residential uses could be considered. The plan map programs the land for R-M zoning, which permits about 20 units per acre. The parcel has been vacant several years, and the owner's asking price has consistently been high.

Parcel 4

This 18-acre parcel is located just above the city limits and above the prestigious Oak Hills residential area. A local family has been holding the plot and nearby land for decades. With annexation by Salt Lake City, the parcel is presently developable as a single family subdivision.

Parcel 5

This 10-acre parcel in southwest Salt Lake County, at about 2200 West 6700 South, sits on the fringe of rapid, intense development. Ivory and Co., a major development firm, purchased it for one phase of a series of subdivisions the company is creating. The land is presently suitable for development.

Parcel 6

This 30-acre single family-zoned parcel is near Murray in an area of mixed housing values. It has remained vacant while the surrounding area has developed completely.

Parcel 7

These 62 acres in the east-side Butler vicinity near 70th South are completely surrounded by residential development and probably have never been farmed. Development could proceed as soon as the land is purchased.

Parcel 8

This quarter-section is located in a zone requiring five-acre agricultural plots. Surrounding land is open. To develop a subdivision, the developer would have to annex to West Jordan, get West Jordan to rezone the land, pay the West Jordan per-lot water hookup fee and extend the sewer.

Parcel 9

This 41-acre parcel is at 9800 South 23rd East in the Draper area. The area remains somewhat rural, although there has been recent development activity. The site is zoned for a subdivision.

Parcel 10

The owner of this 67-acre parcel at 90th South and 35th East has held the property for some years, using it periodically to pasture horses. The land is flat and has no view. Development is just beginning to fill in the surrounding area. The parcel is master planned for a subdivision.

Comparison of Actual and Feasible Land Prices on Specific Sites

Ivory and Co., a large Salt Lake City development firm that has developed various types of housing for almost all income levels and in all parts of the county, supplied various land cost and income estimates and suggested a formula for calculating feasible prices. Firm officials also made several preliminary observations that proved significant. Zoning, they noted, nearly always exerts some influence on land prices. A land parcel zoned for apartments nearly always costs more than the same size parcel zoned for single homes. And if zoning's influence on all land prices was strong and consistent, all prices would be "feasible." However, if one calculated the valley-wide average price a developer can pay for land and still break even in various single family zones in Salt Lake County, the "feasible" price would sometimes increase even as the number of units allowed per acre decreased. Prestige value of larger lots, Ivory and Co. officials said, overshadows value lost with density restrictions.[2] Zoning in general seems to be a factor, but not the controlling variable, in land prices.

Using Ivory and Company's method of calculation, the 10 sample parcels were arranged into a table of actual and feasible land prices (Table 2); this table shows, for instance, that the developer's break-even price for Parcel No. 1 is 262.3 percent *above* the actual price, meaning the developer conceivably could pay the seller's asking price *plus* more than 2 times that price. And he could pay an amount 226.0 percent above the seller's price and make a 10 percent profit. Disparities were calculated according to the formula

$$D = \frac{a - b}{c}$$

where D = the disparity, where a = the developer's break-even or profit point price, where b = the actual land price, and where c = a when a $<$ b or b when b $<$ a.

Though not vital to this study, 1976 estimated combined prices for homes and lots on various parcels were included on Table 2 in Column 5. Mortgage financers generally do not approve a loan where the lot cost is more than 1/4 of the home-lot package price. Consequently, if a lot costs $11,500, the home-lot package will cost at least $55,000 (Parcel 7, Table 1). It appears land price escalation not only skews development patterns but helps push home prices beyond what many families can afford.

Average Valley-Wide and Regional Land Price Disparities

Can developers afford to purchase land without seeking rezoning? For the 10 parcels, the average disparity, shown in Table 3, between break-even and actual prices was 1.9 percent; developers on an average could pay only 1.9 percent more than sellers were asking without losing money. But the average disparity between selling prices and the feasibility profit point was —16.9 percent, indicating that asking prices, on average, would need to drop noticeably for developers to achieve what they view as an acceptable profit.

Profit-point disparities varied sharply, however, with location. The average disparity for parcels in the central ring—those located within 6 miles of Salt Lake City's center—was 54.4 percent. In other words, central parcels could be developed profitably under the existing pricing and zoning. In the middle ring, the disparity between actual and feasible prices was —14.9 percent, the smallest in any of the three rings and less than the average disparity for the 10 parcels. But land in the outermost ring (the developing fringe) seemed grossly overpriced vis-a-vis zoning: disparities there averaged —114.0 percent.

Forces Behind Land "Overpricing"

One could logically blame land price disparities on speculation—owners holding out for what they believe will be higher future prices. Undoubtedly, speculation *is* behind some disparities. But the pattern of average disparities in the three concentric rings in the county hints that speculation is not the prime problem. In the central area, which developed first, one could assume, owners of any still-vacant land have been holding out longer than owners in other locations. Logically, the longer they have remained unsold, the more overpriced parcels are. Consequently, greatest disparities should be at the valley center. Instead the opposite seems to be true (Table 4).

Disparities may be highest in the developing fringe for any of several reasons. For one thing, central and suburban development may help raise fringe prices before the parcels are ever offered for sale. A farmer located near the city or in suburbs "sells his land to a land speculator or dealer at a relatively high price, and with that capital is able to bid successfully for a farm, perhaps a larger and better one, somewhat further away, and the farmer from whom he buys in turn is able to bid for still another farm in a

Carol Grundmann

still more remote location. Like ripples in water . . . the initial increase in land price . . . tends to spread outward diminishing in force, but nevertheless noticeable for some distance. This phenomenon also applies regionally. Many land buyers from California who have sold land there for high prices are now offering relatively high prices for land in Utah."[3]

When development finally approaches the fringe, land owners may rapidly raise prices or put new parcels on the market. The owners calculate that at last they will be able to persuade the zoning commissions that the area is "gone" and agricultural zoning is obsolete. Parcel 5 provides an example of the impact of newly-arrived development. Six years ago, land in the same area was selling for $3,500 an acre; 5 years ago, $5,000 an acre; 4 years ago, $6,000 an acre, 3 years ago, $6,500 an acre and, at the time of the study, $9,000 an acre.

Figure 1. Map showing Parcels 1 through 10.

