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Use of livestock and range management practi ces in Utah

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Abstract

Despite large efforts to generate and extend management innovations for rangeland operators, little is known about the degree to which practices are used. We determined what influenced use of 26 management practices among 340 permittees using data from a mailed survey. Five, co-dominant socioeconomic groups of permittees were identified by cluster analysis: "Large-Scale Operators," 2 types of traditional "Ranchers," and 2 types of "Hobbyists." The main concern across groups was losing access to public land, and coping strategies overall included passivity (64%), intensification of private-land use (27%), and enterprise diversification (5%). Across all groups the 4 highest use rates uniformly occurred for livestock cross-breeding (92%), livestock supplementation (80%), planting improved forages on private land (76%), and interaction with extension personnel (73%). The 4 lowest rates (3 to 12%) occurred for use of futures markets, range-trend monitoring on private land, estrus synchronization, and short-duration grazing (SDG). Groups varied in use of feed and financial consultants, prescribed fire on private land, forward contracting, and controlled grazing systems other than SDG, with Large-Scale Operators tending to use these the most. Larger operation size and higher levels of formal education and income for managers were positively associated with using more practices. Hobbyists tended to use practices the least. Practices which were less complex, clearly linked to animal production, potentially more cost-effective, and had greater compatibility with operational goals were favored. Socioeconomic groups and coping strategies have utility for better targeting research and extension. Understanding why some seemingly beneficial practices are rarely used requires improved communication with rangeland operators.

Key Words: socioeconomic diversity, ranching, hobby ranching, private grazing land, grazing permittees, technology transfer, sustainability, coping strategies

Resumen

A pesar de los grandes esfuerzos para generar y difundir las inovaciones de manejo entre los manejadores de pastizales poco se sabe acerca del grado de uso de estas prácticas. A través de una investigación enviada por correo a 340 usuarios del pastizal determinamos que influye en el uso de 26 prácticas de manejo. Mediante el análisis de conglomerado se dentificaron 5 grupos codominantes de usuarios: "Manejadores a gran escala", 2 tipos de "rancheros" tradicionales y 2 tipos de manejadores "aficionados". La principal preocupación entre grupos fue perder acceso a las tierras públicas y las estrategias generales de solución incluyeron pasividad (64%), intensificación del uso de tierras privadas (27%) y diversificación de la empresa (5%). En todos los grupos las 4 prácticas más uniformemente utilizadas fueron: El uso de ganado cruzado (92%), la suplementación de ganado (80%), la siembra de forrajes mejorados en tierras privadas (76%) y la interacción con personal de extensión (73%). Las prácticas menos usadas (3–12%) fueron: el uso de mercados futuros, el monitoreo de la tendencia de la condición del pastizal en tierras privadas, la sincronización del estro y el pastoreo de corta duración. Los grupos variaron en el uso de consultores en nutrición y financieros, el fuego prescrito en tierras privadas, contratos por adelantado y sistemas de pastoreo controlado diferentes al sistema de corta duración, siendo los manejadores a gran escala los que tienden a usar estos sistemas. El mayor tamaño de la operación y los altos niveles de educación formal e ingresos de los manejadores fueron positivamente correlacionados con el uso de más prácticas. Los aficionados tendieron a utilizar menos prácticas. Las prácticas menos complejas, claramente ligadas a la producción animal, más efectivas en términos de costos y de mayor compatibilidad con las metas de la explotación fueron favorecidas. Conocer los grupos socioeconómicos y las estrategias de solución tienen utilidad para enfocar mejor la investigación y extensión. El entender porque algunas prácticas aparentemente tiles son raramente utilizadas, requiere de una mejor comunicación con los manejadores del pastizal.

Range and animal scientists often seek to develop technologies and management practices that promote sustainability of range livestock operations. One measure of the effectiveness of applied research and extension is the extent

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that technologies and management practices are used by target populations. Higher use rates can be interpreted to suggest that a technology or practice has been successfully transferred and has utility for producers, while lower use rates can be interpreted to indicate the opposite. Constraints which preclude use can include attributes of a given technology or practice (i.e., cost, complexity, effectiveness), behavior of potential end-users, and socioeconomic features of whole production systems (Rogers 1983). Little such research has been conducted in rangeland systems. A few studies indicate that adoption rates of technology and management practices for rangeland operations are often below the expectations of range professionals (Lacey et al. 1985, Hanselka et al. 1991, Banner et al. 1993). Assuming innovations are beneficial, why do low adoption rates occur?

We wanted to assess the extent to which a variety of livestock and range management practices were used among a specific subpopulation of rangeland operators in Utah. We therefore undertook a broad, exploratory investigation. Our objectives were to determine: (1) use rates for 26 management practices, and (2) social, economic, and other factors that most affected overall use rates. To meet the second objective we first had to assess socioeconomic diversity to see if the target population could be broken-out into distinct groups (Jamtgaard 1989). This included analysis of the primary concerns, goals, coping strategies, and felt needs of key decision-makers who manage rangeland operations.

Methods

Sampling

Grazing resources in Utah occur on public lands (> 70% of land acreage) and private lands (Anderson 1989). The target population for this study was range livestock producers who rely on both public and private lands. We focused on permittees with access to BLM, USFS, and Utah State Trust Lands. We ended-up with a list of 2,520 permittees. We hoped that many of these operations would also significantly rely on their private grazing land. This would allow us to better evaluate uptake of selected animal- and land-based practices in the absence of regulations common for public lands.

Thirty-six percent (900) of the 2,520 operations were selected via a simple random sample and were mailed a survey questionnaire in October 1993. Nine hundred was based on our desire to obtain at least 270 responses for a cluster analysis (see below) in conjunction with an anticipated response rate of 30%. The survey was designed and implemented following guidelines in Dillman (1978) with 2 small modifications; namely, we used a 7-week survey period rather than 12 weeks and 2 follow-up mailings instead of 3. The survey contained 46 multiple-choice and short-answer questions. Completed surveys were to be returned to us via pre-paid envelopes.

