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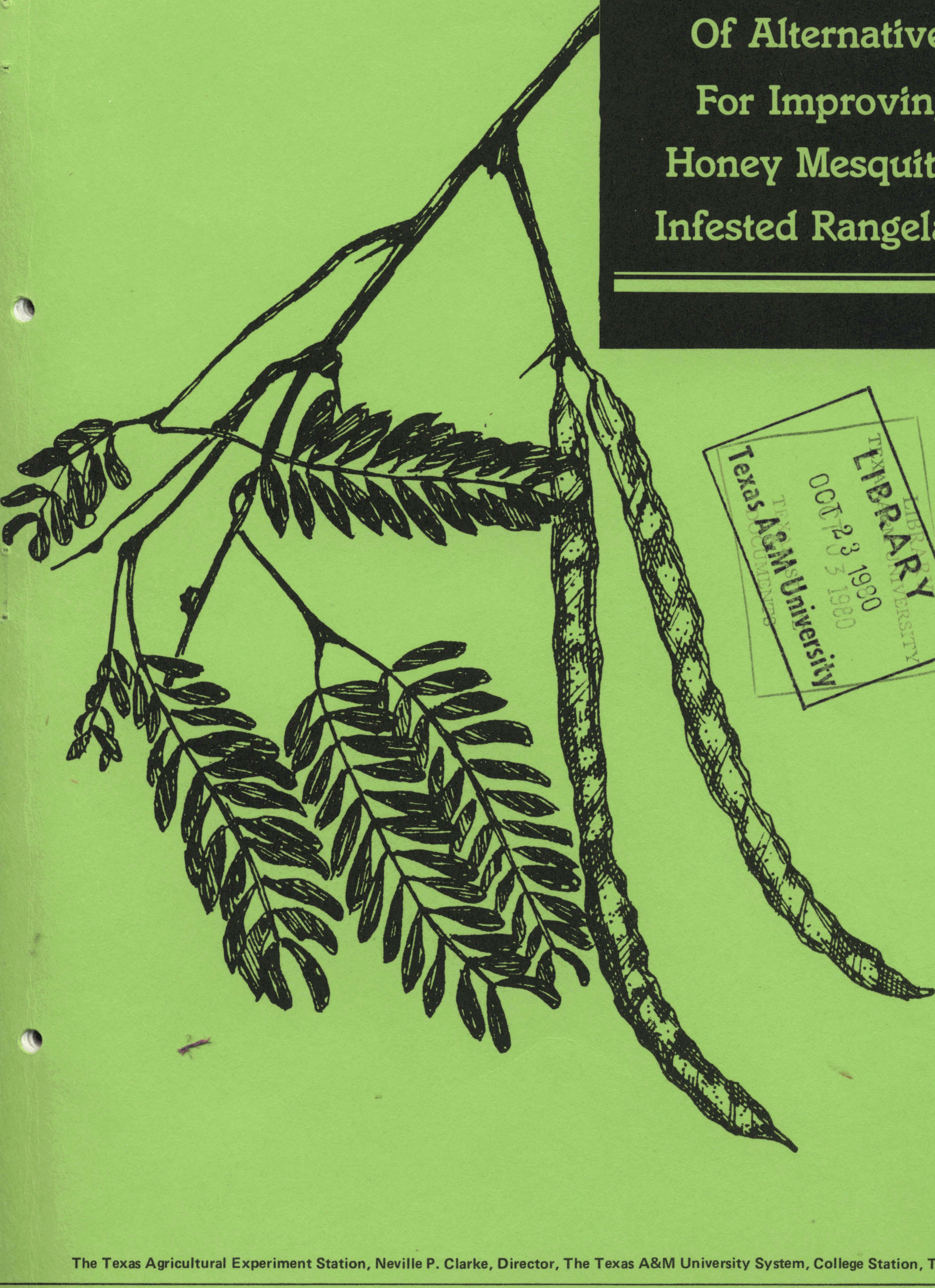
Economic Comparisons Of Alternatives For Improving Honey Mesquite-- Infested Rangeland



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ECONOMIC COMPARISONS OF ALTERNATIVES FOR IMPROVING HONEY MESQUITE-INFESTED RANGELAND

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1980

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CONTENTS

SUMMARY. 1

INTRODUCTION 4

DEVELOPMENT OF PRODUCTION RESPONSE CURVES. 7

BRUSH MANAGEMENT ALTERNATIVES EVALUATED. 21

Aerial sprays 21

Individual-Plant Chemical Treatments. 24

Oiling. 24

Tree Dozing (Power Grubbing). 24

Low-Energy Grubbing 25

Chaining. 25

Root Plowing. 26

Roller Chopping 26

Shredding 26

Raking/Stacking 27

ECONOMIC ANALYSIS. 27

Cost/Revenue Characterization 27

Factors Influencing Selection of Alternatives 35

RESULTS. 36

High Plains 36

Rolling Plains and Rolling Red Plains 47

Grand Prairie and Cross Timbers. 68

North Central Prairies. 81

Blackland Prairies. 96

Texas Claypan Area 106

East Texas Timberland 113

Rio Grande Plain 118

Coast Prairie 127

Edwards Plateau. 132
Central Basin. 150
Trans-Pecos. 157
DISCUSSION. 167
ACKNOWLEDGMENTS 175
REFERENCES CITED. 176
APPENDIX. 180

SUMMARY

Economic responses to honey mesquite control were estimated for each of the major land resource regions in Texas. The results pertain to individual ranch firms, and cannot be extrapolated to the total industry without ascertaining the impact of potential supply/demand shifts on cattle prices.

The economic analysis utilized a net present value and capital budgeting techniques for a 20-year planning period to estimate annual rate of return (internal rate of return), net present value for a 9 percent discount rate, and net cash flow for alternative mesquite control practices. Net cash flows were expressed in constant 1978 dollars and were developed for alternative weaned beef price scenarios of 34 cents to 54 cents per pound over the 20-year planning horizon.

Economic results varied considerably among and within vegetation regions. The variation was a function of range site potential, degree of honey mesquite infestation at the time of treatment, and the control alternative selected. Aerial application of 2,4,5-T consistently produced the highest annual rates of return, regardless of vegetation region. Based on the highest rates of return from each vegetation region, the unweighted average annual rate of return was 15.9 percent. When 2,4,5-T was eliminated as potential control measure, dicamba produced the highest annual rate of return (11.4 percent), approximately one-third less than that from 2,4,5-T.

The simple average of the highest average annual rate of return from each resource region for non-herbicide treatments was 5.7 percent, The average cost of mechanical methods, based on 1978 dollars, would have to be reduced by approximately 50 percent to generate a 9 percent annual rate of return.

Assuming long term rainfall patterns and average cattle prices, the average length of time required to recover all investment capital for treatment and additional livestock with 2,4,5-T (8.5 years) was about half that for the "next-best" herbicide treatment (16 years). Averaged (unweighted) across all resource regions, the net annual cash flows increased 2.25 dollars per acre from the "next best" non-herbicide alternative. However, it was not possible to identify any single "best" honey mesquite control practice since producer preference is a critical criterion for treatment selection. While aerial application of 2,4,5-T produced the highest annual rates of return, a producer could logically select another practice if it met his minimum rate of return criterion, capital was not limiting, and the practice produced higher annual net cash flows than 2,4,5-T.

Selection of a practice other than aerial application of 2,4,5-T necessitates greater investment capital requirements. Ranchers typically have pay-back periods which are shorter than pay out periods for brush control. Consequently, as investment capital requirements increase, pay out periods increase, thereby increasing cash flow deficits. Such situations require a transfer of cash from other sources to meet these deficits. Small producers (93 percent of all Texas ranch producers have 200 or fewer cows) have fewer cash sources (because of cash consumption requirements within the ranch firm) to offset an increasing cash flow deficit than do larger producers.

No industry supply shifts were evaluated in this study. However, it can be anticipated that if brush management becomes more expensive, fewer acres will be treated. Over time, this could result in a reduction in the supply of beef which will cause prices to increase. The net result on beef prices will depend on the nature of the supply shift relative to demand characteristics for beef.

ECONOMIC COMPARISONS OF ALTERNATIVES FOR IMPROVING HONEY MESQUITE-INFESTED RANGELAND

R.E. Whitson and C.J. Scifres

INTRODUCTION

According to a recent compilation, there are nearly 86 million acres of rangeland[1/] in Texas (Table 1). These native grazing lands form the backbone of the State's range livestock industry and provide food and cover for most of its wildlife. However, during the past century, the density and stature of woody plants has increased dramatically. The present brush cover prevents achieving potential forage production from most native grazing lands in Texas. The most cosmopolitan woody plant problem, honey mesquite (Prosopis glandulosa Torr. var. glandulosa), infests almost 55 million acres in Texas. Consequently, considerable research effort has been focused upon development of methods for alleviating the detrimental effects of the mesquite problem. Most success has been achieved in the development of mechanical and chemical methods of mesquite control. A variety of techniques have been successfully applied during the past 25 years. However, during the past 5 to 10 years, interest in the economic performance of the techniques has intensified because:

(1) The rising costs of equipment and energy have seriously influenced treatment costs at the producer level, especially with mechanical honey mesquite control; and,

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1/ Selected terms are defined in the appendix and may be helpful in proper interpretation of research results reported herein.

Table 1. Distribution of the mesquite infestation by canopy cover and site potential within the major land resource areas of Texas.

Major land resource area	Land area (thousands of acres)			Mesquite infestation (%) by canopy cover and site[a]				
				Dense[b]		Moderate[c]		Light[d]
	Total[e]	Native rangeland[f]	Rangeland infested with mesquite[g]	Deep	Shallow	Deep	Shallow	All sites
High Plains	19,000	7,135	3,440	15	<1	23	6	55
Rolling Plains[h]	24,000	13,908	11,860	21	4	20	10	45
North Central Prairies	6,500	3,506	1,610	45	7	25	13	10
Cross Timbers	3,000	1,140	40	21	2	18	5	54
Grand Prairies	7,000	2,660	748	16	20	39	21	4
Blackland Prairie	11,500	865	538	19	<1	27	<1	52
Texas Claypan	8,500	941	310	20	7	60	7	6
East Texas Timberlands	16,000	147	2	0	0	99	1	0
Coastal Prairies	9,500	1,924	64	3	4	8	5	80
Central Basin	1,500	399	389	40	<1	21	<1	37
Rio Grande Plains	20,500	14,801	12,620	20	<1	30	<1	48
Edwards Plateau	24,000	22,344	13,260	11	8	23	14	44
Trans-Pecos	18,000	15,827	9,810	13	<1	14	<1	71
Total	169,000	85,597	54,712					
Avg				19	4	31	7	39

[a] Based on opinionnaire response.

[b] Canopy cover >20%

[c] Canopy cover 10-20%.

[d] Canopy cover <10% as scattered plants in pure stands or in mixture with other species.