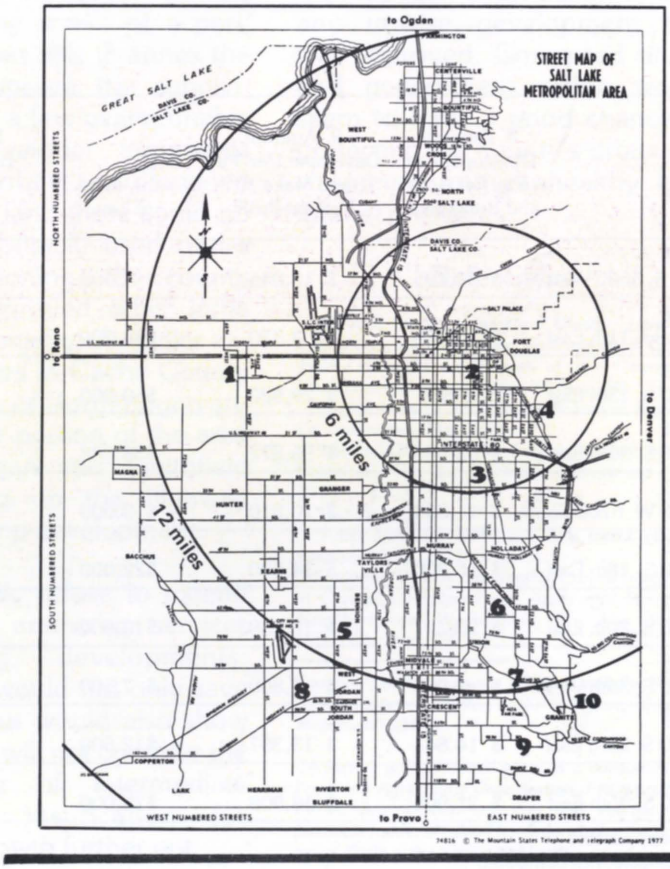

Table 2. COMPARISON OF ACTUAL AND FEASIBLE LAND PRICES

1. Parcel	2. Acres	3. Zoning	4. Market Price for Lots in That Location	5. Est. Prices for Home and Lot Considering Surrounding Area	6. Developer's Total Revenue from Lot Sales	7. Land Development Costs Per Acre
1 500 S. 5600 West	280	None Expect annexation to SLC as equivalent to R-1-6 5.0 units/acre	$ 5,800	$ 29,000	$29,000	$14,505
2 500 S. 11th East	60	R-6 70 units/acre	N/A*	Rents: $175-$300/Month	N/A*	$10,080
3 3300 S. 13th East	57	R-M Multiple residences, 20 units/acre	N/A*	Rent: $185-$250/Month	N/A	$ 3,200
4 1300 S. 30th East	18	R-1-10 3.2 units/acre	$30,000	$110,000	$96,000	$33,920
5 2200 W. 6700 South	10	R-1-10 3.2 units/acre	$ 9,000	$ 43,000	$28,800	$17,456
6 6400 S. 18th East	30	R-1-8 3.6 units/acre	$10,000	$ 60,000	$36,000	$19,800
7 7200 S. 20th East	62	R-1-8 3.6 units/acre	$11,500	$ 55,000	$41,400	$21,123
8 9000 S. 36th West	80	A-5 One unit per 5 acres	$10,000	$ 35,000	$ 2,000	0.00[1]
9 9800 S. 23rd East	41	R-1-8 3.6 units/acre	$ 9,500	$ 45,000	$34,200	$19,359
10 9000 S. 35th East	67	R-1-10 3.2 units/acre	$13,000	$ 52,500	$41,600	$20,592

*Not applicable
[1]Negligible, not computed

	8. Amount Developer Can Pay Per Acre and Break Even	9. Amount Developer Can Pay and Make 10 Percent Profit	10. Price of Land	11. Difference Between Actual Price and Break Even Point	12. Difference Between Actual Price and Profit Point	13. Disparity Between Actual Price and Break Even Price (%)	14. Disparity Between Actual Price and 10 Percent Profit Point (%)
1 500 S. 5600 West	$ 14,495	$ 13,046	$ 4,000	+ 10,495	+ 9,046	+262.3	+226.0
2 500 So. 11th East	$115,920	$103,320	$88,000	+27,920	+15,320	+ 31.8	+ 17.4
3 3300 S. 13th East	$32,800	$ 29,520	$50,000	−17,200	−20,480	− 52.5	− 69.3
4 1300 S. 30th East	$ 62,080	$ 55,872	$38,888	+23,192	+16,984	+ 59.6	+ 43.7
5 2200 W. 6700 South	$ 11,344	$ 10,210	$ 9,000	+ 2,344	+ 1,210	+ 26.0	+ 13.4
6 6400 S. 18th East	$ 16,200	$ 14,580	$22,000	− 5,800	− 7,420	− 35.8	− 50.8
7 7200 S. 20th East	$ 20,277	$ 18,250	$19,600	+ 677	− 1,350	+ 3.4	− 7.3
8 9000 S. 36th West	$ 2,000	$ 1,800	$ 7,500	− 5,500	− 5,700	−275.0	−316.6
9 9800 S. 23rd East	$ 14,841	$ 13,357	$12,500	+ 2,341	+ 857	+ 18.7	+ 6.8
10 9000 S. 35th East	$ 21,008	$ 18,908	$25,000	− 3,992	− 6,092	− 19.0	− 32.2

*Not applicable
[1]Negligible, not computed

Operating methods in the development business further encourage fringe price escalation. Because they want to maintain volume, developers are constantly seeking land. "Landowners have reservation prices, below which they will not sell, but they are prepared to take advantage of higher prices. Developers will pay higher prices, perhaps reluctantly, rather than cease to operate, especially during periods of high demand for housing. The pressures are all upward."[4]

Recommendations

Land prices and zoning do not seem to be in equilibrium in Salt Lake County or in other urban fringe area along the Wasatch front. To discourage further land overpricing and to keep disparities from undermining planning goals, county and local governments must:

1) Deny zoning changes, especially those requiring an extension of public services in locations that are distant from existing developments or communities. Zoning commissions, said a Salt Lake City planner, "must let people know that zoning changes aren't easy to get." Then, perhaps, fewer persons will raise prices expecting to obtain such changes.[5]

2) Agree on a policy that makes it more difficult for municipalities to annex land. Present annexation law enables developers to evade zoning denials. In the early 1970s, for example, Salt Lake County rejected two subdivisions on the southeast bench on grounds the developments were premature for the area. With little more than the stroke of a pen, Sandy City was able to annex the land and approve the subdivisions. Within a few years, unable to resist developer arguments that the area had now "opened up" and that land there could no longer be profitably used under agricultural zoning, the county itself had approved other large subdivisions nearby. A similar example occurred in Cache County where the city of North Logan annexed a large portion of the area between Logan and Smithfield thus opening up the highway frontage to strip development.

3) Generally refuse to extend sewer, water and other services to "leapfrog" developments. Such action would not only save tax money but would also show that localities will not consider the excess price of intermediate parcels as justification for premature growth further out.

4) Enter the land market themselves where the unsubsidized private dollar cannot provide desired land uses. Redevelopment agencies with eminent domain powers already are operating. Public purchase, possibly through bond issues, to preserve bench land as open space has been discussed. A National Urban Coalition conference called on cities to use condemnation to help developers assemble certain sites. Such a program could enable developers to purchase, at fair market price, overpriced sites that are blocking orderly growth.[6]

Much also could be accomplished by a private-planning watchdog group. Such a group could make sure zoning is enacted to conform with master plans. It could testify at meetings against proposed zoning changes that would violate the plans. And it could seek court action to stop any unwise development that was approved. Concerted citizen and government action would seem to have a good chance of protecting the county's urban environment from unhealthy land market pressures.

Columns 1-3 list the 10 sample parcels' addresses, sizes, existing zoning classes and the number of units per acre allowed in the classes. Column 4 shows the amounts Ivory and Co. officials estimated they could charge for lots if their firm were developing those parcels according to the zoning shown, and Column 6 shows resulting lot sales revenue a developer could expect per acre. This second figure was derived by multiplying allowed number of lots (Column 3) by the individual lot price (Column 4).

Using the mathematical formulas, suggested by Ivory and Company results in the "land development costs per acre" in Table 2, Column 7.

Subtracting per-acre costs from per-acre anticipated revenue will give amounts developers can pay per acre and break-even—feasible break-even prices (Column 8). Ivory and Co., indicated however, most firms in the development industry feel they should make at least a 10 percent profit on land sales. So in Column 9, a sum equal to 10 percent of gross lot revenue is subtracted from the break-even price to produce the "amount a developer can pay and make a 10 percent profit"—or the "feasible profit point price."

Finally, Column 10 lists actual per-acre asking prices for the parcels. Columns 11 and 12 show the differences in dollars, plus or minus, between these sums and feasible break-even and profit point prices. The last 2 columns express these "differences" in uniform percentage terms (disparities).

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[1]Council on Environmental Quality, *Land Use* (pamphlet), reprinted from *Environmental Quality, 1974—Fifth Annual Report of the Council on Environmental Quality*, Dec., 1974, p. 52.

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[3]Marion Clawson, The Suburban Land Market, Baltimore: The Johns Hopkins University Press, 1973, p. 130.

[4]Ibid., p. 126.

[5]Allen Johnson, Salt Lake City senior planner, interview, July, 1977.

[6]Anthony Downs, *Stimulating Capital Investment in Central City Downtown Areas and Inner City Neighborhoods*, Washington, DC: The National Urban Coalition, 1973.