Survey Structure, Hypotheses, and Statistics

Defining Socioeconomic Subgroups

About half of the survey sought descriptive information about the operations. These data were largely to be used in a cluster analysis to categorize respondents into varied socioeconomic groups. Permittees were expected to be socially and economically diverse (Workman 1986) and such diversity could affect use of livestock and range management practices. Cluster analysis has been used elsewhere to establish typologies among livestock producers and provide recommendation domains for research and extension (Jamtgaard 1989).

Descriptive information was collected on 30 attributes for each operation. These attributes included personal features of key decision-makers (e.g., formal education, age, goals, self-perceived innovativeness, etc.), features of operating environments (i.e., levels of income, access to physical and capital resources, etc.), and primary concerns, felt needs, and coping strategies of operators. It was hypothesized that attributes of operating environments (i.e., income, indebtedness, public-land dependence, enterprise diversity, and/or scale of operation) would emerge as key variables defining groups. We assumed we could reveal up to 9 groups in the cluster analysis, and with a minimum of 30 observations per group for valid statistical procedures we therefore would need at least 270 respondents.

The clustering procedure followed a K-mean procedure (Romesburg 1990, Wilkinson 1990). Groups that emerged were then considered as treatments and contrasted among themselves with respect to some ancillary social and economic attributes using 2 approaches. A one-way ANOVA was used to assess variability among groups for continuous response variables. Mean separation tests were conducted using Kramer's modification of Tukey's test, suitable for unplanned comparisons with unequal sample sizes (Day and Quinn 1989). Pearson's Chi Square test was used to assess variability among groups for categorical response variables. Standardized residuals for cells that exceeded 2.5 units in size were used to identify significant ($P \leq 0.05$) contributors to lack of fit for homogeneity models (Wickens 1989, p. 136; SAS 1987).

Use of Livestock and Range Management Practices

The other half of the survey dealt with experiences operators had with 26 livestock and range management practices. Practices were selected after consulting with local experts and were intended to be diverse given the exploratory nature of the research. We wanted highly used and rarely used practices in order to enhance resolution of our analyses. Three animal-based practices included use of nutritional supplements, cross-breeding, and estrus synchronization. Four sets of land-based practices included use of range-trend monitoring, grazing systems, planting improved forages, and shrub control, all with respect to the private-land component of each operation. Three types of finance-based practices broadly included activities relevant to economic management and planning. Use of technical advisors and consultants, participation in government agricultural pro-

grams, and livestock marketing methods are examples of each type of finance-based practices.

In accordance with work of Lacey et al. (1985), Hanselka et al. (1991), and expert opinion (i.e., R.E. Banner, K.C. Olson, G.A. Rasmussen, and J.P. Workman, all of Utah State University, pers. comm.; R.L. Dorigatti, CPA of Cook, Dorigatti & Associates, Logan, Utah, pers. comm.) we anticipated that rates of use for all land- and finance-based innovations, as well as that for 1 animal-based innovation (e.g., estrus synchronization) would be low (i.e., < 50%). We expected, however, that other animal-based innovations (i.e., nutritional supplements, cross-breeding) would be highly used because these were either less expensive or had a greater likelihood of achieving desired outcomes (Lacey et al. 1985).

Rates of use of livestock and range management practices could be affected by many factors. These include attributes of a specific practice or technology [i.e., it's accessibility, cost, ease of use, compatibility, etc., (Rogers 1983)], personal attributes of potential end-users [i.e., a person's formal education, age, income-level, risk-aversiveness, etc. (Fliegel and van Es 1983, Rogers 1983)], and aspects of operations [(i.e., land, labor, information, and capital controlled; Rogers 1983)]. Our main goal was to discern which combinations of factors were most important overall in explaining use of livestock and range management practices. We used 3 complementary approaches. The first approach was to involve analysis of any socioeconomic groups emerging from the cluster analysis. For any such group we wanted to see if it was associated with variation in use of livestock and range management practices. These groups would presumably be characterized by aggregates of operation-level attributes. The second approach focused on key personal and operation-level attributes as explanatory factors. We selected income, formal education, and operation scale. Higher income, more formal education, and larger operations are often associated with innovative behavior in other production systems (Fliegel and van Es 1983, Rogers 1983). The third approach was the most direct in terms of respondent participation and was comprehensive in terms of tackling attributes of individuals, operations, and practices in tandem. In the second half of the survey, if respondents had not used a particular practice they were directed to questions listing 6 possible reasons why. Respondents were asked to pick the one best answer. The list of possible answers was derived from Rogers (1983) and included lack of information, capital, or time to implement, excessive risk or complexity of the practice, and incompatibility between the practice and acute needs of their operation. We predicted that incompatibility would be the most common explanation for not using innovations based on opinion of local experts (R.E. Banner and G.A. Rasmussen, Utah State University, pers. comm.).

Statistical procedures varied for each approach above. Pearson's Chi Square test was used to assess variability in observed use rates among socioeconomic groups using use rates across the target population as expected values. The same test was also used to analyze primary constraints perceived by non-users of practices; the null hypothesis was that non-users would select equally from among 6 choices identifying why they did not use a given practice. In both applications, Chi Square standardized residuals for cells that exceeded 2.5 units in size were used to identify significant ($P < 0.05$) contributors to lack-of-fit for homogeneity models (Wickens 1989, p. 136; SAS 1987). We used 2 methods to determine if groups could be ranked in terms of aggregated use rates for livestock and range management practices. The Page Test (Hollander and Wolfe 1973, p. 147; SAS 1987) was first employed to discern non-random, rank-ordering among groups. This test examined repeatibility of rank for groups across the 26 innovations. Each innovation was represented by a vector having groups ordered from 1 (highest) to 5 (lowest) based on the proportion of their members who used the practice. While the Page Test could gauge likelihood of non-random rank-ordering across groups, it could not be used to assess significant differences in ranked position between any given pair of groups. For the latter we used Fisher's distribution-free Sign Test (Hollander and Wolfe 1973; p. 39). Here each group was represented by a vector of 26 ordered values. Each value was the proportion of group members who had used a given practice. Contrasts of vectors involved pair-wise comparisons of proportions; proportions in 1 vector had to exceed those of another at least 18 out of 26 times to refute the null hypothesis that vectors were similar at $P = 0.01$. A Bonferroni adjustment was used to control the overall Type I error rate to $P = 0.10$ across all 10 paired vector comparisons (Day and Quinn 1989). Isolation of effects of income, education, and operation scale on overall use of management practices was conducted by using the 1-way ANOVA. Income class, educational level, and operation scale (Animal Units) were used as treatments while percentage of 26 innovations used was the response variable. Kramer's modification of Tukey's test was used for mean separation.