[e] Adapted from Godfrey, Carter and McKee (undated), except that "Bottomlands" are included in the respective major land resource area which increases values for areas such as the Texas Claypan.

[f] Based on Texas Conservation Needs Inventory (1967) by county, does not include any land artificially seeded.

[g] Based on area estimates from Smith and Rechenthin (1964).

[h] Includes Rolling Red Plains.

(2) Increased scrutiny by society of chemical use in agricultural production systems has prompted federal agencies to challenge the use of certain herbicides for range improvement.

Although these pressures are not restricted to range livestock production, rangeland as a contributor to national agricultural productivity has some unique characteristics which provided the impetus for this study. The importance of rangeland to agricultural production on both the State and National levels is related to the massiveness of the resource rather than to potential high annual productivity on a per acre basis. Rangeland is managed extensively as contrasted to the highly intensive management efforts required for row crop agriculture. Consequently, rangeland, relative to most short-term economic criteria, is viewed by industries such as herbicide manufacturers as a "minor crop" (Scifres and Merkle 1975). Therefore, relatively few of the herbicides registered for agricultural production are cleared for use on rangeland. For these same reasons, refinement of equipment for row crop agriculture has surpassed mechanization advances for range livestock production. Removing or constraining use of any given production alternative for range improvement may result in relatively few remaining alternatives, Moreover, there is little economic information on which to base sound decisions, either at producer or federal levels regarding the economic impact of removing or constraining selected alternatives. With herbicides for example, the major research thrust has involved investigating efficacy, toxicology, application technology, and environmental implications rather than the economics of their use for brush management. Unfortunately, trial and error economic evaluations have formed the primary basis for acceptance of various brush management practices at the producer level. Apparently, this has been deemed an acceptable procedure on the rationale that variation among enterprises and management objectives strongly influence economic acceptability--a practice may be judged to be economically feasible by one producer and fail to perform satisfactorily in another management situation. There is no argument that variation in individual management effectiveness strongly influences performance of any range improvement practice. Yet, sound benefit/cost analyses are essential to the decision-making processes concerning adoption of any agricultural practice, regardless of the characteristics of a specific situation. This study was conducted under the assumption that effective management was utilized for carrying out mesquite control practices.

DEVELOPMENT OF PRODUCTION RESPONSE CURVES

The lack of estimates of annual production responses to treatment has been the major restriction to economic analysis of brush management alternatives. Very little research on brush control has been conducted with long-term production response as a primary criteron for treatment evaluation. Such research is limited because:

(1) Investigators have traditionally placed most emphasis on treatment performance relative to response of target species with little regard for the forage component.

(2) Experimental plots are usually not of adequate size to allow evaluation of forage/animal performance across all major range sites or researcher control has yielded to management requirements of cooperators who furnish the land causing response data to be confounded with pattern of land use and periodic changes in production practices.

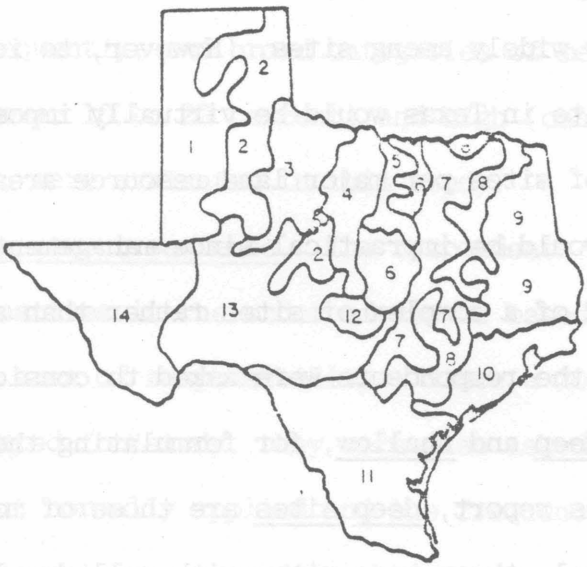
(3) Long-term response data are generated from investigations which span many years and require continuity of evaluation which has not been possible because of cost, personnel changes and short-term research goals.

Even in the few cases where these constraints have been circumvented, experimental approaches have invariably provided data of limited applicability because the research has been necessarily confined to a rather narrow region and/or does not adequately duplicate actual production conditions. One approach to overcoming the time and cost limitations to collecting actual production data is to utilize estimates of persons experienced with brush management practices. The research herein is based on "best estimates" by range trained personnel with experience in the particular resource area for which they were queried. This approach allowed assimilation of working experiences of selected respondents into usable estimates for relatively large land areas. The respondents were asked to provide critical information which affects production responses to brush management alternatives including:

(1) Major land resource area (by precipitation/evaporation zone). The absolute responses of range vegetation to any management effort is governed by the potential of the vegetation resource, especially in relation to effective moisture, soils and growing season. Response data provided by counties were further grouped into homogeneous sets by the respondents. Sets were based on relative potential productivity within each major land resource area (Figure 1) in the state.

(2) Land use of resource surveyed. The respondents provided estimates of acreages of rangeland, cropland, tame pasture, woodlands and all "other" land uses. These data allow projection of the potential impact of constraints on brush management alternatives on a regional basis.

(3) Kinds of livestock. The typical ratio (based on animal units) of kind of animal (cattle, sheep, goats, horses), principal types of operations (breeding [cow-calf etc.] stocker [steers, lambs] or mixed) and acreages of typical operations were provided by counties. For these analyses, the response curves were based on cow/calf production only. This was done because of the statewide adaptability



1. High Plains
2. Rolling Plains
3. Rolling Red Plains
4. North Central Prairies
5. Cross Timbers
6. Grand Prairie
7. Blackland Prairies
8. Texas Claypan Area
9. East Texas Timberlands
10. Coast Prairie
11. Rio Grande Plain
12. Central Basin
13. Edwards Plateau
14. Trans-Pecos

Figure 1. Major land resource areas of Texas.

of the cow and to reduce the number of alternatives in the analysis.

(4) Range site potential. Since range sites are unique vegetation/soil complexes within climates, the production responses to any given treatment may vary widely among sites. However, to identify responses for every range site in Texas would be virtually impossible because of the large number of sites per major land resource areas. Moreover, such an approach would be impractical since management units are typically composed of a complex of sites rather than any one range site. Therefore, the respondents were asked to consider two broad site categories, deep and shallow, for formulating their response estimates. In this report, deep sites are those of moderate to high production potential--those range sites with well-developed, deep soil profiles of high moisture-holding capacity. Shallow sites are those of relatively low production potential--those sites typified by soils of low production potential and which are usually droughty by nature. These terms are relative, and must be used on a comparative basis and in the context of major land resource area. For instance, a "deep" site in regions of high rainfall may have considerably higher production potential than a "deep" site in arid regions.

(5) Degree of mesquite infestation. The density of brush cover on any given site greatly influences the relative response to brush management alternatives. Greatest relative production responses generally occur following treatment of deep sites supporting heavy brush covers. Conversely, the least relative response would be expected from treatment of range sites which support little brush cover. In fact, range sites with low brush cover are generally

considered maintenance problems, or they are not considered for treatment until the brush cover becomes limiting to range forage production and/or livestock handling and care. Approximately 39 percent of the State's mesquite infestation is a light canopy cover (Table 1). Consequently, two broad categories of mesquite infestation, medium (canopy cover 10 to 20 percent) and high (canopy cover greater than 20 percent), were evaluated in this study.

(6) Treatment/treatment sequence. The respondents listed the brush management alternatives in the order of use as based on acreages treated in their area of responsibility. Since a 20-year planning horizon was selected for study, they were also asked to indicate the followup treatment normally applied and the frequency of application for maintenance of range improvement from the primary practices.

(7) Treatment life. The life of any treatment, the time from application until retreatment or application of another practice is deemed necessary, varies with vegetation region, range site potential, and initial brush cover. It was assumed that the initial investment in mesquite control would not lapse but that the appropriate followup treatment would be applied before the brush cover reached original proportions.

(8) Frequency of followup treatment. The normal frequency (years after application of initial treatment) of followup treatment was indicated by the respondents to facilitate estimates of timing and magnitude of cost inputs over the 20-year planning horizon.

(9) Current treatment costs. The respondents submitted 1978 costs (dollars per acre) of each initial and maintenance treatment. These data were verified by contacting individuals in the chemical industry,

heavy equipment contractors, aerial applicators, and ranchers in most of the major land resource areas.

(10) Livestock production responses to treatment. Of the information required for range economic studies, livestock production response data have traditionally been the most difficult to obtain. The respondents estimated the average carrying capacities (acres per animal unit) before treatment (year zero) and after treatment, the maximum carrying capacity after treatment, and the time (years) required after treatment to achieve the maximum carrying capacity. All estimates were formulated for average rainfall conditions. Although it is understood that drought can nullify treatment effects following application of brush management alternatives and that higher than average rainfall may accentuate the responses to honey mesquite control (Scifres and Polk 1974; Scifres, Durham and Mutz 1977), consideration of the economic impact of that variation was beyond the scope of this study.

The general response curve of Workman, Tefertiller and Leinweber (1965) (Figure 2) for aerial spraying of honey mesquite was adopted for this study. This response curve was modified slightly in that carrying capacity (acres per animal unit) changes were used as adjusted for proper grazing use on a yearlong basis (Figure 3). In addition, a 20-year planning horizon was used so that followup treatments could be incorporated. The 20-year planning horizon was felt to be adequate for relative comparison of livestock responses among treatments assuming average annual rainfall conditions. There were several assumptions and/or response alterations in adapting the response curve to the major brush management/range site/brush cover situations including:

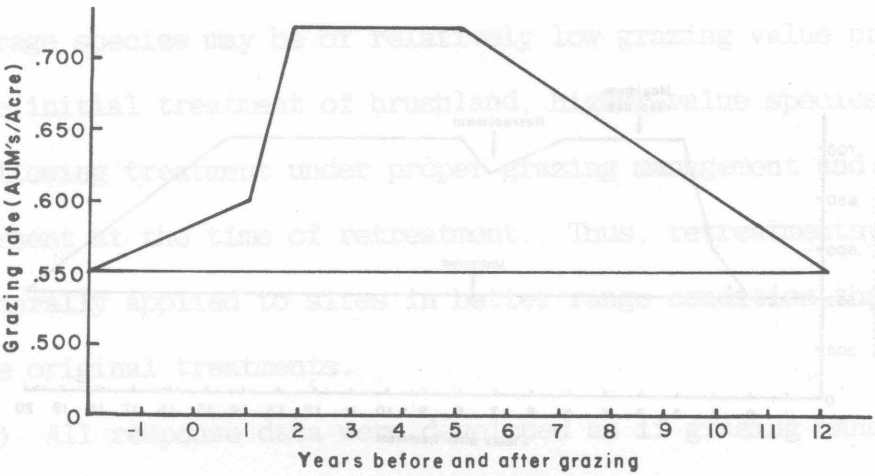


Figure 2. Response curve of Workman, Tefertiller and Leinweber (1965) used for estimating rates of grazing by years before and after aerially spraying honey mesquite on upland range sites on the Rolling Plains of Texas.