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Fellfields and Cushion Plants of the Rockies

Nicos G. Marinos

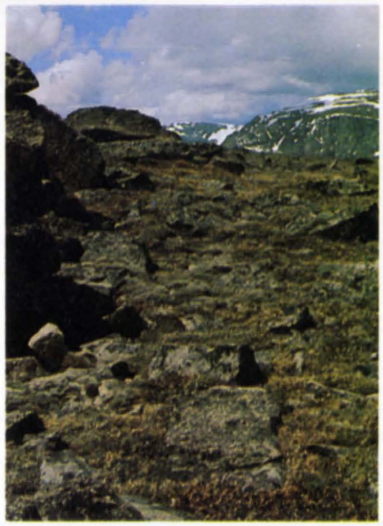


Figure 1.

I have been interested for some time in the physiology and changes in cellular ultrastructure of plants that have been stressed to the limit of their adaptive capacity by extreme environmental conditions. It was not, however, until recently that I considered injecting the realities of field situations into my laboratory oriented approach. It was a big step for a "laboratory bred" plant physiologist who behaved as if plants normally occur in culture flasks, growth rooms and, maybe, in greenhouses! It was a conscious attempt to change this frame of mind that guided my steps to the alpine tundra of the Colorado Rockies—a choice that was influenced greatly by my propensity for high places—during my sabbatical leave in the United States.

Figure 2.

Figure 3.

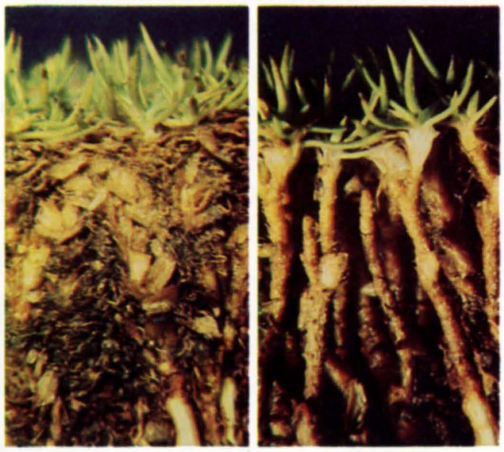


Figure 4.

The alpine tundra is a harsh environment by human standards: high radiation levels, air temperatures that change violently in the course of a day during the growing season and dip well below freezing in the winter, and winds that seldom cease and often howl over the tundra at over 200 mph. Add to these conditions generally poorly developed soils and, in many parts of the tundra, scant soil moisture and we have a remarkably forbidding environment. Yet, over 350 species of higher plants in the Colorado Rockies call this confluence of environmental perils their home! Clearly such plants must be endowed with structural and physiological adaptations that enable them to make efficient use of limited resources.

I first saw the tundra in May. It was rather dull in color and seemed poor in promise, with little to give even a hint of the vibrant life that waits to burst into view during the short growing season. The later emergence of the tundra as a fascinating ecosystem with different types of plant communities thriving in fairly well defined areas was an exciting revelation. The unstable talus slopes, the fellfields, the sites disturbed by the frost heaving of the soil, the alpine bogs, and finally, the meadows where the tundra is at its best in displaying a floral diversity of unforgettable beauty—all were impressive in their way.

The Fellfields

While trying to get a broad understanding of the tundra, I found the rock-strewn fellfields (Figure 1) particularly interesting for a number of reasons. They are exceptionally harsh places in the winter (Figure 2) when the winds blow away the snow and leave the ground exposed and dry for a good part of the year. They also occupy a critical position in the successional sequence of the tundra between the rocky greyness of the summits and talus slopes and the gentle greeness of the meadows.

Although about 70 species of higher plants grow in the fellfields of the Colorado Rockies, the dominant form of vegetation consists of about half a dozen species that are collectively known as cushion plants (Figure 3). These low, ground-hugging plants, unlike all the other perennial herbaceous species of the tundra, remain exposed on the surface throughout the year, bearing the full brunt of the elements. They epitomize many of the adaptive features expected in plants inhabiting severe environments.

Some of the more obvious parameters that affect the fellfield community of plants have been brought together in Table 1.

Why Cushions?

The cushion growth habit is of pivotal importance to the survival of these plants while fully exposed to the erosive forces of the winter winds. Analysis of the internal structure of cushions can give us some rather interesting insights. For example, the moss campion (*Silene acaulis*) is justifiably considered the archetypal cushion plant. It is extremely compact and a very successful pioneer on exposed sites. It occurs in both alpine and arctic tundras. If we slice into a moss campion cushion, we encounter a solid mass of living and dead stems, dead leaves, roots, soil, and fine gravel (Figure 4A) that makes it impossible to discern its internal structure. Removing all the debris (Figure 4B) reveals a veritable forest of shoots, each one ensheathed by the bases of old, dead leaves. The surprise in the successive horizontal layers of a moss campion cushion is the large proportion of the cushion that is made up of dead but nondecomposed plant organs (Table 2). Similarly, in all other cushion species, over 70 percent of the total plant material in a

Table 1. The fellfield environment and the "design requirements" of plants adapted to it.

Season	Environmental challenges	Possible effects on plants	Main "Design requirements"
Winter	• Very high winds	Dessication	• No functional leaves • Cushion habit (if plant exposed) • Overwinter underground
	Ice and sand blasting	Abrasion	
	No snow cover Chill factor • Very low temperatures	Freezing	• Morphological insulation (e.g. buds enclosed within layers of dense mats of hairs) • Ultrastructural cytoplasmic changes that lead to freezing tolerance • Metabolic adaptations (e.g. formation of high molecular weight "antifreeze" substances) • Dormancy
Summer	• Low soil moisture • High winds	Desiccation	• Extensive water uptake system • Large water storage capacity, succulence • Transpirational control (leaf shape, size, depressed stomates)
	Sand blasting	Abrasion	• Low growth habit, e.g. cushion • Overall mechanical strength
	• Sudden temperature fluctuations	Metabolic dysfunction	• Enzyme systems of wide temperature range tolerance • Morphological insulation leading to a dampening of temperature fluctuations in the tissues
	• Sudden radiation level fluctuations	Photosynthetic dysfunction	• Tolerant photosynthetic system (e.g. enzymes, chloroplast ultrastructure) • Morphological protection of the photosynthetic system (e.g. hairy and glossy leaves that would dampen the effect of radiation fluctuations)
	• High radiation levels Visible spectrum	Damage of the photosynthetic system	• High leaf reflectance (glossiness, hairiness) • Structural shielding of the photosynthetic sites • Tolerant photosynthetic system (enzymes, chloroplast ultrastructure)
	Heat	Desiccation and Metabolic dysfunction	• Leaf shape, size and thickness conducive to heat dissipation • High leaf reflectance (glossiness, hairiness) • Efficient transpirational cooling • Extensive water uptake system • Heat tolerant enzyme systems
	U.V.	Nucleic acid related damage	• High leaf reflectance (glossiness, hairiness) • U.V. absorbing epidermal tissues (e.g. epidermal anthocyanins)
	• Short growing season	Incomplete life cycle	• Efficient photosynthesis • Rapid initiation and completion of the reproductive phase of development • Reproductive phase spread over two or more seasons.
	• Poor soil nutrient supply	Mineral Deficiencies	• High extractive capacity of the roots • Low metabolic requirements for mineral nutrients.

cushion is likely to be dead but persisting. This points to a broader aspect of fellfield dynamics: the extremely slow rate of recycling of organic materials.

The rate of this recycling can be estimated by determining the age of the dead leaves that remain attached at various levels inside the cushion. We know that each shoot of a cushion like the moss campion produces 3-4 pairs of leaves every season. By counting the number of dead leaves down a shoot we can estimate their age at different levels. In a tight cushion like the moss campion it is quite common to find dead leaves that had functioned 40 or 50 years ago! In less dense cushions like the sandwort (*Arenaria obtusiloba*), the period of persistence tends to be shorter. Protracted low temperatures and basically dry conditions clearly do not favor profuse populations of and high activity by decomposing soil organisms.