All statistical differences cited as significant in this paper were at the $P \leq 0.05$ probability level. Means in the text are accompanied by standard errors.

Results

Sampling Effectiveness

We obtained 522 mailed responses from November, 1993, through January, 1994, for a response rate of 58%. Only two-thirds of the responses (340 or 39% of the original sample) were completely filled-out, however, and these were used for the analysis. A follow-up telephone survey in April, 1994, of 52 randomly selected, non-respondents confirmed a high similarity among respondents and non-respondents in key attributes. Survey results were thus interpreted as being unbiased and can be extrapolated to the target population (Birkenfeld 1994).

Table 1. Socioeconomic groups and defining variables of Utah permittees based on a cluster analysis of 340 survey respondents.

Variables	Group				
	Large-Scale Operators	Private Hobbyists	Public Hobbyists	Private Ranchers	Public Ranchers
Annual labor supplied by family (%)	≤50	≥80	≥85	≥80	≥90
Annual income from non-agricultural sources (%)	0 to 100[1]	≥50	≥50	≤35	≤35
Annual AUMs supplied by public land (%)	0 to 100[1]	≤33	≥50	≤40	≥50
Sample count	56	96	66	66	56

[1]Figures include operations having permits that were not used, hence the rare occurrence of either no non-agricultural income or no AUM's supplied by public land in the year of the survey.

General Features of the Target Population

Key decision-makers for operations in our survey were overwhelmingly male (99%) and middle-aged (average: 55 ±0.7 years old). Operations were all family owned and operated. On average, operations were held by the same families for 68 ±2.3 years. In general, cow-calf operations were the predominate animal-production activity (85% of operations); this was occassionally diversified to include sheep or (rarely) dairy. Most operations (86%) were involved in cultivated forage production. All respondents owned private grazing land, and 7 ±0.1% of this private grazing land had surface or subsurface irrigation. Over 80% of operations had a source of income not related to livestock production.

Socioeconomic Diversity

Only 3 of 30 variables (i.e., relative dependence on family labor, income from non-livestock sources, and public forage) were needed by the cluster analysis to define 5 socioeconomic groups. Groups were inclusive, as only 1 of 340 operations failed to be categorized. We named groups in an attempt to concisely convey identity. These names reflect our interpretation of the blends of economic and social features revealed in our analyses. Groups are described below.

Large-Scale Operators

The "Large-Scale Operators" were primarily distinguished in the cluster analysis by their greater reliance on hired labor, which was a proxy for operation scale (Table 1). They exhibited a wide range of dependence on public grazing and income from non-livestock sources. Compared to other groups, the Large-Scale Operators tended to have: (1) a greater percentage of members in the highest income bracket, (2) a higher percentage of members having an open line of bank credit, (3) higher absolute assets, (4) larger cattle herds and sheep flocks, (5) an average of 5-times more privately owned land, (6) more hay production, and (7) nearly 3-times more AUMs on public lands (Tables 2, 3). A larger proportion of Large-Scale Operators tended to have college degrees and over half considered themselves as managerial innovators (Table 4). Profit and lifestyle were often stated as important motivations that Large-Scale Operators had for being involved with range livestock production. Despite comprising just 16% of the permittee population, Large-Scale Operators owned over one-third of permitted brood cows, over three-fourths of permitted ewes, and dominated use of public and private grazing lands (Table 5).

Smaller-Scale Hobbyists and Traditional Ranchers

The other 4 groups all relied heavily on family labor and were largely comprised of small- to medium-sized operations. These groups were primarily distinguished among themselves by variation in their relative dependence on income from non-livestock sources, and secondarily by variation in relative dependence on public versus private grazing.

Two groups were categorized as "Hobbyists" because they obtained >50% of their income from non-livestock sources (Table 1). Although both groups of Hobbyists relied on both public and private grazing, they markedly varied in terms of permitted AUMs. Therefore, we called one group "Public Hobbyists" and the other "Private Hobbyists." The Public Hobbyists had 3.5-times more permitted AUMs than the Private Hobbyists, and permitted sheep were an important component of this difference (Table 3). Both groups of Hobbyists tended to regard themselves as less-innovative managers. Hobby factors (i.e., use of livestock to generate ancillary income) were prominent in their production motivations (Table 4). Although both groups of Hobbyists out-numbered Large-Scale Operators almost 3:1, Hobbyists controlled far fewer animal and land resources (Table 5).

We called the last 2 groups "Ranchers" because they obtained relatively more income from livestock production than Hobbyists, were highly dependent on family labor to run medium-sized operations, and had social features that appeared more "traditional" in nature (Tables 1–4). For example, profit was the dominant production motivation. Ranchers tended to have received less formal education than members of other groups. Ranchers were more heterogenous in how they perceived their degree of managerial innovativeness. Like Hobbyists, Ranchers were also divided into Public and Private groups based on relative dependence on public grazing. "Public Ranchers" on average ran 3.7-times more AUMs on public lands than "Private Ranchers" (Table 3).

Except for the Private Hobbyists that comprised 28% of the sample, the other groups were similar in representation (i.e., from 16 to 19%). Extrapolating back to the target population, this translates into about 415 Large-Scale Operators, 712 and 489 Private and Public Hobbyists, respectively, and 489 and 415 Private and

Table 2. Economic features of Utah permittees statewide and by socioeconomic group.