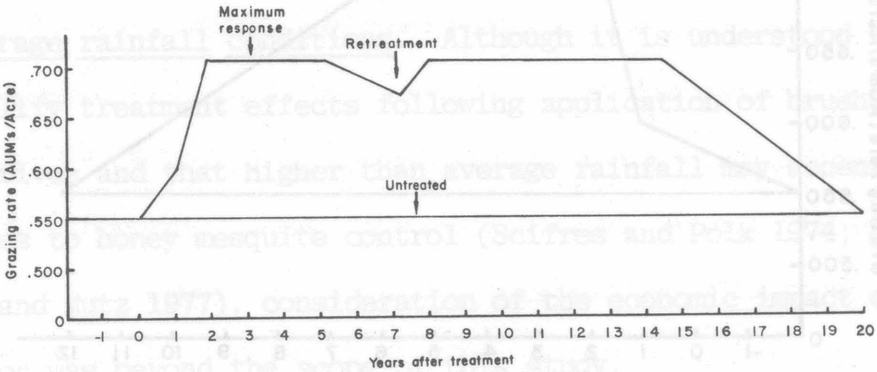


Figure 3. Modification of the response curve of workman, Tefertiller and Leinweber (1965) to include retreatment of honey mesquite-infested rangeland over a 20-year planning horizon.

(a) Retreatment was scheduled when the brush canopy cover had been replaced to the extent that the maximum carrying capacity was reduced to the estimated 20-year average carrying capacity for the treatment.

(b) The length of time between retreatments was increased in longevity (for example, the increase was 1 year in the case of aerially spraying with 2,4,5-T) to account for range improvement accured from the initial treatment. Whereas the resident forage species may be of relatively low grazing value prior to the initial treatment of brushland, higher-value species establish following treatment under proper grazing management and are present at the time of retreatment.. Thus, retreatments were generally applied to sites in better range condition than were the original treatments.

(c) All response data were developed as if grazing management effectiveness was adequate to avoid range deterioration following treatment. As with variation in rainfall, it was beyond the scope of this study to evaluate the impact of management effectiveness as a variable, but management was assumed to be adequate.

(d) The relative magnitude of response varied with initial brush cover on the range site (the relative response to treatment was greater on high than on medium infestations on a site of a given production potential), and with site potential (response was greater on deep than on shallow soils) for all alternatives, based on estimates of the respondents.

(e) The maximum response varied with effectiveness of herbicides on associated species. For instance, a mixture of 2,4,5-T +

picloram (4-amino-3,5,6-trichloropicolinic acid) more effectively controls broadleaved weeds such as annual broomweed (Xanthocephalum dracunculoides) than does 2,4,5-T alone (Scifres, Brock and Hahn 1971). It also controls species such as pricklypear (Opuntia sp.) and other perennials normally associated with honey mesquite. However, aside from consideration of such species which are usually associated with honey mesquite, it assumed that no other major species occurred in the stands. For example, this analysis did not consider honey mesquite as occurring with signficant amounts of other woody species on the South Texas Plains but as essentially pure stands. This assumption caused vegetation response differences on the South Texas Plains between 2,4,5-T and the 2,4,5-T/picloram mixtures to be estimated somewhat more conservatively than would usually occur (Scifres, Durham and Mutz 1977).

(f) Where mechanical treatments were followed by artificial reseeding, grazing was assumed to be deferred for 1 year after treatment and to be reduced by 50 percent the second year after treatment to allow forage stand establishment.

(g) Followup treatments were applied to ensure a treatment life of at least 20 years. Where treatment life exceeded 20 years, a salvage value was determined for the treatment/retreatment based on the remaining effective treatment live as a percent of total projected treatment life.

(11) Labor savings. The respondents also provided estimates of annual savings (dollars per acre) in labor for handling and caring for the livestock following application of the brush management alternatives. Efficiency of handling and care of livestock is often the basis of scheduling retreatment of brush, even before the available forage

supply is reduced by increasing canopy cover.

(12) Wildlife implications. These analyses were conducted on the assumption that all brush management programs would consider the need for quality wildlife habitat, and that treatments would generally be applied in such a manner as to deteriorate the habitat. This assumption was essential to the analyses because of the extreme diversity in vegetation, wildlife management goals, and even differences in game species on various enterprises across the state. Since wildlife management is now approached on an enterprise by enterprise basis, introducing wildlife habitat as a variable would result in an infinite array of analysis possibilities. Moreover, there is little data relating the economic response of wildlife to honey mesquite control. However, some broad generalizations concerning the use of some brush management methods on wildlife habitat are possible.

Complete treatment of a management unit with herbicides, especially those containing picloram, is less desirable for wildlife habitat maintenance than spraying strips alternating with untreated strips of brush. Aerial spraying 80 percent of a mature honey mesquite brushland in alternating strips with 2,4,5-T + picloram at 1 pound per acre total herbicide did not adversely affect populations of white-tailed deer (Odocoileus virginiana), nilgai antelope (Boselaphus tragocamelus), wild turkeys (Meleagris gallopavo) or feral hogs (Sus scrofa) in South Texas (Beasom and Scifres 1977). Complete spraying of rangeland caused at least short-term population shifts with all species except nilgai antelope.

The detrimental influence of complete spraying on white-tailed deer habitat was attributed to a reduction in production and species diversity of forb populations (Beasom and Scifres 1977). Total treatment apparently reduced habitat quality for wild turkeys by seriously reducing canopy cover of roosting sites and by reducing mast, a desired food item. Feral hogs reacted negatively to complete spraying apparently because of reduced availability of mast, especially acorns and mesquite beans.

The only species that reacted negatively to both strip- and complete spraying in the study of Beasom and Scifres (1977) was javelina (Pecari tajacu). This response was attributed to the preference of javelina for pricklypear as a food item, which was reduced significantly by both treatments.

Tanner, Inglis and Blankenship (1978) conducted an experiment similar to that of Beasom and Scifres (1977) in the western portion of the Rio Grande Plains. They found that white-tailed deer tended to evacuate a 4,500-acre pasture for 5 months following strip spraying (80 percent sprayed) with 2,4,5-T + picloram at 0.5 to 1 pound per acre. However, deer were attracted to the treated pasture in above normal numbers the following winter and returned to normal numbers 11 months after spraying. They attributed these shifts to availability of browse which was initially reduced by the herbicide. Surviving plants developed succulent regrowth the year of herbicide application and the regrowth matured the year after treatment. Darr and Klebenow (1975) felt that the effect of spraying on browse was beneficial to deer in the Rolling Plains of North Texas.

Whitson, Beasom and Scifres (1977) reported that strip-spraying of brush tended to maximize economic returns to land owners, and apparently, it offered a hedge against low cattle prices when compared to complete treatment or no herbicide use. For example, complete spraying was economically feasible based on a 10 percent discount rate and a 9-year projected treatment life when cattle prices averaged at least 49.5 cents per pound. However, when cattle prices were lower, partial treatment was preferable economically because returns from lease hunting, where 20 percent of the brush was left untreated for wildlife habitat, more than compensated for returns from cattle production.

Deer use following brush control is influenced by the interaction of habitat and treatment characteristics (Darr and Klebenow 1975). For instance, chaining bottomland habitat in the Rolling Plains reduced deer use, and the larger the area chained, the less it was used by deer. Therefore, as with herbicides, mechanical methods should not be applied to entire managment units if wildlife habitat is a consideration. Application of mechanical methods in strips, preferably following major breaks in topography and with occasional disruptions to increase edge effect, will prevent significant reductions in wildlife habitat quality (Scifres 1979a). Moreover, sensible application of these methods can be used to effectively improve wildlife habitat.

Species of wildlife desired is also an important consideration. Whereas clearing the woody plants and stimulating grass cover may not be ideal for white-tailed deer, quail (Colinus virginiana) and other upland game birds prefer grasslands with scattered brushes for nesting cover to heavy brush stands.

(12) Indirect effects. There are a number of effects attributed to brush management in addition to the direct economic responses. Many of these effects are conservation responses that have not been documented on a research basis, and which have not (or presently cannot) be assigned a monetary value. These include soil conservation, increased water yield, and decreased sedimentation. Also, this study did not entertain the indirect effects of the treated management unit on associated units. Treatment of one pasture of a ranch can result in improvement of other pastures through increasing the deferment time for untreated pastures. This research considered the treated management unit as an isolated entity.

It is conceivable that a producer might accept a zero rate of return from a brush management treatment if the investment offered adequate conservation opportunities. However, until a dollar value can be assigned these indirect effects, they can be utilized only to embellish economic interpretations.

Conversely, in some areas, brush control is considered a detriment to land values for certain segments of the real estate market. Land values for certain nonagricultural uses, especially "ranchettes" and retreats for the urbanite, may be reduced by removal of woody plants.

Potential cost decreases as indirect results of brush management include reduced veterinary costs because of increased ability to care for sick and diseased animals, and potential reduction in number of breeding males required. Again these benefits vary widely and the relative magnitude is influenced by managerial effectiveness as it interacts with brush management at the firm level.

BRUSH MANAGEMENT ALTERNATIVES EVALUATED

Since the brush management alternatives include an evaluation of chemical and mechanical methods, a brief discussion of their use and characteristics is important to understanding results of the economic comparison. Because of the lack of widespread application, biological methods, such as goating and prescribed burning, are not discussed. This does not mean that their use in certain situations is not important for honey mesquite control, and that their use will not become more widespread in the future. Prescribed burning technology is still in the formative stages, and goating is limited to areas of the animal's adaptation.

Aerial Sprays

Honey mesquite is most susceptible to foliar-applied herbicides at 40 to 90 days after bud burst. Depending on vegetation region, the Texas "spray season" usually lasts from the first week in May to the first week in July. The herbicides are applied primarily with fixed-wing aircraft usually in spray swaths 36 to 42 feet wide. The usual herbicide carrier is a diesel oil:water emulsion, 1 gallon of diesel oil and enough water to total 3, 4, or 5 gallons per acre of spray solution. These carriers are referred to as "standard volumes." In some areas of the State, especially the Rolling Plains and Trans-Pecos, it has become increasingly popular to apply the herbicides in only 1 gallon per acre of the diesel oil:water (1:3) emulsion. This practice is referred to as "low volume" spraying. The cost components of aerial spraying include herbicide, diesel oil, emulsifier, and application (hauling of materials, mixing of spray, and application of the spray including loading, flying and flagging). Cost of several of these components are reduced, compared to standard volumes (Fisher et al. 1974) where low-volume applications are possible. Only a brief discussion of herbicide alternatives for aerial spraying will be discussed since detailed comparisons of the herbicides are available (Scifres 1973, 1979a).