The slow recycling of organic materials combined with the slow growth rate of cushion plants (the mean rate for all species of cushion plants in a typical fellfield site is about 1.5mm per shoot per season) contributes to the slow regeneration of fellfields following natural or man-made disturbance. This fragility is dramatically visible in the Rocky Mountain National Park. The Ute Indians, over hundreds of years before the days of the white man, made annual migrations over the Continental Divide. These movements gradually etched a trail across the high tundra. Although the trail has not been used for a long time and some invasion by cushions is under way, the scar is still plainly visible.

The importance of compact structure to survival in the tundra is underlined by the appearance of cushions that have been somehow damaged. The wind abrades and exposes their internal structure in often spectacular ways (Figure 5). Once damaged, a cushion inevitably falls victim to further erosion and desiccation until it perishes.

Table 2. Analysis of the internal structure of a moss campion (*Silene acaulis*) cushion. The sample was obtained from the central area of the cushion and measured 4cm x 5cm in surface area and 4.5cm in depth. Each level represents successive 1.5cm deep layers. All values are expressed as grams dry weight.

Level	Current season's growth	Living stems	Dead plant Matter	Soil and fine gravel
Surface	0.5300	0.2933	3.3928	1.0137
Middle	——	0.5928	3.4974	3.7700
Bottom	——	1.0557	4.7274	4.9627
Totals	0.5300	1.9418	11.6176	9.7464

Dead matter as % of total plant matter in the cushion: 82.45%

Productivity

I found cushion plants a constant source of surprise. Their slow growth rate, for example, does not prepare one for the figures that emerge when one calculates their net productivity expressed in $g \cdot m^{-2}$ (of leaf surface, one side) $\cdot$ day^{-1}. (The calculated values are based only on the amount of current season's leaf growth and do not include assimilates that have contributed to growth and storage in stems and roots.) The figures range from a low 2.55 for *Phlox condensata* to a high 4.42 for *Silene acaulis* with a mean of 3.43 for all 6 main cushion species. The surprise comes when these values are compared with the productivity of a maize crop (whole plant yield) in Minnesota that has had, undoubtedly, a great deal of care lavished upon it: 11 $g \cdot m^{-2}$ (ground area, normal crop density) $\cdot$ day^{-1}. So cushion plants must be quite efficient photosynthesizers under adverse conditions. My planned examination of leaf anatomy and untrastructure may give us clues as to how they do it.

Other Adaptations

Water is often scarce in the fellfields, and the risk of desiccation is compounded by the dry winds and high temperatures that build up within a cushion during bright sunny days when cushion temperature may be 15-20°C higher than air temperature. The water relations of cushions remain to be investigated, but some morphological features are strong indicators of a well developed water uptake and conservation system. Their roots are relatively deep and extensive, while their stems within the mass of the cushion are thick and with large water storage capacity (e.g., Figure 5). The leaves of a cushion plant are rather glossy and succulent with depressed stomates. All these are devices that enable a plant to extract water from the soil, store it, and reduce its loss.

Figure 5.

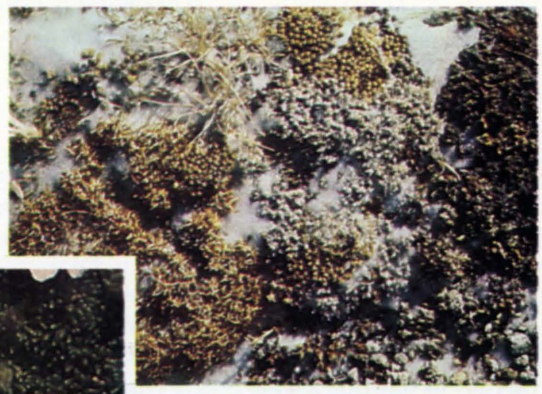


Figure 6.

Figure 7.

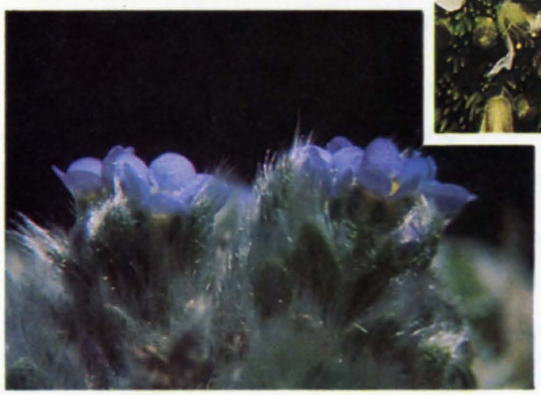


Figure 8.

Figure 9.

Cushion plants also demonstrate another adaptive feature common to tundra plants. Flowers that will be seen in 1978 were initiated and partly developed during 1977. In other words, the dead looking cushions we see in the middle of the winter (Figure 6) hold in trust, within the tiny buds that in most cushion species are exposed right on the surface, the floral display (Figures 7, 8, 9) that brightens the fellfields in June and July. By early fall, floral development has progressed to the point where the primordia of all the parts of the flower—sepals, petals, anthers, pistil—have been laid down, then development ceases. Although at the time of writing this article I have not had the opportunity to examine collected material to determine the stage of development of pollen and egg cells, I am certain, from the general developmental stage of the overwintering buds, that the formation of the reproductive cells is arrested at some premeiotic stage.

Such a reproductive behavior is sensible from the survival point of view considering the very short tundra growing season. The development of a flower consists of two particularly sensitive stages; initiation of the flower and development of the reproductive cells. Further, reproductive development is a time and energy- consuming process. When floral development is spread over at least two seasons, critical stages can be completed during the relatively favorable periods of successive seasons, minimizing the risk of developmental failure. Furthermore, the preformed flowers are ready to bloom rapidly with the coming of spring to the tundra. No time is wasted.

Literature on the physiology and ultrastructural cytology of alpine cushion plants is singularly silent. Yet, I am convinced that cushion plants must hold, within their rather humble appearance, some very interesting answers to a whole range of questions about the mechanisms of adaptation to severe environments. It seems that we need more botanists who combine a professional interest in such questions and a dash of personal madness that will lead them to the high country, where they would have to endure the same environmental challenges (without the built-in adaptive mechanisms) as the objects of their study.

Nicos G. Marinos is Professor of Biology at the Flinders University of South Australia, working on his sabbatical leave with Frank B. Salisbury, Professor, Plant Science Department, USU. The study reported here was supported partially by the Utah Agricultural Experiment Station.