Variable	All (n = 340)	Group: Large-Scale Operators (n = 56)	Private Hobbyists (n = 96)	Public Hobbyists (n = 66)	Private Ranchers (n = 66)	Public Ranchers (n = 56)	Chi-Square	F-ratio
	----------(%)----------							
Annual labor supplied by family	85	34a[1]	95b	95b	96b	96b		**
Annual AUMs supplied by public land	39	39b	18a	63c	23a	66c		**
Income sources	----------(%)----------							
Livestock production	49	58b	24a	23a	80c	78c		**
Crop production	6	6ab	2a	2a	11b	8ab		**
Non-agricultural activities	45	36b	74c	75c	9a	14a		**
Total Annual gross income	----------(% earning)----------						**	
≤$25,000	26	20	19	39	29	28		
$25,001–$60,000	49	40	57	52	43	46		
$60,001–$100,000	14	11	20	9	12	17		
>$100,000	11	29[2]	4	0[2]	16	9		
Credit access	----------(% having)----------						*	
Open line of credit	39	53	38	37	46	24		
To complete loan process	41	35	36	45	42	51		
Never applied for agr. loan	16	9	22	18	7	18		
Other	4	3	4	0	5	7		
	----------($000's)----------							
Debt	98	159b	68a	46a	101ab	150ab		**
Assets	747	1,784b	440a	330a	664a	832a		**

*,**Significant at the 0.05 and 0.01 levels, respectively. Significance of F-ratio is row-specific, while significance of Chi-square is specific to a set of rows associated with a variable. For example, the Chi-Square for total income was significant at P ≤ 0.01, and the analysis was based on 12 degrees of freedom for cells representing 4 income levels across all 5 groups.

[1]For groups within a row, means with the same lower case letters are not significant at P≤ 0.05.

[2]Indicates significantly large (P ≤ 0.01) standardized residuals; these are the main contributors to significance of respective Chi-square tests. The null distribution is represented by data collated for all respondents.

Public Ranchers, respectively. Each group has an associated 95% confidence interval of ±19 operations.

Concerns, Coping Strategies, and Felt Needs of Respondents

Respondents were asked to identify important threats to their livelihood, coping strategies, and felt needs (Table 6). Increased restrictions in access to public lands were by far the greatest perceived threat overall; groups more dependent on public lands were most uniform in this response. Far behind public-land access were concerns about continued availability of private land and lack of suitable information and technology for production and management.

Only 32% of respondents had what we referred to as a "pro-active" coping strategy for the future. Most of these operators planned to intensify use of private-land resources; this was 5-times more common than plans to diversify the household economy. The high, overall percentage of those with non pro-active coping strategies (64%) had 2 components. About one-quarter planned either to turn over decision-making to someone else in the family or simply get out of livestock production in the near future; we labeled these respondents as "passive." The remaining three-quarters desired to be pro-active managers but were constrained from doing so by lack of resources (unspecified); we labeled these as "semi-passive."

Despite high variation among socioeconomic groups in access to resources and production motivations, it is notable that incidence of coping strategies did not differ among groups. Overall, the primary unfulfilled need of pro-active respondents was for improved information and technology. This was most prominent for groups having a greater incidence of profit motivations and higher dependence on privately owned land.

Use of Livestock and Range Management Practices

There was high variability in the use of 26 livestock and range management practices overall (Tables 7, 8). About half of the practices had been used by <25% of the sampled operations. These included low rates of use for private consultants, estrus synchronization, marketing of livestock based on futures market pricing, participation in several government programs, technical methods for monitoring range trend, and rest rotation or short-duration grazing. One out of every 4.5 operators still relied on continuous grazing. Eight practices were used by over 50% of the population. Notable were the exceptionally high use of livestock nutritional supplements and cross-breeding. Three out of 4 operators had planted improved forages and 6 out of 10 used herbicides. Operators often had substantive contact with government advisors concerning management of public or private land.

Table 3. Livestock and land resources held by Utah permittees statewide and by socioeconomic group.

Variable	All (n = 340)	Group: Large-Scale Operators (n = 56)	Private Hobbyists (n = 96)	Public Hobbyists (n = 66)	Private Ranchers (n = 66)	Public Ranchers (n = 56)	F-ratio
Livestock[1]			(head)				
Pure-bred beef cows(n)	59 (19)	97 (3)	61 (5)	16 (2)	61 (4)	50 (5)	NS
Other beef cows(n)	169 (278)	392 c[2] (42)	74 a (78)	85 a (56)	161 ab (55)	238 bc (47)	**
Yearlings(n)	166 (105)	587 (19)	40 (29)	34 (21)	113 (21)	134 (15)	NS
Stockers(n)	321 (47)	1,042 (10)	72 (14)	23 (5)	181 (12)	227 (6)	NS
Ewes(n)	1,074 (67)	2,912 b (19)	196 a (14)	675 ab (12)	263 a (14)	263 a (8)	**
Dairy cows(n)	36 (12)	160 (1)	1 (1)	26 (2)	47 (5)	2 (3)	NS
Land resources[1]			(hectares)				
Owned grazing land(n)	983 (340)	2,969 b (56)	436 a (96)	398 a (66)	808 a (66)	855 a (56)	**
Irrigated grazing land(n)	72 (332)	152 c (56)	46 ab (92)	31 a (65)	109 bc (64)	38 a (55)	**
Crops(n)	114 (195)	283 b (29)	49 a (56)	44 a (37)	132 a (40)	134 a (33)	**
			(metric tons)				
Hay produced(n)	497 (294)	939 b (49)	233 a (82)	256 a (51)	598 ab(61)	617 ab (51)	**
Hay sold(n)	405 (76)	882 b (11)	180 a (24)	191 ab (12)	385ab (16)	640 b (13)	*
Hay purchased(n)	123 (111)	248 b (26)	74 a (27)	53 a (22)	109 ab (21)	113 ab (15)	*
			(AUM's)				
Private land forage(n)	1,629 (340)	5,086 b (56)	887 a (96)	421 a (66)	1,597 a (66)	904 a (56)	**
Public land forage(n)	1,043 (340)	2,466 b (56)	223 a (96)	832 a (66)	507 a (66)	1,904 b (56)	*

*,** Significant at the 0.05 and 0.01 levels, respectively.
[1]Average resources were calculated only across those respondents involved in each enterprise. Numbers in parentheses indicate respective sample size (e.g., there were 19 pure-bred cattle operations in the sample overall, with an average size of 59 head. Three of these operations were held by Large-Scale Operators with an average size of 97 head).
[2]For variables analyzed using an ANOVA, means within the same row having the same lower case letter are not significant at $P \leq 0.05$.