(1) 2,4,5-T. The standard brush herbicide since the mid 1950's, 2,4,5-T, is the most popular treatment for honey mesquite control in Texas. It is generally applied at 0.5 pound per acre in the northern and western parts of the State but may be applied at 0.67 pound per acre in the eastern third (average annual rainfall greater than 28 inches) of the State. Many species of broadleaved weeds are controlled by 2,4,5-T although it is generally not as effective against herbaceous species as are more recently developed herbicides. The herbicide 2,4,5-T is sold under many tradenames and is available in various formulations.

(2) 2,4,5-T + picloram. Picloram was formally introduced in the 1960's (Hamaker et al. 1963) and has been used for brush control in Texas since the early 1970's as a 1:1 commercial mixture with 2,4,5-T. The 2,4,5-T + picloram combination is synergistic for honey mesquite control (Bovey, Davis and Morton 1968), and kills, on the average, about 42 percent compared to a longterm average of 26 percent mortality of honey mesquite treated with 2,4,5-T only (Fisher et al. 1972). Addition of picloram also increases the spectrum of associated species controlled, both herbaceous and woody (Bovey and Scifres 1971). The 2,4,5-T + picloram mixture is generally applied at 0.5 pound per acre for honey mesquite control but 1 pound per acre may be used where a proportion of hard-to-kill woody species are associated in the stand such as on the Rio Grande Plain, Coastal

Prairie or Edwards Plateau.

(3) 2,4,5-T + dicamba (3,6-dichloro-o-anisic acid). Dicamba and 2,4,5-T are commercially available in a 1:1 mixture. In contrast to the mixture containing picloram, the 2,4,5-T + dicamba mixture is additive for honey mesquite control (Scifres and Hoffman 1972). The combination broadens the spectrum of herbaceous species controlled somewhat, compared to 2,4,5-T alone, but usually does not increase the number of woody plant species controlled. The same rates of the 2,4,5-T + dicamba combination are used as when 2,4,5-T is applied alone.

(4) Dicamba. Honey mesquite control with dicamba is usually equivalent to that resulting from the same rate of 2,4,5-T alone applied under the same conditions (Scifres and Hoffman 1972) in the eastern two-thirds of Texas. However, the effectiveness of dicamba apparently increases in the drier portions of the state, generally the Trans-Pecos vegetation resource, and in New Mexico. Conversely, the herbicide apparently performs in a less predictable manner in the wetter (eastern and southeastern) portions of Texas. Dicamba is not usually used alone for honey mesquite control but was included in this study because of its performance similarities to 2,4,5-T and 2,4,5-T + dicamba. Moreover, should use of 2,4,5-T be eliminated for brush control, dicamba is considered the "next best" alternative from the standpoint of registered herbicides for honey mesquite control. For purposes of this study, forage and livestock responses were assumed to be the same for 2,4,5-T and dicamba.

Individual-Plant Chemical Treatments

Individual plant treatments may be applied as foliar, cut-stump, or basal sprays but the latter is usually preferred for range situations. Single-stemmed plants or those with few stems having diameters of 5 inches or less on rocky, porous or sandy soils are most easily controlled with basal sprays. Herbicide is usually mixed at 4 to 8 pounds (active ingredient) in 100 gallons of diesel oil or kerosene. The lower 6 to 8 inches of the trunks should be wetted to runoff. Basal sprays may be applied at almost any time of the year but summer treatments are generally used.

One to 2 pounds of herbicide in 100 gallons water or diesel oil:water emulsion are used for individual plant, foliar sprays. The foliage should be wet thoroughly but not to runoff. Treatments are generally most effective in late spring as are broadcast sprays.

Oiling

Oiling is one of the oldest methods of honey mesquite control. One pint to 2 quarts of diesel oil or kerosene is poured around the base of each tree to wet the bark and soil to the lower most dormant bud. Best penetration of the oil occurs when the soil is dry and pulled away from the base of the trunks.

Tree Dozing (Power Grubbing)

Power grubbing is most effective for stands of widely-spaced, single-stemmed honey mesquite plants on sites supporting good forage cover (Scifres 1973). The woody plants are uprooted below the lower most bud leaving a "pit" in the soil. The pits trap moisture and may be individually seeded to enhance the grass stand. Power grubbing is also used as a "cleanup" or maintenance measure following other methods. Standard power grubbing operations usually employ crawler tractors of 100 horsepower or larger that are equipped with a front-mounted, U-shaped "stinger" blade. Efficiency of power grubbing varies widely depending upon size of the plants, stand density, and soil texture and water content.

Low-Energy Grubbing

"Low-energy" grubbing refers to the use of a 65-horsepower or smaller crawler tractor with a modified hydraulic system and automatic transmission. Low-energy grubbing is more cost efficient than standard power grubbing for controlling sparse to moderate stands of honey mesquite on rangeland (Wiedemann, Cross and Fisher 1977). Therefore, it is an excellent maintenance practice and was included as such in this study. Low-energy grubbing also appears promising for controlling other woody species such as huisache (Bontrager, Scifres and Drawe 1979).

Chaining

Chaining refers to dragging a heavy-duty anchor chain (80 to 100 pounds per foot), usually 200 to 300 feet long, between two crawler tractors to uproot brush plants. Chaining is most effective when the plants are large enough to be uprooted rather than bent under the chain and when soil-water content is adequate to allow uprooting. It can be used on relatively thick stands. "Double chaining," covering the land twice with the second trip in the opposite direction to the first, is more effective than one-way chaining (Scifres 1973). Chaining also is used effectively following aerial spraying of honey mesquite

Root Plowing

The root plow is a large (10 to 16 foot) straight or V-shaped blade mounted on a heavy duty crawler tractor. The blade is usually pulled 10 to 16 inches below the soil surface to sever the roots and dislodge the honey mesquite plants. Its best use is clearing dense brush stands on deteriorated range sites of high production potential in preparation for artificial seeding. When root plowing is used without artificial seeding, the rate of vegetation replacement, because of the soil disturbance, is relatively slow (Mutz et al. 1978).

Roller Chopping

Roller choppers are constructed by attaching heavy duty blades to run lengthwise on drums and vary widely in size and weight. The drums are usually filled with water to increase their weight, and pulled over the brush to crush, mash and cut off the woody plants. Roller chopping causes minimal soil disturbance and is a means of rapidly reducing the brush cover. However, since damage is inflicted only upon the woody plant tops, underground buds and those along surviving stem segments rapidly develop regrowth. The effect of roller chopping on the brush plants is essentially the same as shredding. However, larger plants are cut off by roller choppers than with conventional shredders, and roller choppers are better adapted to the rough terrain of rangeland. Also, the cuts made by the roller chopper blades into the soil surface may trap and hold water that would normally run off undisturbed rangeland. When the soil is damp or wet, the roller chopper can tear up herbaceous vegetation as well as the soil surface.

Shredding

Large, flail-type shredders may be used to temporarily reduce the brush cover on rangeland. In general, conventiaonal shredders are effective only on those woody plants with trunk diameters of 2 inches or smaller. Therefore, they are used primarily for maintenance following use of other methods. Although relatively large shredders of improved durability have been developed recently, they have not been in use long enough to allow economic evaluation.

Raking/Stacking

Large rakes attached to the front end of crawler tractors are use to push the woody plants into stacks. The stacks are usually burned to remove the debris or if seedbeds are to be prepared for artificial seeding. Drag-type rakes (root rakes) often are used to dislodge brush roots from the soil and place them in windrows.

ECONOMIC ANALYSIS

Cost/Revenue Characterization

A capital budgeting net-present value analysis was utilized to evaluate the brush management alternatives. Use of this method required identification of the following economic data:

(1) Cost increases. Increased costs associated with brush management included expenditures for the brush control practice(s), added breeding livestock, and added operating expenses. These costs were expressed in 1978 dollars for a projected 20-year planning horizon. Texas Agricultural Extension Service budgets were used to identify operating costs in each resource region of the State. These budgets were adjusted to include costs that were expected to increase as the result of increases in the livestock breeding herd following brush

management. Fertilizer costs (Holt et al. 1976) were included for tame pasture alternatives. Estimated annual costs ("out-of-pocket" only—not fixed costs) are summarized by Vegetation Region in Table 2. Total costs (including application) of 0.5 pound per acre (active ingredient) for commercial formulations of 2,4,5-T, 2,4,5-T + dicamba, dicamba, and 2,4,5-T + picloram were estimated to be 5.50, 5.95, 7.50 and 9.75 dollars per acre, respectively. For 0.67 pound per acre, the costs were estimated to be 6.16, 6.75, and 8.85 dollars per acre for 2,4,5-T, 2,4,5-T + dicamba, and dicamba, respectively. The 2,4,5-T + picloram combination was assumed to be applied only at the 0.5 pound per acre rate. Silvex was also included in the analysis; however, because of its limited potential use, economic results were not presented in the tables. Silvex could not logically be considered a substitute for 2,4,5-T since it also is being evaluated relative to potential withdrawal or regulated constraints on its use. Thus, it was assumed that constraints on use of 2,4,5-T would also apply to silvex. Costs of mechanical alternatives varied with major land resource area and are presented in the discussion of results.

Costs for any treatments requiring a deferment period included a land rental fee for the year(s) of deferment. This annual cost was assumed to average 60.00 dollars per cow.

(2) Revenue increases. Estimated increases in revenue were identified for cow-calf operations for each brush management alternative in each vegetation region. Sources of revenue increases were (a) increases in the size of the livestock herd, (b) increases in weaning weights of calves from original cows grazing the land before treatment, and (c) increases in percentage weaned calf crop from the original

Table 2. Estimated pretreatment livestock production and variable cash costs per cow used for economic comparison of honey mesquite control alternatives, Texas.

Major land resource area	Before treatment[a] Weaning weights (lb/calf)	Weaned calf-crop (%)	Variable cash costs ($/cow)[b] Rangeland	Tame pastures
High Plains	424	89.0	78.76	-
Rolling Plains	439	88.0	72.02	112.02
Rolling Red Plains	439	88.0	72.02	112.02
Cross Timbers	410	84.5	79.42	109.70
North Central Prairie	466	87.5	79.42	130.19
Grand Prairie	414	86.5	82.47	113.23
Blackland Prairie	400	80.0	79.70	119.70
Texas Claypan	389	78.8	79.70	101.36
East Texas	388	80.0	79.70	101.36
Coastal Prairie	395	76.0	69.78	94.26
Rio Grande Plains	440	77.6	63.24	107.47
Edwards Plateau	408	85.0	68.92	108.92
Central Basin	408	85.0	68.92	-
Trans-Pecos	434	81.0	65.53	-
State Average	418	83.3	74.26	110.02

[a] Livestock production estimates by Soil Conservation Service personnel. Weaning weights represent an average for steers and heifers.