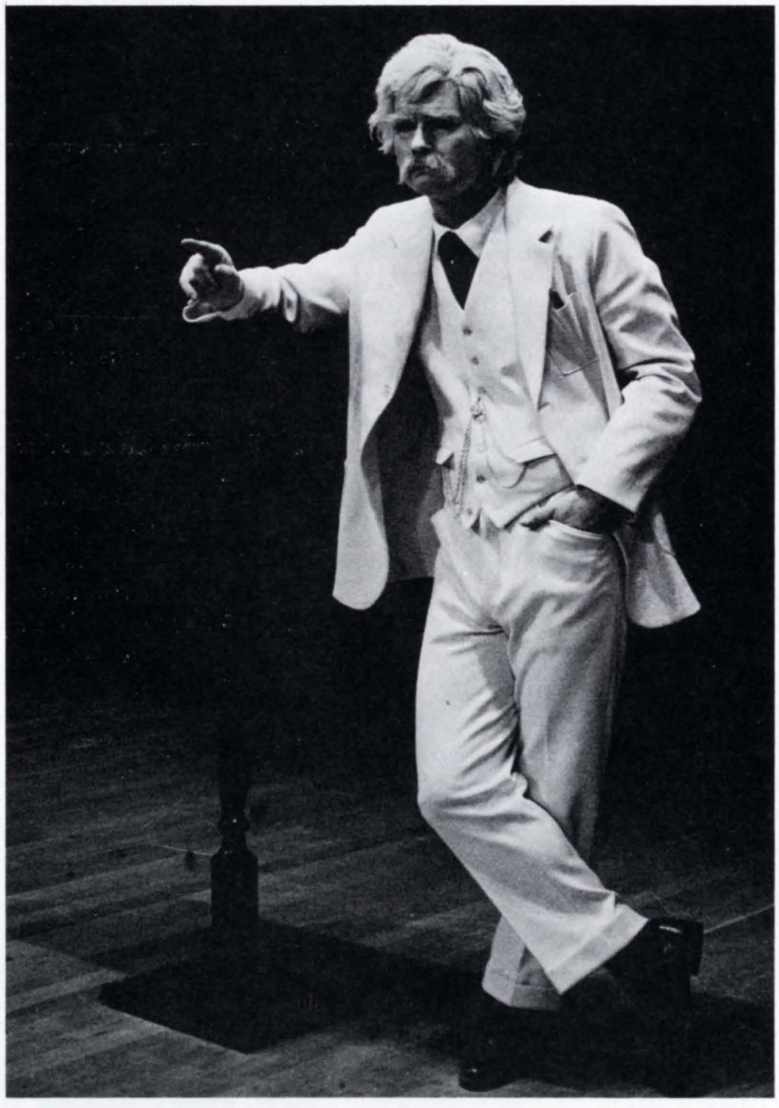
Culture in the Country: A Grassroots Approach

Glenn R. Wilde
and Richard C. Haycock

Although Utah is one of our nation's youngest states, Utahns can point with pride to its cultural achievements and development. Utah supports nationally-recognized organizations such as the Utah Symphony, Ballet West, and the Repertory Dance Theatre, as well as nine state-supported and two private colleges and universities which contribute substantially to the cultural life of residents.

Nevertheless, most of the social and cultural development has flourished along the Wasatch Front, a narrow strip of land about 10 miles wide and a hundred miles long in which seventy percent of the state's population resides. The remainder of the state's population is scattered, residing on farms which surround "hub" or service communities with populations ranging from one hundred to five thousand residents.

Most of these rural communities were established before 1880 as Mormon colonies, and many, if not most, have maintained a cultural identity and continuity with their past. Isolated and separated by great distance, these rural communities were forced to create indigenous forms of entertainment—occasional community dances, a local community orchestra or church choir, and a local dramatic society. But



Larry Cantwell performing a Yours Truly, Mark Twain presentation for rural communities.

*The National University Extension Association gave a Special Recognition Award to the Utah Rural Arts Consortium during its national conference in April, 1978. This award was one of six given for continuing education programs of exceptional merit from throughout the United States as judged by a panel representing the NUEA and the American Council on Testing (ACT).

with the age of television and the decline of the family farm since the 1940's, the cultural fabric of the rural community changed.

Defining Problems of Rural Cultural Development

Most rural communities in Utah, as well as throughout the nation, experienced a population decline following the Second World War. This decline may be attributed to a number of factors, including the economic returns on a small family farm, the desire of young people to go to college for broader and more remunerative employment prospects, and the lack of business and industrial development in these rural communities to provide employment for the young. Many left the rural areas for employment in California, Washington, and Oregon, removing, in a sense, the future vitality for the rural Utah community.

These factors have had ramifications on the quality of life enjoyed by rural Utahns. Concerns about providing adequate health care and facilities, about maintaining educational opportunity in the public schools, and about developing business and industrial opportunities became major issues for state and local governments to resolve.

Defining the Issue of Rural Cultural Development

In 1971 the Extension Services of Utah State University and the Intermountain Regional Medical Program (IRMP) co-sponsored a problem identification workshop on rural resource development at Utah State University. In 1970 there were 1,382 licensed physicians in Utah, but of this number only 148 were practicing in rural communities, although these communities comprised about thirty percent of the state's population. Forty community leaders from the six-county area (south-central Utah) and the Uintah Basin were selected to participate in the workshop, among whom were medical personnel, elected officials, business and civic leaders, and school personnel. One of the significant conclusions of the workshop was that there was a relationship between the cultural and social opportunities available in a rural community and the community's ability to attract doctors and businesses.

The Utah Rural Arts Consortium grew from a simple idea that cultural resources of our universities could be shared with rural communities.

Doctors and other professionals, accustomed to broader cultural and educational opportunities surrounding colleges and universities, had, at that time, less desire to move to rural areas with fewer social advantages, even though their earning potentials may be similar to those in the more competitive urban areas. Business consultants also stressed the desirability of cultural and social opportunity as one of the factors in locating manufacturing plants in rural areas of the state. For major businesses, social and cultural factors are a part of a general community profile; admittedly these factors did not weigh as heavily as transportation, capital, or availability of a qualified work force, but it was significant that both doctors and businessmen identified cultural and social opportunity as a factor for revitalization of the rural community.

USU's Kellogg Quality of Rural Life Program Development

For nearly a year following the community problem-identification workshop, the idea of rural cultural development lay fallow. In 1972 Utah State University was awarded a $600,000 grant for rural development in the western states: social and cultural development was one of the identified major thrusts.

The Utah Rural Arts Consortium grew from a relatively simple idea that cultural resources at colleges and universities in the state could be shared with rural communities on a non competitive basis, and that through coordination and planning with communities, this could be efficiently and effectively accomplished. Three goals were established, which remain the continuing objectives for the Consortium, under the Utah Division of Fine Arts:

(a) to expand the existing cultural resources of state and private institutions to rural areas throughout the state through a coordinated and planned effort by institutions and communities;

(b) to develop a cultural climate in local communities which would be conducive to the local support and development of cultural arts and arts organizations; and

(c) to make efforts to afford through continuing education activities, both at the university and community levels, a broad and developmental program in the arts.

Although simple in concept, the Utah Rural Arts Consortium is a highly complex organization. A planning process model utilizing Program Evaluation and Review Technique (PERT) methodology was developed during 1973-74 (Wilde, USU, 1974) which was specifically designed for cultural development for areas of low population density in rural western states. Basically, the PERT model identified three general areas for research and development: (1) community needs assessment; (2) consortial organization and consortial-community planning; and (3) pilot program implementation and evaluation. This model is available at Utah State University, and can be adapted for use by other agencies for the development of similar programs.

Rural Cultural Needs Assessment

In an effort to aid in planning and development for the project, a community survey was conducted to broadly assess attitudes about and interests in cultural and social programming in rural Utah (Wilde and Haycock, USU, 1974). The survey sought three basic information items: (1) the relationship of cultural development to broader goals of community development; (2) the enrichment of the local public school curriculum and the kinds of enrichment programs deemed vital: and (3) the selection of the kinds of programs which would be best received by members of the community.

The cultural arts survey was conducted in four rural counties—Juab, Millard, Sanpete and Sevier—which were considered a "macro-community." The combined population of these four counties was slightly over 31,000 residents: these peo-

Active participation of school children in learning mime by working with members of the professional Oregon Mime Troupe.