Table 4. Social features of Utah permittees statewide and by socioeconomic group.

Variable	All (n = 340)	Group: Large-Scale Operators (n = 56)	Private Hobbyists (n = 96)	Public Hobbyists (n = 66)	Private Ranchers (n = 66)	Public Ranchers (n = 56)	Chi-Square
Education			(% receiving)				*
High school diploma or less	34	29	30	38	35	41	
Some post high-school education	38	27	39	35	48	38	
College degree	28	44	31	27	17	21	
Innovativeness			(% saying they)				*
Are the first to use new practices	42	56	38	31	41	51	
Are cautious and watch others before adopting	38	26	34	48	46	33	
Avoid new methods if possible	20	18	28	21	13	16	
Production Motivation			(%)				**
Profit	49	49	29[1]	35	82[1]	59	
Profit and lifestyle	27	36	23	27	15	39	
Hobby	20	2	46[1]	29	3[1]	2[1]	
Investment/tax shelter	4	13[1]	2	9	0	0	

*,** Significant at the 0.05 and 0.01 levels, respectively. Significance is specific to a set of rows associated with a variable. For example, the Chi-Square for education was significant at $P \leq 0.05$, and the analysis was based on 8 degrees of freedom for cells representing 3 levels across all 5 groups.
[1]Superscripted entries indicate significantly large ($P \leq 0.01$) standardized residuals; these are the main contributors to significance of the respective Chi-Square test. The null distribution is represented by data collated for all respondents.

There was a moderate level of use of grazing exclosures to serve as benchmarks for monitoring range trend. Deferred rotational grazing was about 3-times more common than the next most frequently used grazing system on private land.

Group membership appeared to influence use of 9 out of 26 practices (Tables 7, 8). Compared to most other groups, the Large-Scale Operators appeared to make greater use of certain technical advisors, forward contracting to sell livestock, and prescribed fire. Large-Scale Operators tended to use rest-rotation grazing to the highest degree, but often had more than one grazing system compared to other groups. Hobbyists occassionally exhibited the lowest rates of use for practices like deferred rotation grazing or grazing for weed control. Ranchers or Hobbyists more dependent on private land appeared to use rest rotation grazing less often than other groups.

Considering use rates across all 26 practices, results of the Page Test were

Table 5. Ownership or control (%) of livestock and land resources by socioeconomic groups of Utah permittees.

Variable[2]	Group: Large-Scale Operators (16%)[1]	Private Hobbyists (28%)	Public Hobbyists (19%)	Private Ranchers (19%)	Public Ranchers (16%)
	(%)				
Permitted cows	35	13	10	19	23
Permitted ewes	77	4	11	5	3
Private grazing land	51	12	6	16	15
Private, irrigable grazing land	36	17	8	30	9
Public land AUMs	39	6	16	9	30
Private land AUMs	51	15	5	19	9

[1]Percentages that group made-up of the sample of 340 permittees.
[2]Percentages based on 48,133 beef cows, 71,995 ewes, 325,349 ha of total private grazing land, 23,756 ha of private, irrigable grazing land, 118,152 AUMs on public land, and 184,612 AUMs on private land.

interpreted to reveal that groups were ordered non-randomly (P = 0.01). The group with the highest overall use of the 26 practices was the Large-Scale Operators ranked first with a score of 2.2, followed by the Private Ranchers (2.9), Public Hobbyists (3.0), Public Ranchers (3.1), and Private Hobbyists (3.8). Paired comparisons using the Sign Test were interpreted to indicate that the Large-Scale Operators had higher overall use rates than the Private or Public Hobbyists (P = 0.01). All other comparisons did not significantly differ. Increased income, formal education, or operation scale were each positively associated with increased rates of use for the 26 management practices (Table 9).

Survey respondents indicated that incompatibility between a given practice and acute needs of operations was the most frequently given reason why practices were not used for 8 out of 10 innovations. In such cases incompatibility was mentioned 2 to 4-times more often than the next most important constraint (Table 10). In contrast, lack of information was offered as the greatest constraint limiting use of technical range-trend monitoring, while risk was mentioned as a co-dominant constraint with incompatibility for adoption of novel practices for livestock marketing. Cost was more frequently mentioned as a constraint for land-based innovations involving new forages or brush control.

Discussion

Socioeconomic Diversity

We feel that the groups identified by cluster analysis are logical and distinctive. As we hypothesized, the variables that were most important in the cluster analysis were features of the operating environment. The 3 discriminatory variables of income distribution, private versus public land access, and use of family labor reflect aspects

Table 6. Perceived threats, coping strategies, and future needs of Utah permittees statewide and by socioeconomic group.

Variable	All (n = 340)	Group: Large-Scale Operators (n = 56)	Private Hobbyists (n = 96)	Public Hobbyists (n = 66)	Private Ranchers (n = 66)	Public Ranchers (n = 56)	Chi-Square
Greatest perceived threat	(% saying their greatest threat is)						**
Reduced public-land access	60	61	46	73	48	82	
Reduced private and public land access	13	16	18	6	19[1]	4	
Loss of water rights	5	2	6	6	6	0	
Financial problems	6	2	7	5	8	6	
Lack of information and technology	12	16	16	8	11	6	
Other	4	3	7	2	8	2	
Coping strategy	(% planning to)						NS
Take a passive approach	17	13	15	23	15	20	
Take a semi-passive approach	47	47	50	47	40	49	
Intensify production on ranch	27	29	29	21	35	20	
Diversify on- or off- ranch	5	2	4	3	6	7	
Other	4	9	2	6	4	4	
Primary future need	(% saying their greatest need is)						**
None	9	4	17[1]	8	2	7	
Continued public land access	17	13	14	31[1]	16	9	
More private land access	11	20	8	8	16	7	
Financial assistance	12	9	12	15	5	19	
Information and technology	33	40	30	16	44	39	
Labor or time savings	13	7	17	16	11	7	
Other	5	7	2	6	6	12	

**Significant at the 0.01 level. Significance is specific to a set of rows associated with a variable. For example, the Chi-Square for greatest perceived threat was significant at P ≤ 0.01, and the analysis was based on 20 degrees of freedom for cells representing 6 threat categories across all 5 groups.
[1]Indicates significantly large (P ≤ 0.01) standardized residuals; these are the main contributors to significance of the respective Chi-Square test. The null distribution is represented by data collated for all respondents.