[b] Variable cash costs from Texas Agricultural Extension Service Livestock Budgets, 1978-1979. These costs represent an estimated increase in annual expenditures (less interest on investment) if one additional cow was added to an existing breeding herd.

cows grazing the land before treatment. Selling price projections to the year 2000 were obtained from the U.S. Department of Agriculture (Smith, Dec. 1978, personal communication) and were expressed in 1978 dollars. For this study, six alternative weaned calf prices, ranging from 34 to 54 dollars per hundredweight were used to estimate economic feasibility of mesquite control. A selling price of 44 dollars per hundredweight was projected as an average price (1978 dollars) for weaned steers and heifers over a 20-year planning horizon in order to present relative economic comparisons. No livestock price cycles were incorporated in the study because of the long-term nature of the planning horizon. However, adjustment factors for annual rates of return and cash flows were developed for each mesquite control alternative for livestock prices ranging from 34 to 54 dollars per hundredweight. The results of the study would have been more conservative if the initial portion of the 20-year planning horizon represented the unfavorable portion of the livestock cycle. Conversely, if the initial years represented the portion of the cycle with favorable prices, results would be more favorable toward implementing brush management practices.

No industry supply curve shifts were assumed to occur as a result of brush management. If shifts occur because of widespread adoption or elimination of brush control alternatives, the results of these analyses would need to be adjusted accordingly. A decrease in supply could likely have a positive impact on total industry revenue because of the inelastic demand for beef at the ranch level. However, if any selected mesquite control practice were discontinued, reduction in supply would not likely occur uniformly among ranch firms. Thus, the portions of the industry with mesquite infestations would be affected by a ban on a given control and could bear a disporportionate amount of the economic loss because of the non-uniform losses of production capability.

Increases in revenues from indirect production responses were not included in the study. As mentioned previously, a ranch manager could expect to increase carrying capacity indirectly from non-treated areas if, by treating a portion of his ranch, a deferment period was provided for the non-treated areas. Conversely, the manager could expect, in many cases, continued decline in carrying capacity over time if no brush management was undertaken. For this study, the "before treatment" carrying capacity was utilized as a constant value over the 20-year planning horizon. Projected carrying capacities "after treatment" were always compared to the carrying capacity which existed at the time of treatment.

(3) Cost decreases. It was assumed that reduced labor requirements was the only cost decrease associated with brush management, and was related only to the original cows utilizing the treated areas.

Net cash flows were generated for each year of the 20-year planning horizon. The only non-cash items included in the analysis were the salvage value in year 20 of added breeding livestock and, if appropriate, an estimate of any remaining mesquite control value at the end of the 20-year horizon. All "before treatment" livestock production estimates, as well as projected changes following treatments, were obtained from the questionnaire.

Results are presented for each vegetation region and include:

(1) Annual rates of return.

(2) Initial treatment costs.

(3) Cost reduction required to yield an annual 9 percent return.

(4) Average annual net-cash flow.

(5) Years required to break-even.

(6) Average annual beef production per acre before and after treatment.

An annual rate of return was estimated for the investment in added breeding livestock, brush management, and operating capital over the 20-year planning horizon. This rate is commonly considered an internal rate of return. The internal rate of return, if used as the discount rate in a net present value analysis, would result in an accumulated net present value of zero for the 20 year cash flow. It can be directly compared to interest rates charged by financial institutions, and properly considers the timing and magnitude of all costs and returns over time.

Since annual rates presented in this study are based on constant 1978 dollars, the analysis does not include the potential impact of inflation. If it is deemed desirable to include an estimate of the influence of inflation, an assumed inflation rate can be added to the annual rates of return estimated for this study. However, addition of an estimated inflation rate assumes that inflation will affect costs and returns equally and within the same time period. For example, an individual investing in long-term government bonds at 10.5 percent in 1978 at a projected 7 percent inflation rate actually realizes a 3.5 percent real rate of return on his investment. If brush management had no additional risk or uncertainity (compared with the bonds) the individual could invest in a brush management alternative that produced an annual rate of return of 3.5 percent (as reported in this study) and be as well off in an economic sense.

Since investment in brush management would likely represent an increase in risk and uncertainty, compared to investment in long-term government bonds, a risk-return premium would be warranted for selection of brush management over the more secure investment. The amount of this premium would depend on individual judgement in view of other opportunities for investment at the firm level. For this study, an annual interest rate of 9 percent was assumed to include a risk-return premium as well as the opportunity cost associated with the "next best" investment (such as the 3.5 percent government bond example). It could be argued logically that assignment of a "constant" premium for risk and uncertainity is unrealistic. For example, the risk associated with reseeding projects are usually considered greater than with aerial spraying. However, since no comparative, reliable estimates of risk were available, a uniform annual interest rate was used.

The magnitude of the initial treatment cost reduction that would be required from a given practice to result in an annual return of 9 percent is presented. This cost reduction can be used to determine the precentage reduction in initial cost necessary to achieve an annual 9 percent return. No particular emphasis should be given to the 9 percent value except that it was assumed to represent a realistic level of return to compensate a producer for the added risk and uncertainity expected from brush management. If an individual accepts the annual projected rate of return (internal rate of return) discussed earlier, no reduction in the initial treatment cost would be necessary.

Initial treatment cost reported in the study includes implementation of brush management. Maintenance (followup) treatment costs, also included in the analyses, were the same as initial costs for all broadcast herbicide treatments, but were generally less costly for mechanical treatments. Added investment in breeding livestock was included in the analysis but was not reported as part of the initial brush management cost.

Calculation of annual average net cash flow allows evaluation of the influence of magnitude of investment and rate of return on funds available at the firm level following adoption of a selected alternative. Since the timing of the cash flow was not considered, two treatments that produced different annual rates of return could have similar cash flows (even with a similar magnitude of investment).

Determining the number of years required to recover the initial brush control costs and added investment in breeding livestock allow identification of a potential breakeven period. This criterion often becomes extremely important when lending institutions are involved in funding brush management. A practice that produced an acceptable rate of return might not be adopted if a shorter payback period were required, unless cash flows were adequate from other ranch activities, or from other sources, to pay back the investment. Generally, lending institutions require a relatively short payback period for brush control (less than 5 years in many situations). However, it is possible to utilize longer-term credit sources, such as the Federal Land Bank, to borrow against land value for financing range improvements.

The average weaned calf production response allows estimates of potential increases in beef production from alternative practices in each major land resource area. Pretreatment production estimates are included to allow percentage increases to be evaluated. Identical livestock production responses were assumed following use of 2,4,5-T, silvex [2-(2,4,5-trichlorophenoxy) propionic acid], 2,4,5-T + dicamba or dicamba for honey mesquite control. The 2,4,5-T + picloram mixture resulted in somewhat higher production responses than other herbicides primarily because it controls a broader spectrum of associated species, and has a longer average treatment life than that of the other chemical alternatives.

Factors Influencing Selection of Alternatives

Since various environmental and managerial variables influence responses to brush management practices, no specific practice can be uniformily judged superior for every situation. Consequently, two resource managers may make correct decisions and not choose the same practice for similar management situations. For example, assume the use of a given herbicide produced an annual return of 15 percent compared to another alternative which produced 9 percent. If capital was not limiting and an individual would accept 9 percent as a minimum annual return, he might choose the "lower yielding" practice if risk conditions were different or if it allowed investment of more total funds which, in turn, would provide a greater absolute net return than could be realized from the higher annual return investment. If investment capital is limited, the correct decision is usually to choose the practice with the highest rate of return for a given level of investment capital which is above the individual minimum risk-return preference.

Potential impact associated with the size of the operation also influences decision-making when selecting brush-management alternatives.

About 93 percent of all ranch firms in Texas which sell 2,500 dollars or more livestock annually operate with herds of less than 200 cows (Table 3). These firms are maintaining 63 percent of the State's breeding herd. The remaining 37 percent of the State's breeding herd is maintained by 7 percent of the ranch firms which operate with herds of more than 200 cows. As ranch firms decrease in size, they can be expected to experience greater cash flow problems, since fewer "surplus dollars" are available for paying off range improvement loans after meeting consumptive needs.

RESULTS

The relative importance of honey mesquite as a management problem varies within and among the vegetation resource areas of the State. Therefore, it is imperative that basic differences in the vegetation, soils, climate, and range livestock production systems among these areas be considered when assessing the honey mesquite problem.

High Plains

The High Plains encompass about 19 million acres in extreme northwest Texas (Figure 1) of which more than 7 million acres is used as rangeland (Table 1). This high tableland is essentially level and dotted with playa lakes. The elevation is 3,000 to 4,000 feet and the annual frost-free period is 180 to 230 days. Average annual rainfall is 14 to 21 inches, and rangeland is typified by short grasses such as buffalograss (Buchloe dactyloides) and blue grama (Bouteloua gracilis). Honey mesquite is the major brush problem in association with sand sagebrush (Artemesia filifolia), cholla (Optuntia imbricata), yucca (Yucca glauca), and sand

Table 3. Estimated size distribution of ranch firms and beef cows by major land resource area in Texas.[a]

Major land resource area	Totals: Numbers		Totals: Contribution to State (%)		Distribution (%) by herd size (cattle numbers): 1-199		200-499		500+	
	Beef cows (thousands)	Ranch firms[b]	Beef cows	Ranch firms	Beef cows	Ranch firms	Beef cows	Ranch firms	Beef cows	Ranch firms
High Plains	495	6,436	8.6	8.4	58	91	19	7	23	2
Rolling Plains Rolling Red Plains	526	10,112	9.2	13.2	78	96	10	3	11	1
Cross Timbers, North Central Prairies	284	4,865	5.0	6.3	77	96	12	3	11	1
Grand Prairies, Blackland Prairies, Texas Claypan	1,491	23,163	26.0	30.3	71	95	16	4	12	1
East Texas	775	11,508	13.5	15.0	79	95	12	4	9	1
Coastal Prairies	664	7,378	11.6	9.6	50	91	22	7	28	2
Rio Grande Plains	874	7,149	15.3	9.3	40	88	21	8	39	4
Edwards Plateau, Central Basin	388	4,843	6.8	6.4	62	90	22	8	16	2
Trans Pecos	228	1,164	4.0	1.5	25	74	30	18	45	8
State totals	5,725	76,618	100	100	63	93	17	5	20	2

[a] Inventory values from Cattle, Calves and Goats Inventory: 1974 Census of Agriculture, Production regions for meat animal cost analysis, U.S. Dep. Agr., Econ. Res. Ser.

[b] Values represent firms reporting at least $2,500 in sales.

shinnery oak (Quercus havardii). The High Plains is typified by upland soils with slow-to-moderate drainage, primarily dark brown to reddish brown, mostly deep, neutral to calcareous clay loams, sandy loams, and sands. Cow calf operations are the most common ranch enterprises on the High Plains which supports about 8.5 percent of the State's cows and of the ranches in Texas (Table 3). Only about 2 percent of the ranches support more than 500 beef cows with 91 percent of the operations having fewer than 200 cows.

About 48 percent of the rangeland on the High Plains is infested with honey mesquite (Table 1). Although more than half of the infestation is represented by light canopy cover, the moderate to dense infestations occur primarily on the sites with highest production potential. Based on an annual survey conducted by The Texas Agricultural Extension Service (Hoffman, 1978), from 1973 through 1977 an average of 63,752 acres were treated annually with chemicals for brush control and an average of 28,253 acres were treated by mechanical methods.