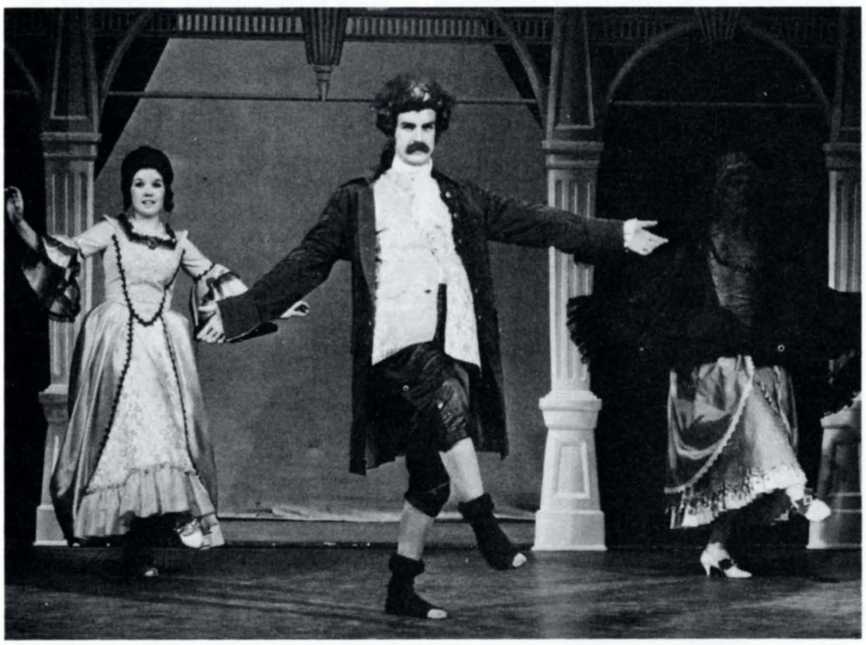
ple shared similar social and cultural values and economic activities. Furthermore, the area, like other energy-rich rural areas throughout Utah, had potential for economic growth.

Sample Design

A random sample of 306 households was drawn by the Bureau of Government and Opinion Research of Utah State University. The sample selection was apportioned according to the current population of each county. The sample was designed to yield statistically significant data with a tolerated error factor of plus or minus 4% and a confidence level of 95%. The survey instrument was pre-tested to validate its utility.

Survey Findings and Analysis

One of the most significant findings was that over 86% of the residents surveyed believed that cultural and social programs should be included in long-range community development planning by state and local leaders. With the many problems associated with rural development, cultural and social development has often been overlooked and neglected as a consideration for broad community development programs. Furthermore, over 84% of the residents indicated that they would attend programs and performances if they were available in the community, but only 72% of the respondents committed themselves to paying admission to attend and many indicated that it would depend on the nature of the program. Only five percent indicated that they would neither support nor attend. To validate the responses, both Spearman and Kendall computer correlations were used: in both correlations the significance levels were 0.001 for the above questions. This, of course, indicated that the responses were consistent.



Utah State University Musical Theatre Production of "The Contrast" which toured rural communities in 1977.

Opportunities in Rural Schools

Partly because of the decline in the child-bearing population in rural areas, the curriculum opportunities were also narrowing, and to some extent, programs in the arts were limited. In the survey, four questions were related to curriculum enrichment in the public schools: over 85% of the respondents agreed that workshops would benefit the school curriculum, and nearly 92% of the respondents believed that such exposure and "hands on" experience would benefit students and older residents. Again, there was a significant correlation among residents.

Community Desires and Program Planning

To ascertain the varieties of cultural programming the residents would support in their communities, specific questions were asked about cultural forms, such as theatre, music, dance, and visual arts. Each of these general groupings were then broken into particular types of cultural programming (including examples) for selection. The survey revealed diversity in the types of cultural programming which residents would support, although there was concurrence that they would broadly support cultural events.

Nearly 80% of the respondents would like to have "live" theatre productions available to their community. Table 1 lists the

types of theatre productions in rank order according to these community preferences.

Musical programs seemed to be the best supported, with nearly 90% of the respondents favoring programs: however, when indicating particular types of musical productions, the greatest number preferred musical theatre (see Table 2). Nearly 74% of the respondents indicated that they favored dance programs and workshops, and nearly 81% favored art exhibits and workshops in the visual arts and crafts.

Although the survey-assessment was conducted in only four rural counties, the conclusions, it was assumed, would be most likely similar to those in other rural regions within the state. A state-wide survey of cultural activities in Utah conducted by the Bureau of Community Development at the University of Utah (Gisler, et. al., October, 1974) confirmed many conclusions of the Utah State University survey. One further conclusion of the University of Utah survey is worth noting: the rural residents were more interested in becoming involved in cultural activities and "hands on" experiences in the arts than residents living in medium-sized to highly urban communities. Dr. John Gisler, the principal investigator, surmises that this may be due to the inaccessibility of cultural opportunities.

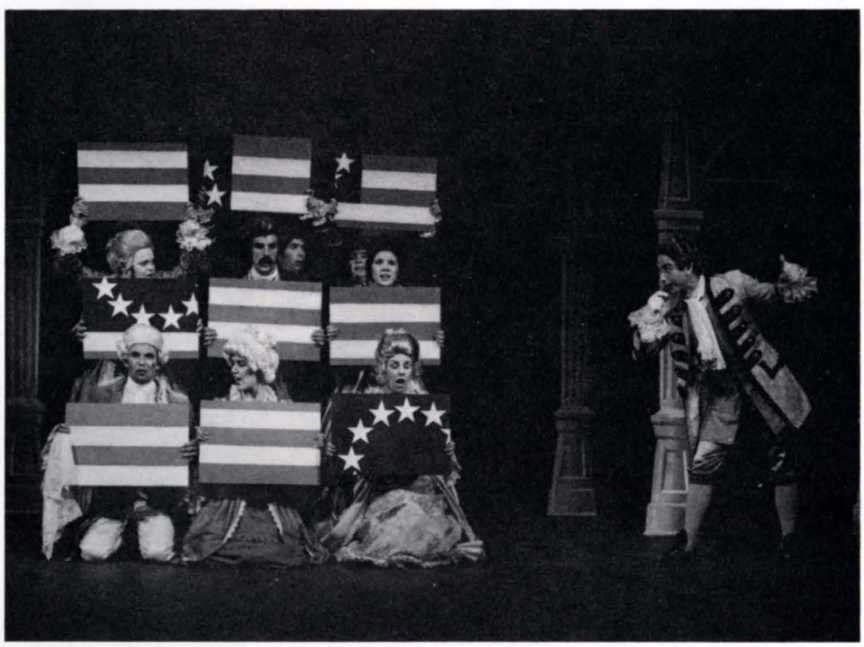
At the same time the survey was being conducted and assessed, a consortium of Utah's colleges and universities was being formed. This consortium not only organized the touring productions and program, but also worked in local communities to organize sponsoring groups to support the cultural events.

Table 1: Theatre Forms and Community Desires (The following forms are in rank order according to community preferences.)

Forms	Yes	Don't Know	No
Comedy	79.8	1.3	6.8
Musicals	75.2	1.3	11.4
Drama	62.5	3.3	22.1
Romance and Melodrama	61.9	3.6	22.5
Reader's Theatre	45.3	6.8	35.8
Shakespeare	42.3	5.9	39.7

Table 2: Preferences in Music Forms (The following are in rank order according to community preferences.)

Forms	Yes	Don't Know	No
Popular	72.0	2.9	16.6
Chorale	66.8	2.6	22.1
Symphony	48.9	4.6	38.1
Jazz	41.0	2.0	48.5



A Cultural Mini-Season

In Spring, 1975, the recently organized Utah Rural Arts Consortium initiated a pilot program series in the four-county area, which was supported by funds provided by the Kellogg Quality of Rural Life Program. A series of productions, including musical theatre, chorale, dance, and individual peroformances, toured communities in the area. The minimum community fee was established for each production which was returned to a revolving account for future program development. Revenues collected in excess of the touring fee were to remain in the community for a community development project: in essence, this provided community incentive to sell tickets which would stimulate local cultural activities.

The cultural mini-season was well received by residents in the community, and most communities did generate income for local projects.

The Coming of Age

From its meager beginnings with a budget of only $600, the Utah Rural Arts Consortium now supports over seventy-five major productions in twenty-two rural communities throughout Utah, from Roosevelt to St. George and from Blanding to Logan. Its annual budget is over $75,000, with nearly 50% of this generated from local communities. It is now under the administration of the Utah State Division of Fine Arts, which has employed a permanent tour director and also contributes substantially to the continued operation of the touring program.