Table 7. Use rates (%) for animal- and finance- based innovations by Utah permittees statewide and by socioeconomic group.

Innovation	All (n = 340)	Group: Large-Scale Operators (n = 56)	Private Hobbyists (n = 96)	Public Hobbyists (n = 66)	Private Ranchers (n = 66)	Public Ranchers (n = 56)	Chi-square
Animal-based	(%)						
Nutritional supplements	80	84	80	82	77	79	NS
Cross-breeding	92	98	91	92	88	95	NS
Estrus synchronization	11	6	7	13	18	15	NS
Finance-based[1]							
Technical advisor							
Loan officer	25	36	16	28	18	35	**
Accountant	31	45	22	35	30	29	*
Private range consultant	9	16	6	5	8	13	NS
Private feed consultant	6	15	3	2	6	5	**
Government personnel[2]	73	75	72	74	76	67	NS
Government Programs[3]							
Agricultural Conservation Program (ACP)	42	38	38	41	48	48	NS
Long-Term Agreement (LTA)	11	14	10	6	14	14	NS
Water Quality Incentive Program (WQIP)	8	9	6	11	3	11	NS
Conservation Reserve Program (CRP)	12	7	7	15	14	16	NS
Marketing Practices							
Forward contracting	38	50	31	32	39	45	*
Direct sales to public	51	48	50	55	50	55	NS
Futures markets	3	2	3	6	3	2	NS

*,**Significant at the 0.05 and 0.01 levels, respectively. In no cases were standardized residuals significant (P≤0.01) for individual cells. Groups which most contribute to significance of Chi-Square tests can be identified by comparing group entries with respective entries for all respondents because the latter served as expected values for each Chi-Square test.

[1]Where finance-based innovations are related to economics and planning on privately owned lands, unless indicated otherwise.

[2]Includes interaction with agencies dealing with private lands such as county extension agents and personnel of the Natural Resource Conservation Service (NRCS).

[3]Where the ACP, LTA, and WQIP are short- or long- term cost-share projects that can be targeted as specific range resource problems, typically on private lands. Participants in the LTA were commonly also participants in ACP. The CRP deals with protection of highly erodible lands by excluding them from cultivation or grazing.

Table 8. Use rates (%) for land-based practices on privately owned land by Utah permittees statewide and by socioeconomic group.

Innovation	All (n = 340)	Group: Large-Scale Operators (n = 56)	Private Hobbyists (n = 96)	Public Hobbyists (n = 66)	Private Ranchers (n = 66)	Public Ranchers (n = 56)	Chi-Square
Range trend monitoring:	(%)						
Fenced exclosures	57	55	57	58	55	61	NS
Photo points	8	16	6	6	9	4	NS
Transects	7	12	6	7	6	5	NS
Grazing systems:[1]							
Deferred rotation only	59	67	61	44	70	55	*
Rest rotation only	19	29	11	24	14	20	*
Short duration only	12	15	19	9	7	6	NS
Multiple rotations[2]	15	29	16	9	13	10	*
Continuous grazing only	22	21	22	27	18	22	NS
Improved forages	76	80	74	69	85	71	NS
Prescribed fire	18	27	20	22	12	9	*
Herbicides	62	64	59	57	69	61	NS
Mechanical shrub control	29	34	27	34	26	23	NS
Grazing for weed control	17	23	7	26	15	18	**

*,** Significant at the 0.05 and 0.01 levels, respectively. In no cases were standardized residuals significant (P ≤ 0.01) for individual cells. Subgroups which most contribute to significance of Chi-Square tests can be identified by comparing subgroup entries with respective entries collated for all respondents because the latter served as expected values for each Chi-Square test.

[1]Percentages within columns exceed 100%; this is because some operations used more than 1 grazing system (i.e., use of different systems on different types of land or on the same parcel of land over time). About 5% of permittees did not use their private land for grazing (not tabulated). Note that "multiple rotations" or "continuous grazing" are not included among the 26 total innovations; they are tabulated here for illustration purposes only.

[2] Includes various combinations of deferred rotation, rest rotation, and short duration grazing.

Table 9. Factors affecting use of 26 livestock and range management practices.

Factor[1]	n	Use Rate(%[2])
Annual Gross Income:		
≤ $25,000	88	38a
$25,001-$40,000	93	40ab
$40,001-$60,000	70	40ab
$60,001-$100,000	48	39ab
>$100,000	35	45b
Formal Education:		
Did not complete high school	26	33a
Received high school diploma	83	36a
High school diploma and trade school	26	43b
Attended university	94	42b
Received university degree	94	42b
Operation scale (Animal Units):		
Very small (≤ 39)	72	35a
Small (40-99)	92	38a
Medium (100-239)	91	40b
Large (≥ 240)	83	45c

[1]Subcategories of factors defined on the basis of respondents answers to multiple-choice or short answer questions.
[2]Rates of innovation adoption were calculated as 100 x (no. innovations adopted/26). Means accompanied by the same letter within a factor (i.e. income, education, or operation scale) were not significantly different (P > 0.05) in a 1-way ANOVA, with mean separation provided by using Kramer's modification of Tukey's test.

of capital, land, and labor considered by economists to be primary drivers for production decisions (Workman 1986).

Other important social features also tended to vary among groups including level of formal education, innovativeness, and operational goals. Our work therefore confirmed a high degree of social and economic diversity among Utah permittees. Such variation in resources and production goals among rangeland operators has been noted elsewhere (Smith and Martin 1972, Grigsby 1980, Bartlett et al. 1989, Rowan 1994, Rowan and Connor 1995, Rowan and White 1994). Although the groups exhibited marked variation in terms of resource access and operational goals, the prominent concerns, coping strategies, and felt needs were remarkably similar across groups. This similarity may have been a corollary of the period when the survey was conducted. The early 1990s were a time of intense "Range Reform rhetoric." We suspect that this highly charged atmosphere served to focus a diverse array of operators on the prospect of losing public land access and how they could deal with such change.