Based on a comparison of the most commonly-used brush management alternatives on deep soils on the High Plains, the highest annual rate of return exceeded 9 percent and resulted from aerial applications of 2,4,5-T (Table 4). If 2,4,5-T and all herbicide combinations containing 2,4,5-T were eliminated, only dicamba would remain as a registered chemical alternative for honey mesquite control. Shifting to dicamba reduced annual rates of return to 4.5 to 5.5 percent. Because of the higher cost of dicamba treatment, the shift would also increase capital requirements by 45 percent, compared to 2,4,5-T (Table 5).

The treatment sequence, root plowing-roller chopping-seeding, and maintaining range improvement by power grubbing produced a 2.9 percent

Table 4. Annual rates of return (%) for honey mesquite contol on deep soils based on a cow-calf operation and $44/cwt cattle prices (1978 dollars) over a 20-year planning period in the Texas High Plains.[a]

Treatment[b]		Mesquite canopy cover and initial carrying capacity (acres/AU/yr)	
Initial	Maintenance	Moderate (36)	Dense (41)
2,4,5-T	2,4,5-T	9.4	9.5
2,4,5-T + dicamba	2,4,5-T + dicamba	8.1	8.4
Dicamba	Dicamba	4.5	5.5
2,4,5-T + picloram	2,4,5-T + picloram	5.4	5.0
Tree doze	Grub	2.7	2.3
Tree doze-seed[c]	Grub	2.4	0.7
Tree doze-roller chop-seed[c]	Grub	1.9	--
Root plow-roller chop-seed[c]	Grub	--	2.9
Typical counties		Oldham	Lynn

[a] The rate of return considers all operating and investment capital in brush control and breeding livestock. Costs and returns were projected in constant 1978 dollars. Thus, annual rates of return do not include inflation impacts and are considered a real rate of return. An estimate of market or nominal rates of return may be made by adding an assumed inflation rate to the real rates. This process assumes inflation will affect costs and returns equally.

[b] All herbicides aerially applied at 0.5 lb/acre.

[c] Seeding with native mixture of adapted species.

Table 5. Initial treatment costs and cost reduction ($/acre) required to yield a 9% annual rate of return on the investment in honey mesquite control and added breeding livestock (1978 dollars) on deep soils based on a cow-calf operation and $44/cwt cattle prices over a 20-year planning period on the Texas High Plains.[a]

Treatment[b]		Mesquite canopy cover and initial carrying capacity (acres/AU/yr)			
		Moderate (36)		Dense (41)	
Initial	Maintenance	Initial cost	Cost reduction	Initial cost	Cost reduction
2,4,5-T	2,4,5-T	5.50	0	5.50	0
2,4,5-T + dicamba	2,4,5-T + dicamba	5.95	0.53	5.95	0.45
Dicamba	Dicamba	7.50	2.99	7.50	3.01
2,4,5-T + picloram	2,4,5-T + picloram	9.75	3.37	9.75	3.75
Tree doze	Grub	20.00	10.50	22.00	12.31
Tree doze-seed[c]	Grub	25.00	14.94	35.00	24.66
Tree doze-roller chop-seed[c]	Grub	35.00	22.03	--	--
Root plow-roller chop-seed[c]	Grub	--	--	50.00	28.15
Typical counties		Oldham		Lynn	

[a] Initial treatment costs do not include breeding livestock investments. The net present value assumes a 9% interest charge for all added capital invested in brush control, increased breeding animals, and operation expenses.

[b] All herbicides aerially applied at 0.5 lb/acre.

[c] Seeding with native mixture of adapted species.

annual rate of return, the highest of the mechanical brush management systems on deep soils (Table 4). However, the capital requirement for the root plowing-based system was nine times that of aerial spraying with 2,4,5-T (Table 5).

All honey mesquite management approaches, except aerial spraying with 2,4,5-T required reduction of initial costs to achieve a 9 percent annual rate of return (Table 5). Use of the "next best" chemical alternative to herbicides containing 2,4,5-T, dicamba, would require an average cost reduction of 3.00 dollars per acre if cattle prices were maintained at 44 cents per pound. However, substituting half of the 2,4,5-T with dicamba would require cost reductions of only 45 to 53 cents per acre to yield a 9 percent rate of return, based on 1978 costs. Cost reduction requirements for mechanical practices ranged from 10.50 to 28.15 dollars per acre to generate a 9 percent annual rate of return on the investment.

Annual net cash flow increases were estimated to be 54 to 72 cents per acre for aerial applications of 2,4,5-T if 1978 cost/prices were maintained (Table 6). Net cash flow was projected at 23 cents per acre per year less if dicamba was aerially applied than when 2,4,5-T was selected. Annual net cash flow increases for all mechanical methods on deep soils of the High Plains were positive with greatest net cash flow (1.36 dollars per acre) resulting from root plowing-roller chopping-seeding and maintaining range improvement by power grubbing. Tree dozing maintained by power grubbing increased the annual net cash flow 42 to 47 cents per acre, regardless of honey mesquite canopy cover. Tree dozing and artificially seeding the pits increased annual net cash flow 21 cents per acre on sites with dense canopy cover and 54 cents per acre on sites with moderate canopy cover.

The pay-back period ranged from 11 to more than 20 years (Table 7), indicating problems in financing brush management practices by ranchers on

Table 6. Increased annual net cash flow ($/acre) following control of honey mesquite on deep soils based on a cow-calf operation and $44/cwt cattle prices (1978 dollars) over a 20-year planning period on the Texas High Plains.[a]

Treatment[b]		Mesquite canopy cover and initial carrying capacity (acres/AU/yr)	
Initial	Maintenance	Moderate (36)	Dense (41)
2,4,5-T	2,4,5-T	0.54	0.72
2,4,5-T + dicamba	2,4,5-T + dicamba	0.49	0.67
Dicamba	Dicamba	0.31	0.49
2,4,5-T + picloram	2,4,5-T + picloram	0.53	0.48
Tree doze	Grub	0.47	0.42
Tree doze-seed[c]	Grub	0.54	0.21
Tree doze-roller chop-seed[c]	Grub	0.61	--
Root plow-roller chop-seed[c]	Grub	--	1.36
Typical counties		Oldham	Lynn

[a] The net cash flow is total added cash sales ($44.00/cwt) less costs of brush control, added breeding livestock and increased annual operating costs plus the salvage value of cows and brush control (if applicable) at the end of the 20-year planning horizon. Interest charges were not included and the timing of cash flows was not considered.

[b] All herbicides aerially applied at 0.5 lb/acre.

[c] Native mixture of adapted species.

Table 7. Years required to recover initial mesquite control and livestock investment on deep soils with a cow-calf operation and $44/cwt cattle prices (1978 dollars) over a 20-year planning period on the Texas High Plains.[a]

Treatment[b] Initial	Maintenance	Mesquite canopy cover and initial carrying capacity (acres/AU/yr) Moderate (36)	Dense (41)
2,4,5-T	2,4,5-T	12	11
2,4,5-T + dicamba	2,4,5-T + dicamba	12	12
Dicamba	Dicamba	20 +	18
2,4,5-T + picloram	2,4,5-T + picloram	16	20
Tree doze	Grub	19	19
Tree doze-seed[c]	Grub	20 +	20 +
Tree doze-roller chop-seed[c]	Grub	20 +	--
Root plow-roller chop-seed[c]	Grub	--	20
Typical counties		Oldham	Lynn

[a] A 20-year planning horizon was utilized and no interest charges was included. The time period represent a "pay-back period" commonly used to evaluate investment opportunities. Salvage values of cows and brush control (if applicable) are not included as part of the pay-out period, but would represent gross returns to the operation at the time of "pay-back." A 20 + indicates greater than 20 years will be required to recover the investment.

[b] All herbicides aerially applied at 0.5 lb/acre.

[c] Native mixture of adapted species.

the High Plains if surplus cash flows were not available from other activities by the operation. Pay-back period for aerial application of 2,4,5-T or 2,4,5-T + dicamba was 11 or 12 years but was 18 to more than 20 years when dicamba alone was applied. From 16 to 20 years were required to pay back the investment in 2,4,5-T + picloram, and pay-back period for mechanical methods ranged from 19 to more than 20 years.

Potential increases in livestock production from mesquite control on the High Plains ranged from 42 to 126 percent (Table 8). Since site potential was the same, there was little difference in potential weaned calf production after treatment for either canopy cover situation. Honey mesquite control with herbicides increased weaned calf production to 13.7 pounds per acre per year, compared with 8.9 to 10 pounds per acre annually on brush-covered rangeland. Tree dozing did not increase weaned calf production compared to spraying, except when the pits were seeded on sites with moderate canopy cover or when tree dozing was followed by roller chopping and seeding. Highest weaned calf production, 21.2 pounds per acre per year, occurred following the root plowing-roller chopping and artificial seeding improvement sequence.

In order to develop comparisons among the honey mesquite alternatives, cattle prices were projected to average 44 cents per pound over the next 20 years based on 1978 prices. Obviously, any changes in cattle prices and/or associated production costs will alter the economic responses used as criteria of comparison. Moreover, it would be impractical to attempt analysis of a range of cost/price situations because of the number of resource regions and associated production situations. However, changes in net cash flows and annual rates of return within a range of cattle prices from 34 to 54 cents per pound can be estimated from data presented here.

Table 8. Total weaned calf production (lb/acre/year) following honey mesquite control on deep soils on the High Plains of Texas, 1978.[a]

Treatment[b] Initial	Maintenance	Mesquite canopy cover and initial carrying capacity (acres/AU/yr) Moderate (36)	Dense (41)
None (pretreatment)		10.0	8.9
2,4,5-T	2,4,5-T	13.7	13.7
2,4,5-T + dicamba	2,4,5-T + dicamba	13.7	13.7
Dicamba	Dicamba	13.7	13.7
2,4,5-T + picloram	2,4,5-T + picloram	14.4	14.2
Tree doze	Grub	14.1	13.5
Tree doze-seed[c]	Grub	16.5	14.4
Tree doze-roller chop-seed[c]	Grub	18.2	--
Root plow-roller chop-seed[c]	Grub	--	21.2
Typical counties		Oldham	Lynn

[a] Production responses over a 20-year planning period.

[b] Herbicides aerially applied at 0.5 lb/acre.

[c] Native mixture of adapted species.

Average cash flows per acre can be adjusted by multiplying the net increase in beef production per acre by the amount of price change and adding or subtracting the result from the 44 cents per pound situation. For example, assume that 50 cents per pound was considered realistic and tree dozing and seeding was to be evaluated. The average annual net increase in beef production per acre for this practice is estimated to be 6.5 pounds per year (16.5 - 10.0) (Table 8). The change in price, 6 cents per pound (50 - 44), multiplied times the annual production increase (6.5 pounds per acre) results in a projected 39 cents per acre per year increase in value from the 44 cents per pound price situation. This value summed with the value reported for a cattle price of 44 cents per pound, will yield the net annual average cash flow increase for a 50 cents per pound situation. For the tree dozing and seeding alternative, increasing the cattle price from 44 to 50 cents per pound resulted in an annual net cash flow increase from 54 cents per acre (Table 6) to 93 cents per acre.