The Rural Arts Consortium has had broad impacts in rural communities. Over 12,000 people have participated in arts workshops since expanding the Consortium state-wide in 1976, and even a greater number have attended performances in the communities. In 1975, there were five chartered arts councils in the state of Utah, mostly on the Wasatch Front; today, there are seventeen arts councils to direct community development activities, the majority of which are in the rural Utah communities as a result of Consortium activities.

Postscript

The Utah Rural Arts Consortium was not designed to become a substitute for local cultural initiative, but was dedicated to the purpose of stimulating and complementing local cultural activity. It is through this enthusiasm that a growing sense of community is emerging.

Glenn R. Wilde is Assistant Dean for the Extension, College of Humanities, Arts, and Social Sciences.

Richard C. Haycock is Associate Dean of the College of Humanities, Arts, and Social Sciences.

Drs. Haycock and Wilde are currently engaged in additional research to expand the Utah Rural Arts Consortium concept on a regional basis.

Workmen giving a facelift to the Beaver Courthouse.

Lois M. Cox

Projects in Progress

In this regular feature of Utah Science we briefly describe some of the research in progress across the USU campus. Each installment is a scant sampling of the remarkably diverse research scene.

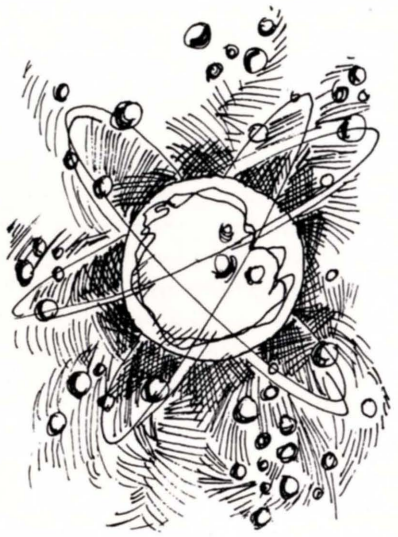
Updating Horatio Alger

The real world rarely delivers a "happily ever after" ending. In fact, to get merely a close approximation thereof demands more persistence and hard work than most of us are willing to invest. But every once in a while, somebody has enough faith in his or her ideas to resist the temptation to give up the struggle. And, when the final results verify what they'd thought, it can verge on a fairy tale come true.

For V. Gordon Lind, Professor of Physics, the prove-up point came in November 1977, after a 7-year series of exasperating frustrations. But the tale actually began even earlier than 1970.

Lind's specialty is high-energy physics, which means that he is concerned with the Lilliputian world of atoms, the neutrons and protons of their nuclei, and the even smaller particles such as mesons that also function in the nucleus. The mesons are especially important since, in a tranquil nucleus, they apparently serve as a sort of nuclear glue—somehow helping to keep the neutrons and protons within bounds.

The energy in this tiny cosmos commonly occurs as photons (involved whenever electrons shift their orbits) and gamma rays (which are given off when nuclear components are disturbed). In fact, specific gamma ray patterns serve as fingerprints for specific



nuclei. But it is the levels rather than the forms of energy that characterize atoms and nuclei that continue to amaze most of us. Scientists such as Lind, who are concerned with high-energy physics, need energy sources that produce in the 800 to 900 *million* volt range in order to carry out experiments. (A car battery is rated at 6 or 12 volts.)

Those experiments are currently designed to answer questions that include: "What does the nucleus of an atom look like; what are its most fundamental components; how do the components operate?" Asthe researchers stuggle with such seemingly impractical questions, spin-off information about energy forms and functions, potentials for "new" elements and compounds, and atom/nucleus relationships eventually is translated into items that affect our daily lives. A prime example of the application of atomic phenomena is in the laser, while nuclear investigations have led to the medical use of previously inaccessible isotopes.

As experimental results accumulated over the past 40 years, the general concensus among the researchers gradually came to be that the nuclear surface was composed of individual neutrons and protons that moved in an orderly fashion. This concept fit comfortably within the firmly entrenched "shell theory" of nuclear form.

But it seemed that the chemical elements hadn't been reading the journal articles. For Lind found in 1971 that when the nucleus of an element such as calcium (which consists of 20 protons and 20 neutrons) was subjected to bombardment with high-energy particles, it gave off gamma rays, neutrons and protons in unexpected combinations. The peculiar thing was that the strongest peaks of emitted gamma ray activity always fingerprinted nuclei that differed from the original by alpha particle *multiples*. (An alpha particle has two protons and two neutrons.) According to the conventional shell theory explanation of nuclear structures, however, neutrons and protons would generally exit from a nucleus as *individual* particles.

To account for the alpha particles, Lind proposed that the nuclear surface might actually consist of neutron/proton clusters rather than just single particles. He therefore suggested that disturbed nuclei could reasonably give off something *besides* protons, neutrons, and gamma rays—namely, preformed alpha particles, and other types of clusters.

Then began the chore of trying to get access to one of the few (1 in Canada and 2 in the United States) facilities where his theories might be tested. Working primarily with O. H. Otteson and R. E. McAdams (fellow USU physicists) and W. F. Denig (a graduate student) to develop detector equipment and procedures, Lind's actual experiments had to depend upon the cooperation of diverse groups of other scientists. (Such collaboration among investigators was mandatory because of the scarcity of research facilities and the complexity of the experiments.) Over the years, some trial runs provided tantalizing hints of unrealized potentials, results from other tests couldn't be followed up, hoped-for beam time didn't materialize, and available equipment and techniques remained too unsophisticated to produce conclusive evidence for or against the alternative concepts.

But then, in 1977, by accepting an unpopular time slot (Thanksgiving), the USU group and their collaborators finally gained entry to the Los Alamos atom-smashing laboratories for a virtually private testing of their newly designed equipment and theories. By using two detectors that operated simultaneously (one to observe particles and one to observe gamma rays), and hooking into a computer that would record all parameters of *all* possible events, Lind, Otteson, McAdams, and Denig managed to give themselves a uniquely memorable Thanksgiving holiday.

Their double detector device, with its 90 billionth of a second response capacity proved fully adequate to identify not only gamma rays and protons as coming from the secondary target nuclei, but pions as well. The significant thing was that the existing pions had lost virtually none of their entry energy. That implied that the preformed proton/neutron clusters fingerprinted by the gamma rays were so loosely held on the nuclear surface that they could be readily dislodged. If the protons and neutrons had had to be knocked loose as individual particles, the pions would have lost much of their energy in the process, and might not have survived at all.

Beyond such implications for theories about nuclear anatomy and function, the Thanksgiving research coup pointed toward possible rationales for currently experimental cancer treatments that are using pions instead of x-rays to penetrate and destroy cancerous tissues. The pions may be able to destroy more of a malignancy, while producing fewer adverse effects on other parts of the body (than can x-rays), because of the apparent nuclear cluster structure.

The story, of course, is far from ended. As soon as the reams of data generated in November have been throughly analyzed, Lind, Otteson, and McAdams will be designing experiments and petitioning for beam time that will give them increasingly detailed insights into the idiosyncracies of atomic nuclei.

A Queen in Trouble

Alfalfa, widely considered royalty among forages, has also gained a reputation in Utah for being a "tough, take-care-of-itself perennial." That reputation, although at first glance well-earned, could be the downfall of the crop. The queen *is* a tough old girl, but she needs help in solving her problems if yields are to be economically attractive.

The seriousness of one of those problems is just beginning to be recognized. Bacterial wilt held center stage among diseases of alfalfa in Utah (and elsewhere) until plant breeders developed and dispersed resistant varieties. Only then could it be seen that bacterial wilt had probably been bearing more than its fair share of blame for declining stands of alfalfa.

Neal Van Alfen (Assistant Professor of Biology) says that his 1977 survey of alfalfa-producing areas of Utah showed that "most established fields, dryland as well as irrigated, were suffering from some degree of crown rot and/or root rot infection. We also found

that both crown and root rot infections made their moves early. Among the newly planted fields that we saw, virtually all were infected within their first year. In fact, 96 percent of our sampled plants from first-year fields, had one or both diseases."