Under conditions of high risk and uncertainty agricultural producers are often advised to sustain themselves by diversifying the household economy and/or reducing indebtedness (National Research Council 1989, Holechek et al. 1994). While the large percentage of Utah permittees who are generally passive (64%) may reflect a lack of resources, pessimism, and/or dearth of options, many may also be embracing a conservative "wait and see what happens" strategy appropriate for dealing with high uncertainty (Holechek et al. 1994). One possible strategy in risk management is to avoid making private-land investments if there is uncertainty that public land access would really be reduced. Under this strategy passiveness may confer a greater chance of economic survival for low- and middle-income operators. Under this strategy passiveness should not necessarily be viewed as an impediment to "progress," but rather as a conscious means for managing risk.

At the other extreme we have the pro-active minority. Only 5% of permittees planned to diversify their enterprises. This small number runs counter to prevailing expert opinion that diversification is the main course of action for pro-active managers under pressure (L. Butler, NRCS, pers. comm.). It remains unclear what constrains operators from attempting to diversify their operations in Utah.

Although enterprise intensification is not recommended by experts as a form of risk management, it appears to be the main strategy for pro-active operators here. This apparent paradox may be explained by the need of some operators to intensify use of private land in order to partially or fully compensate for anticipated losses in public grazing. If an operator was unable to compensate, the vulnerability of the household would increase as livestock-based income declined. If operators can tolerate the investment risks, the decision to intensify now could help ensure a viable income stream from livestock production in the future and reduce uncertainties associated with dependence on public lands. In this sense, some operators could be intensifying now in order to mantain economic diversity of the household in the future.

Felt needs reflected concerns and coping strategies and only slightly varied among subgroups. We lack details on felt needs for improved information and technology and are pursuing this in on-going research. We speculate, however, that many of the pro-active operators are seeking ways to intensify use of private land via intensive grazing on irrigated and subirrigated sites. Such topics have not traditionally received much attention from applied research or extension in the Intermountain West. This could partially explain the gap in technology and information that was indicated by survey respondents.

Use of Livestock and Range Management Practices

Our assessment of the use of livestock and range management practices has several limitations. For example, due to the broad and exploratory scope of our study, we were unable to collect details regarding the extent to which management practices had been used. We also do not know whether practices have been properly implemented. Despite such problems we feel this work provides a useful, initial overview.

Use of management practices is affected by attributes of given practices, potential end-users, and whole production systems (Rogers 1983). We begin by examining empirical data

Table 10. Primary reasons given by Utah permittees for not using livestock and range management practices.

Variable	n	Nonadopters Saying Primary Reason Was: Incompatibility	Lack of Information	Lack of Time	Cost	Risk	Complexity	Chi Square
		(%)						
Animal based								
Nutritional supplements	54	59[1]	5	0[1]	22	12	2[1]	**
Cross-breeding	23	78[1]	0	4	0	18	0	**
Estrus synchronization	284	37[1]	19	14	9[1]	14	7[1]	**
Finance-based								
Technical advisors	52	56[1]	4	7	9	19	5	**
Government programs	115	57[1]	21	9	3[1]	5[1]	5[1]	**
Marketing practices	33	31	18	10	0	31	10	*
Land-based[2]								
Range trend monitoring	87	21	37[1]	25	4[1]	10	3[1]	**
Improved forages	51	45[1]	7	2[1]	23	19	4[1]	**
Grazing systems	31	45[1]	10	6	16	23	0	**
Brush control	53	40[1]	5	11	27	11	6	**

*,** Significant at the 0.05 and 0.01 levels, respectively.
[1]Indicates significantly large (P≤0.01) standardized residuals; these are the main contributors to significance of the Chi-Square test for the respective row. The null hypothesis was that responses would be equally distributed among the 6 choices.
[2]Implemented on private land.

for those practices that were either widely used or rarely used, regardless of socioeconomic group. This allows us to isolate important attributes of practices that could help explain their utility (or dis-utility) for our target population.

Four practices (i.e., cross-breeding of livestock, livestock nutritional supplementation, planting forages, and herbicide application) were reportedly widely used, with overall rates of 62 to 92%. In contrast to the widely used practices, about 6 others (i.e., use of futures markets, technical range-trend monitoring, selected government programs, range consultants, estrus synchronization, and short-duration grazing) were rarely used, with overall rates of 3 to 12%. Comparative data from elsewhere are rare, which precludes much generalization. Some of our figures, nevertheless, are remarkably similar to survey results among private-land operators in Texas (Hanselka et al. 1991, Rowan 1994, Rowan and Connor 1995).

What are some important contrasts between practices that were widely used versus those that were rarely used? We speculate that the widely used practices share some common features. These include: (1) relatively straight-forward modes of implementation, (2) relatively lower costs of implementation and/or continuing use, (3) a more-direct link to animal-based production concerns, and/or (4) they appear to offer a higher chance that users can control outcomes and thus promote effectiveness over the short term. Cross-breeding seems to be the one practice that embodies most of these characteristics. Cross-breeding was also (by far) the most praised of the 26 practices in terms of user satisfaction (Coppock and Birkenfeld, unpubl.). The practices that were rarely used are more heterogeneous in character, but they generally appear to have features different from those listed above. These prominently include: (1) greater complexity, including more interaction with unfamiliar people, (2) higher expense to implement, (3) more nebulous links to animal production, and/or (4) more nebulous prospects for user control of outcomes and short-term effectiveness.