Annual rates of return can be adjusted by multiplying the rate of return adjustment factor for a given honey mesquite alternative by the price change from 44 cents per pound and adding (or subtracting) it to the annual rate of return presented in Table 4. The rate of return adjustment factors for the price range, 34 to 54 cents per pound, for the High Plains are:

Alternative	Adjustment factor
2,4,5-T	.54
2,4,5-T + dicamba	.53
Dicamba	.49
2,4,5-T + picloram	.46

Tree doze	.22
Tree doze/seed	.21
Tree doze/roller chop/seed	.24
Root plow/roller chop/seed	.24

For example, assume that an estimate of the rate of return is desired for tree dozing and seeding (given a moderate honey mesquite canopy) when cattle prices are 50 cents per pound instead of 44 cents per pound. The adjustment factor (0.21) is multiplied by the price change per hundredweight ($50.00-$44.00 = $6.00) yielding a value of 1.26 percent. This value is added to the annual rate of return when cattle prices are $44 per hundredweight (2.4 percent from Table 4), yielding a total annual rate of return of 3.33 percent for the new cattle price situation. A reasonable accuracy of the estimate cannot be insured if livestock prices outside the range, 34 to 54 cents per pound, are used.

<u>Rolling Plains and Rolling Red Plains</u>

The Rolling Plains is often considered as two distinct land resource areas; the eastern portion being often referred to as the Rolling Red Plains or "reddish prairie" because of the preponderance of reddish and reddish brown soils. This differentiation is based primarily on soils but differences in rainfall also occur. The Rolling Plains and Rolling Red Plains cover about 24 million acres of northwest Texas (Figure 1).

The Rolling Plains and Rolling Red Plains are broad, nearly level to rolling plains with moderate to rapid surface drainage. About 60 percent of the area is estimated to be in native range (Table 3). Elevation is 1,000 to 3,000 feet, and average annual rainfall is 18 to 28 inches with the Rolling Plains averaging 18 to 22 inches annually.

The annual frost-free period is 185 to 235 days. Upland soils are pale brown to reddish brown to dark grayish brown, neutral to calcareous, sandy loams, clay loams, and clays over reddish calcareous, loamy to clayey subsoils (Godfrey, Carter and McKee undated). The bottomlands are minor areas of reddish brown, loamy to clayey, calcareous alluvial soils.

The Rolling Plains and Rolling Red Plains support 9.2 percent of the State's beef cows and contain 13.2 percent of the ranches in Texas (Table 3). Only 1 percent of the ranches operate with 500 or more head of beef cows whereas 96 percent of the ranches have fewer than 200 beef cows and account for 78 percent of the cow inventory for the resource region.

Vegetation is mixed grass with sodgrass and midgrasses (bunchgrasses) intermingled in various proportions depending on range site. Honey mesquite is the primary brush problem in association with lotebush (<u>Zizyphus obtusifolia</u>) and pricklypear (<u>Opuntia</u> spp.). The sandy soils support sandy shinnery oak, yucca, and sand sagebrush with scrub oaks (<u>Quercus</u> spp) increasing in importance in the eastern portion of the vegetation region.

Over 85 percent of the native range of the rolling Plains and Rolling Red Plains support a honey mesquite infestation (Table 1). During the past 5 years, herbicides have been applied to about 278,000 acres annually, and about 105,000 acres were treated per year with mechanical methods for brush control (Hoffman 1978). About 45 percent of the presnet honey mesquite infestation is represented by light canopy cover, a reflection of past brush management efforts (Table 1). However, 42 percent of the infestation (about 5 million acres) have moderate to dense canopy covers on range sites of higher production potential.

Rolling Red Plains. Economic responses on the Rolling Red Plains were similar to those discussed for the High Plains. Regardless of site potential or canopy cover (and associated pretreatment carrying capacity) on the Rolling Red Plains, highest annual rates of return resulted from aerial applications of 2,4,5-T (Table 9). Highest rates of return (15.4 percent) occurred from applications of 2,4,5-T to dense canopy covers of honey mesquite on deep soils. Annual rates of return from treating deep soils with a moderate canopy cover or from treating shallow soils were about 11 percent. Although aerial spraying combined with chaining has traditionally been a standard management system for dense honey mesquite stands on the Rolling Plains, annual rates of return were about the same as from spraying only (Table 9). Annual rates of return from dicamba, the only herbicide treatment not containing 2,4,5-T, ranged from 7.1 percent to 7.6 percent, except on deep soils supporting a dense canopy (10.8 percent). Highest rate of return from the mechanical practices, 10.5 percent, was generated by chaining followed by maintenance sprays of 2,4,5-T. The utility of this practice is limited primarily to areas supporting sites of honey mesquite plants large enough to be uprooted by the chain.

Adjustment factors for evaluating annual rates of return for cattle prices ranging from 34 to 54 cents per pound for the various alternatives on the Rolling Red Plains are:

Alternative	Adjustment factor
2,4,5-T	0.61
2,4,5-T (chain)	0.63
2,4,5-T + dicamba	0.59
Dicamba	0.55
2,4,5-T + picloram	0.54

Table 9. Annual rates of return (%) from honey mesquite control on the Rolling Red Plains based on a cow-calf operation and $44/cwt cattle prices (1978 dollars) over a 20-year planning period.[a]

Treatment[b]		Mesquite canopy cover by site and initial carrying capacity (acres/AU/yr)			
		Deep soils		Shallow soils	
Initial	Maintenance	Moderate (30)	Dense (33.5)	Moderate (40)	Dense (43)
2,4,5-T	2,4,5-T	11.3	15.4	11.3	11.1
2,4,5-T	Chain	--	14.3	--	11.1
2,4,5-T + dicamba	2,4,5-T + dicamba	10.3	14.2	10.3	10.2
Dicamba	Dicamba	7.1	10.8	7.5	7.6
2,4,5-T + picloram	2,4,5-T + picloram	8.5	10.1	7.6	6.8
Chain-rake-seed	2,4,5-T	--	-0.6	--	--
Tree doze-seed[c]	Grub	3.7	4.9	-1.0	-0.4
Root plow-seed	Grub	4.5	3.3	-0.2	-0.2
Root plow-kleingrass	Grub	5.7	4.5	--	--
Chain	2,4,5-T	8.3	10.5	--	--
Oil	Oil	2.2	--	0.4	--
Typical counties		Cottle	King	Willbarger	Kent

[a]The rate of return considers all operating and investment capital in brush control and breeding livestock. Costs and returns were projected in constant 1978 dollars. Thus, annual rates of return do not include inflation impacts and are considered a real rate of return. An estimate of market or nominal rates of return may be made by adding an assumed inflation rate to the real rates. This process assumes inflation will affect costs and returns equally.

[b]Herbicides were aerially applied at 0.5 lb/acre.

[c]Refers to adapted native-grass mixture.

Chain-rake-seed	0.29
Tree doze-seed (native mix)	0.21
Root plow-seed (native mix)	0.18
Root plow-kleingrass	0.46
Chain	0.50
Oil	0.30

These factors can be used to adjust the annual rates of return for variation in cattle prices, within the stipulated range, as described in the example for the High Plains.

Initial costs for herbicide alternatives on the Rolling and Rolling Red Plains were the same as those for the High Plains (Table 5). Initial costs for the mechanical brush management alternatives on the Rolling Red Plains ranged from 8.00 dollars per acre for chaining and maintaining improvement with broadcast sprays of 2,4,5-T to 80.00 dollars per acre for root plowing and establishing kleingrass pastures (Table 10). No initial cost reduction was required for aerial applications of 2,4,5-T, 2,4,5-T followed by chaining, or 2,4,5-T + dicamba to yield a 9 percent annual return to management for honey mesquite control on the Rolling Red Plains (Table 11). In addition, no initial cost reduction was required for dicamba or 2,4,5-T + picloram to yield a 9 percent annual rate of return when applied to dense honey mesquite canopies on deep sites. However, application of these herbicide alternatives to the other honey mesquite/site situations required a cost reduction of 0.44 to 2.17 dollars per acre to yield a 9 percent annual rate of return. The only mechanical practice not requiring a cost reduction to yield a 9 percent return was chaining followed by applications of 2,4,5-T to dense honey mesquite canopies on deep soils. The same treatment required a cost reduction of 72 cents per acre if applied

Table 10. Initial costs ($/acre) of selected brush management alternatives applied for honey mesquite control on the Texas Rolling Red Plains, 1978.[a]

Treatment[b]		Mesquite canopy cover by site and initial carrying capacity (acres/AU/yr)			
		Deep soils		Shallow soils	
Initial	Maintenance	Moderate (30)	Dense (33.5)	Moderate (40)	Dense (43)
Chain-rake-seed[c]	2,4,5-T	--	30.00	--	--
Tree doze-seed[c]	Grub	40.00	40.00	42.50	45.00
Root plow-seed[c]	Grub	50.00	60.00	67.50	72.50
Root plow-kleingrass	Grub	80.00	80.00	--	--
Chain	2,4,5-T	8.00	8.00	--	--
Oil	Oil	22.50	--	20.00	--
Typical counties		Cottle	King	Wilbarger	Kent

[a] Initial treatment costs do not include breeding livestock.

[b] Herbicides aerially applied at 0.5 lb/acre.

[c] Refers to native-grass mixture of adapted species.

Table 11. Initial cost reduction ($/acre) required for yielding a [illegible] investment in honey mesquite control and added breeding livestock (1978 dollars) based on a cow-calf operation and $44/cwt cattle prices over a 20-year planning period on the Texas Rolling Red Plains, 1978.[a]

Treatment[b] Initial	Treatment[b] Maintenance	Mesquite canopy cover by site and initial carrying capacity (acres/AU/yr) — Deep soils: Moderate (30)	Deep soils: Dense (33.5)	Shallow soils: Moderate (40)	Shallow soils: Dense (43)
2,4,5-T	2,4,5-T	0	0	0	0
2,4,5-T	Chain	--	0	--	0
2,4,5-T + dicamba	2,4,5-T + dicamba	0	0	0	0
Dicamba	Dicamba	1.67	0	1.13	1.29
2,4,5-T + picloram	2,4,5-T + picloram	0.44	0	1.21	2.17
Chain-rake-seed[c]	2,4,5-T	--	20.22	--	--
Tree doze-seed[c]	Grub	21.27	17.39	34.97	36.23
Root plow-seed[c]	Grub	23.37	35.85	50.16	54.24
Root plow-kleingrass	Grub	30.05	40.28	--	--
Chain	2,4,5-T	0.72	0	--	--
Oil	Oil	12.76	--	14.08	--
Typical counties		Cottle	King	Wilbarger	Kent

[a] The net-present value assumes a 9% interest charge for all added capital invested in brush control, increased breeding animals, and operation expenses.