Fusarium, a type of fungus, has been present in every case of infection. The researchers are therefore checking the pathogenicity of various fusarium species. "Once that is defined, however," points out Van Alfen, "we will still have to find a way to separate primary from secondary invaders."

In other preliminary work, Van Alfen and Vicki Turner (Graduate Assistant) are trying to determine precisely how devastating these diseases may be to stands of alfalfa. As statewide surveys and field trials answer that question, laboratory tests of possible controls will continue. Experiments have already showed that none of the alfalfa varieties acceptable in Utah have an effective in-the-field resistance. If the diseases do pose a serious threat to the vigor and longevity of alfalfa, Van Alfen hypothesizes that management/cultural techniques will provide more reliable controls than characteristically capricious fungicides.

Water From the Sun?

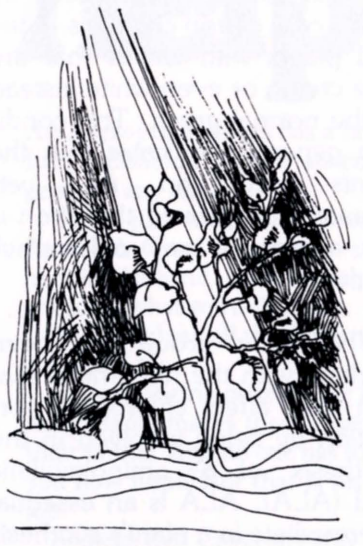
Well, not exactly. But Duane Chadwick (Associate Professor of Electrical Engineering) has invented a solar-powered water pump that will put water in places it might not otherwise reach. By surmounting early malfunctions and one model-smashing accident, Chadwick has taken his concept to a patentable reality.

"My goal," says Chadwick, "was to create a pump that would be practical to build and operate in the desperately poor parts of the world, where problems of irrigated agriculture are often compounded by a lack of hydraulic gradient. The pump's production was to match or better that of one man using such common primitive means as a bucket, treadmill, or goat skin to transfer water from a source to the land."

It looks as if the prototype (now being built) more than satisfies Chadwick's original objectives. The pump can be constructed for about $200.00, out of materials that are readily available throughout the world. Its maximum lift is only about 10-15 feet, but that is adequate for many areas in need of such equipment. Without relying on pistons, indeed, with virtually no moving parts, the solar-powered pump can deliver about 6 gallons per minute. The principles upon which this remarkable machine operates can be easily understood and applied by mechanically naive individuals.

The pump should be cost effective and is thoroughly efficient in using its energy source. This means that it can probably turn dry-season irrigation into a reality for people who otherwise must let fertile land lie unproductive during many months of each year.

When asked what is next on his research schedule, Chadwick replied, "I'd like to make the pump as usable at night or on cloudy days as when the sun is shining. So what I'm looking for now, is a simple, compact, inexpensive way to store heat. As it stands, the pump can soon be put to work in the countries that need it. But if I can come up with a suitable heat-storage device, its usefulness could about double."



Molecular Mysteries—Chlorophyll Style

Green—the color of spring—*and* the symbol of one of nature's most perplexing mysteries. In fact, the more scientists learn about photosynthesis—the process by which the green chlorophyll in plants absorbs solar energy for later conversion into chemical energy, and ultimately into our foods—the less they are unequivocally certain about.

The standard scientific approach to any intricate problem is to break it into its smallest com-

ponents. For photosynthesis, that means looking at molecular mechanisms. And among the hundreds involved, perhaps none is more crucial, nor has had more hours of research devoted to it, than the biosynthesis of chlorophyll. Nevertheless, the details of how plants produce and regulate their supply of green pigment remain mostly elusive.

Currently, Gene W. Miller (Professor of Biology) is heading up an effort to gain further insights into how iron relates to the supply of chlorophyll in plants. As Miller explains, "Almost everyone who gardens, sooner or later meets up with a case of iron chlorosis. They find plants with leaves that are pale cream or even white instead of the normal green. This condition generally indicates that the plants need iron. And yet, research has proved than iron is not a part of any chlorophyll precursor."

The Miller group has been working with the hypothesis that iron may affect chlorophyll formation by being involved in the synthesis of δ- aminolevulinic acid (ALA). ALA is an essential intermediate in a plant's synthesis of both chlorophyll and heme (the iron-containing part of the hemoglobin molecule). To check their ideas, Miller, Alice Denney (Research Associate) and John Priest (Graduate Assistant) have been using barley shoots and various wave lengths of light. The barley was grown from seed, entirely in the dark; the light was white, red, or far red. The laboratory analyses required sophisticated equipment and skills, plus many tedious hours.

"Right now," says Miller, "it looks as if barley leaves may contain two separate pools of ALA. We know that some ALA is formed in the dark, just as is a nonoperative amount of chlorophyll. We also know that a 1-second burst of white light induces more ALA production, *and* facilitates the major chlorophyll formation that occurs later when uninterrupted light is supplied."

The USU researchers have been manipulating that first burst of light, seeing what it does to a plant, and testing how different kinds of later light might change those effects. Once they'd begun to think in terms of two pools of ALA, logic led them to wonder whether the ALA formed in the dark might be involved in heme synthesis, while the light-induced pool functions in chlorophyll formation.

The problem, of course, is to prove or disprove those possibilities. Which is what the ongoing series of experiments is expected to do. Whatever the specific results, however, they should certainly clarify a bit more of one of nature's best kept secrets.

Grazing— The Crowd Effect

Some traditional principles of range management don't seem adequate to today's circumstances. To intensify production and optimize efficiency, we have to know more about the behavior of free-ranging animals. Why do they eat what, as much, and when they do? What causes them to have definite preferences about how they divide their days into eating and resting periods.

The problem is a little like trying to discover why certain apparently appetizing and nutritious

items on a restraurant menu are consistently neglected by diners. Grazing animals are equally choosy about what plants and plant parts they eat. But, whereas unpopular dishes are eventually dropped from a restraurant menu, on a range, the animals' preferential grazing habits may produce the opposite effect. As they persist in eating only what they like, the less palatable (though perhaps equally nutritious) members of the plant community are likely to begin dominating the scene.

Now that rotational grazing patterns are being imposed on federally owned ranges (cattle on these lands are restricted to relatively small areas until all edible forage has been removed), the situation is both more complicated and more urgently in need of clarification. Such unnatural "crowding" inevitably forces the cattle to compete with one another for the preferred, and ultimately the nonpreferred, forage. And competition (for cattle as for people) can be stressful, with the ability to cope being a major variable between individuals.

The coping strategies open to cattle or sheep are obviously limited. They may eat faster (up to a point): they may eat for longer periods and rest less. Either way, they will be burning more than average energy, which in turn, implies a need to eat larger quantities of food.

Data accumulated in other range states indicate that the ranges and their vegetation are thriving under the rotational grazing system. Unfortunately, the cattle generally are *not*. Animal performance ratings (as measured by numbers of calves produced and their size at marketing) have either fallen off or barely held even with those of earlier, less restricted years.

The nagging question, for researchers such as John Malechek (Associate Professor of Range Science), then becomes, "Why"?

To get at that question, Malechek and three other specialists in range or behavior are applying their know-how to a progressive set of experiments. According to Malecheck, they are "beginning with a few head of cattle on small seeded pastures. With this approach, we can control at least some of the variables, while we perfect our equipment and techniques. We are first looking at the time (duration and within-day allotments) spent in grazing, the number of bites taken per minute, and the distance traveled while grazing". A litte later, using standardized methods, the researchers will be correlating what and how much is eaten with nutritional parameters such as digestibility and intake of specific nutrients.

"Eventually," says Malechek, "as we begin to work under practical range conditions, we expect to gain some insights into how and why some animals adapt more easily than others to crowded, competitive grazing. Hopefully, modified management and/or genetic selection for certain behavior traits will let us continue to optimize range productivity without adversely affecting animal performance."

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