Our main opportunity to disentangle why certain practices were not used came from survey respondents, who had a menu of reasons to choose from concerning 10 representative practices. In contrast to our tidy dichotomy above focusing on cost, complexity, risk, and short-term effectiveness, it was incompatibility between available practices and priority needs of operations that dominated responses as to why some practices were not used. The major exceptions to this pattern were that: (1) risk was acknowledged to be a co-dominant constraint with incompatibility for use of novel marketing procedures for livestock and (2) lack of information constrained use of technical methods for monitoring range trend. There are paradoxes in these 2 responses. First, the livestock marketing procedures (i.e., use of futures markets) are supposed to reduce producer risk of income fluctuation by "locking-in" sale prices. This suggests that some operators did not understand what they were for. In the range-trend monitoring case, local experts contend that rural Utah has been saturated with information on how to monitor range trend. In both cases, therefore, it appears that information is either still not reaching respondents or is not being understood and effectively used. Some recent evidence supports the latter in the case of range-trend monitoring. A different survey effort was conducted in which 300 land managers were contacted after participating in short courses on traditional methods for range-trend monitoring in Utah (G.A. Rasmussen, Utah State Univ., unpubl. data). It was found that at 2 years following the short-courses only 1 person was still monitoring range trend. Subsequent analysis revealed that the main problems in transfering this practice were that the justification for monitoring range trend was ineffective and field methods were much too complex. It was concluded that the extension

approach needed to be re-thought and re-packaged. One idea, for example, was to develop a better justification based on the value that range-trend monitoring has for sustaining the animal production system (Rasmussen et al. 1997). This outcome is in accordance with the concept that innovations that are simpler and more clearly linked to animal production will be more readily used.

The dominant response that available management practices are often incompatible with priority needs of operations supported predictions of our extension experts. This result also ran counter to a prevailing view that producers need larger doses of extension information to exhibit more progressive behavior (Hanselka et al. 1991). We can interpret the incompatibility message in several ways. First, it could reflect that common technical problems are still not being addressed. For example, problems with soil salinity or water management may preoccupy managers and such situations still pose many technical challenges for research. Second, it could also be that development of management practices and technologies is out of sync with dynamic producer strategies. The previous example of irrigated pasture as a non-traditional intensification tactic may be relevant here. Third, that acute problems of operations are really broad and social or economic in nature. For example, the spectre of unfavorable government policies, adverse public opinion towards ranching, and simply the daunting task of managing complex operations under uncertainty and risk may make isolated technical issues seem increasingly trivial. Clarifying felt needs and possible remedies for those needs is a major focus of ongoing research.

Besides attributes of specific practices, attributes of managers and production systems appeared to influence use of livestock and range management practices. This was revealed by cases where use of practices varied among socioeconomic groups. For example, use of 5 practices (i.e., financial advising, feed consulting, forward contracting, and deferred- and rest-rotation grazing systems) varied among groups. In general, Larger-Scale Operators (and in some cases Ranchers) appeared to use these practices more often while Hobbyists used them less often. This pattern was a major contributor to the significant ranking of groups for use of all 26 management practices, with Large-Scale Operators using the most practices and Hobbyists using the fewest. Ancillary predictions that innovative managers would have more formal education and higher incomes (Rogers 1983) was also supported. Operation scale, therefore, with the concomitant factors of profit motives, managerial expertise, and entrepreneurism, appears to be the critical factor associated with increased use of management practices in our study. The presumed mechanism is that the production goals and greater resources of larger operations allows them to take more risks and make innovative investments. Larger range operations elsewhere have been associated with more land investment in Montana (Lacey et al. 1985), and innovative, technology-seeking behavior in Nevada (Harris et al. 1995). Small-acreage operators in Texas have been associated with the opposite features (Rowan 1994, Rowan and Connor 1995).

Conclusions

We focus our summary conclusions around answers for 3 questions: (1) what determines use rates for the spectrum of technologies and management practices included in our study, (2) are the socioeconomic groups useful for understanding variation among rangeland operators and improved targeting of research and extension, and (3) what can we do to enhance the up-take of practices that are rarely used?

Our work confirmed that use rates are jointly influenced by attributes of production systems and potential adopters as well as those of technologies or management practices. Attributes of production systems and potential adopters, however, were often confounded and difficult to segregate. Because technologies and management practices exhibited a very wide range in use rates (i.e., from 3 to 92%), attributes of technologies and management practices appear to be most critical. Those which variously exhibit less complexity, have more predictable or controllable outcomes, potentially greater cost-effectiveness, and a clear and direct compatibility with production goals appeared most favored– the best example is livestock cross-breeding. A marked contrast to cross-breeding is provided by use of futures markets and technical range-trend monitoring. Interaction between attributes of production systems and managers is secondary, but also important, in affecting use rates. Polar opposites incorporating socioeconomic group and coping strategy provide a good example: use rates for a given technology or management practice could be expected to be lowest among a subpopulation of passive Hobbyists versus a subpopulation of pro-active, Larger-Scale Operators. Pro-active, Larger-Scale Operations may offer the greatest scope for rapid impact and more natural resources may be affected in absolute terms. Passive Hobbyists, however, also merit attention from research and extension because of their abundance.

Our answer to the second question is a "qualified yes." Groups significantly differed in many social and economic aspects, and the fact that group membership of a given operator could be approximated by knowing only 3 variables is fortuitous. Groups have different resources, goals, and vulnerability to changes in federal land policy. The practical problem, however, is that group membership was not synonymous with variation in primary concerns, coping strategies, or felt needs. The overall picture is therefore clarified by focusing more on coping strategy, operation scale, and production goals, because these are the features that should largely dictate the ability and motives of a given operation to alter management practices and make effective use of improved information and technology.

Our answer to the third question will always be open to debate, but we

sense that continuing to do what we have always been doing may not be effective in all cases. In other words, our survey respondents did not appear to think they needed more of the same information or technology to be more innovative, and this may be best exemplified by range-trend monitoring. Our respondents often seemed to think they were "hip-deep" in information. This may not always be the "right" information, however, or it may be the "right" information but ineffectively packaged or marketed. Making a practice easier to use, less expensive, more effective, and more relevant to an operator's values and goals is the common-sense message here. If this still fails to improve use rates, challenge the validity of a given practice from the perspective of a potential user. The overwhelming response that most unused practices were incompatible with priority needs of operations was an eye-opener. Research and extension therefore need to focus more on what the evolving and priority needs of different classes of operations really are and why. This involves more attention towards how management decisions are made and improving 2-way communication with a customer-driven agenda. It also challenges a common assumption that we have all (or most) of the answers already. More attention to identifying overall producer goals and strategy, balancing production concerns versus the need to manage risks, and finding out how specific innovations fit operations in a holistic sense could be fruitful. Similar perspectives have been voiced elsewhere (Banner et al. 1993, Holechek 1996, Richards and George 1996). Such an approach requires more attention to a "mentoring and mutual learning" style of interaction with rangeland users.

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