[b] All herbicides aerially applied at 0.5 lb/acre.

[c] Refers to native-grass mixture of adapted species.

to moderate mesquite canopies on deep soils. Cost reductions for other mechanical practices to yield a 9 percent annual rate of return ranged from 12.76 to 54.24 dollars per acre.

Increases in estimated annual net cash flows varied widely among the honey mesquite control alternatives on the Rolling Red Plains (Table 12). However, annual cash flows associated with aerial application of 2,4,5-T, 0.81 to 1.32 dollars per acre, were consistently higher than the herbicide alternative not containing 2,4,5-T. Aerial applications of 2,4,5-T followed by chaining increased annual net cash flow by 0.77 to 1.52 dollars per acre when applied to dense canopy covers of honey mesquite. Dicamba increased annual net cash flows by 0.65 to 1.06 dollars per acre depending on the specific honey mesquite/range site situation. Applied to honey mesquite on deep soils, 2,4,5-T + picloram resulted in increased annual net cash flows similar to those from 2,4,5-T alone. This response was attributed to the slightly longer effective average life of the 2,4,5-T/picloram combination and improved weed control, compared to 2,4,5-T alone.

Where mechanical treatments were applied to shallow soils, annual net cash flows ranged from a -34 cents per acre to + 7 cents per acre (Table 12). However, on the deep soils, mechanical practices increased the annual net cash flow and, in most cases, the increases exceeded those from herbicide treatments. Greatest increases in annual net cash flow, 4.34 to 5.49 dollars per acre, were generated by the most intensive alternative, establishment of kleingrass pasture. Increasing annual net cash flow, if the annual rates of return are above an operators minimum acceptable level but less than other alternatives, is one motive for selecting mechanical brush control practices over other alternatives.

Table 12. Increased annual net cash flow ($/acre) from selected honey mesquite control alternatives based on a cow-calf operation and $44/cwt cattle prices (1978 dollars) on the Texas Rolling Red Plains, 1978.[a]

Treatment[b]		Mesquite canopy cover by site and initial carrying capacity (acres/AU/yr)			
		Deep soils		Shallow soils	
Initial	Maintenance	Moderate (30)	Dense (33.5)	Moderate (40)	Dense (43)
2,4,5-T	2,4,5-T	0.92	1.32	0.81	0.92
2,4,5-T	Chain	--	1.52	--	0.77
2,4,5-T + dicamba	2,4,5-T + dicamba	0.87	1.26	0.77	0.88
Dicamba	Dicamba	0.67	1.06	0.65	0.76
2,4,5-T + picloram	2,4,5-T + picloram	0.95	1.25	0.70	0.73
Chain-rake-seed[c]	2,4,5-T	--	-0.09	--	--
Tree doze-seed[c]	Grub	1.59	2.23	-0.34	-0.13
Root plow-seed[c]	Grub	2.50	2.26	-0.10	-0.09
Root plow-kleingrass	Grub	5.49	4.34	--	--
Chain	2,4,5-T	0.96	1.30	--	--
Oil	Oil	0.43	--	0.07	--
Typical counties		Cottle	King	Wilbarger	Kent

[a] The net cash flow is total added cash sales ($44.00/cwt) less costs of brush control, added breeding livestock and increased annual operating costs plus the salvage value of cows and brush control (if applicable) at the end of the 20 year planning horizon. Interest charges were not included and the timing of cash flows was not considered.

[b] All herbicides aerially applied at 0.5 lb/acre.

[c] Refers to native mixture of adapted species.

Again, the decision to select a given alternative for a selected management unit is influenced by overall financial requirements of the ranch firm. If past investments in practices which yield a high annual rate of return have been installed on other management units, the manager may option to install a practice which may be complementary in nature to established practices and will significantly increase net annual cash flow through the operation. Such an approach, of course, assumes that investment capital is not a limitation and minimum rates of return are achieved.

Time required to recover the initial investment in aerial application of 2,4,5-T or 2,4,5-T followed by chaining for honey mesquite control on the Rolling Red Plains ranged from 7 to 11 and 12 years, respectively (Table 13). Nine to 13 years were required to recover the initial investment in aerial applications of 2,4,5-T + dicamba and 10 to 15 years were required for recovery of the initial investment in applications of dicamba. Because of the relatively high initial cost (Table 5), 12 to 16 years were required for recovery of the initial investment in aerial application of 2,4,5-T + picloram (Table 13).

On shallow soils, more than 20 years were required to recover the investment in the selected mechanical alternatives for honey mesquite control on the Rolling Red Plains (Table 13). Chaining followed by application of 2,4,5-T required 10 years for recovery of the initial investment, similar to the time requirement for recovering the investment in 2,4,5-T alone applied to the same sites. These responses illustrate the importance of site selection based on production potential for range improvement activities. For example, root plowing or tree dozing followed by seeding a mixture of native range grasses on soils required 16 to 19 years for recovery of the initial investment, even on the more productive sites (Table 1

Table 13. Years required to recover initial honey mesquite control and livestock investment based on a cow-calf operation and $44/cwt cattle prices (1978 dollars) on the Texas Rolling Red Plains, 1978.[a]

Treatment[b]		Mesquite canopy cover by site and initial carrying capacity (acres/AU/yr)			
		Deep soils		Shallow soils	
Initial	Maintenance	Moderate (30)	Dense (33.5)	Moderate (40)	Dense (43)
2,4,5-T	2,4,5-T	10	9	7	12
2,4,5-T	Chain	--	7	--	11
2,4,5-T + dicamba	2,4,5-T + dicamba	11	9	13	12
Dicamba	Dicamba	12	10	15	14
2,4,5-T + picloram	2,4,5-T + picloram	13	12	16	16
Chain-rake-seed[c]	2,4,5-T	--	20 +	--	--
Tree doze-seed[c]	Grub	18	16	20 +	20 +
Root plow-seed[c]	Brub	18	19	20 +	20 +
Root plow-kleingrass	Grub	12	20	--	--
Chain	2,4,5-T	10	10	--	--
Oil	Oil	20	--	20 +	--
Typical counties		Cottle	King	Wilbarger	Kent

[a] A twenty year planning horizon was utilized and no interest charges are included. The time period represents a "pay-back period" commonly used to evaluate investment opportunities. Salvage values of cows and brush control (if applicable) are not included as part of the pay-out period, but would represent gross returns to the operation at the time of "pay-back." A 20 + indicates greater than 20 years will be required to recover the investment.

[b] All herbicides aerially sprayed at 0.5 lb/acre.

[c] Native mixture of adapted species.

Applying the same treatments to shallow soils caused the time to recover the investment to exceed the 20 year planning horizon. Although 20 years were required for recovery of the initial investment in establishing kleingrass on deep soils supporting dense canopy covers of honey mesquite, only 12 years were required on sites supporting moderate canopy covers.

Average annual production responses were similar among herbicide alternatives ranging from 18.0 to 19.3 pounds of beef per acre on the deep soils with greater responses following application of 2,4,5-T + picloram than from 2,4,5-T, dicamba or 2,4,5-T + dicamba mixtures (Table 14). Greatest annual average production response, 62.8 pounds of beef per acre, occurred where tame pastures (kleingrass) were established following root plowing. Revegetation projects utilizing native forage mixtures following tree dozing or root plowing were estimated to produce from 23.8 to 27.8 pounds of beef per acre per year for the 20 year planning horizon.

Rolling Plains. Annual rates of return from aerial applications of 2,4,5-T on the Rolling Plains varied from 12.7 to 16.9 percent on deep soils, depending primarily on site potential (Table 15). Rates of return from honey mesquite control on deep soils on the Rolling Plains were somewhat higher than on the Rolling Red Plains, apparently because of somewhat higher rainfall. However, annual rates of return were lower on shallow soils of the Rolling Red Plains (Table 9) than on the Rolling Plains (Table 15). This differential was attributed to higher initial carrying capacities on the shallow sites of the Rolling Plains which reduced the potential production change following brush control, compared to the Rolling Red Plains. Application of 2,4,5-T for honey mesquite control on shallow soils of the Rolling Plains varied from 4.1 to 7.9 percent. Annual

Table 14. Total weaned calf production (lb/acre/year) from selected honey mesquite control based on a cow-calf operation and $44/cwt cattle prices (1978 dollars) on the Texas Rolling Red Plains, 1978.[a]

Treatment[b] Initial	Maintenance	Mesquite canopy cover by site and initial carrying capacity (acres/AU/yr): Deep soils, Moderate (30)	Deep soils, Dense (33.5)	Shallow soils, Moderate (40)	Shallow soils, Dense (43)
None (pretreatment)		12.5	11.2	9.2	8.6
2,4,5-T	2,4,5-T	18.2	18.0	13.6	13.4
2,4,5-T	Chain	--	16.5	--	13.0
2,4,5-T + dicamba	2,4,5-T + dicamba	18.2	18.0	13.6	13.4
Dicamba	Dicamba	18.2	18.0	13.6	13.4
2,4,5-T + picloram	2,4,5-T + picloram	19.3	18.5	14.1	14.0
Chain-rake-seed[c]	2,4,5-T	--	16.2	--	--
Tree doze-seed[c]	Grub	25.5	23.8	14.3	14.6
Root plow-seed[c]	Grub	27.8	26.6	16.7	16.8
Root plow-kleingrass	Grub	62.8	55.2	--	--
Chain	2,4,5-T	18.3	18.4	--	--
Oil	Oil	19.1	--	14.1	--
Typical counties		Cottle	King	Wilbarger	Kent

[a] A 20-year planning period was utilized to determine average production response.

[b] Herbicides aerially applied at 0.5 lb/acre.

[c] Native mixture of adapted species.

Table 15. Annual rates of return (%) from selected honey mesquite control alternatives based on a cow-calf operation at $44/cwt cattle prices (1978 dollars) over a 20-year planning period on the Texas Rolling Plains, 1978.[a]

Treatment[b] Initial	Maintenance	Mesquite canopy cover by site and initial carrying capacity (acres/AU/yr): Deep soils, Moderate (29)	Deep soils, Dense (25)	Deep soils, Dense (30)	Deep soils, Dense (42)	Shallow soils, Moderate (31)	Shallow soils, Dense (35)
2,4,5-T	2,4,5-T	14.2	16.9	14.6	12.7	4.1	7.9
2,4,5-T + dicamba	2,4,5-T + dicamba	13.1	15.8	13.7	11.8	4.8	6.8
Dicamba	Dicamba	9.9	12.5	10.5	8.5	0.8	3.5
2,4,5-T + picloram	2,4,5-T + picloram	11.1	12.1	9.2	8.9	1.8	4.3
Tree doze	2,4,5-T	4.5	--	--	4.5	-0.5	--
Root plow-seed[c]	2,4,5-T	4.3	2.4	3.9	2.2	--	--
Tree doze-seed[c]	2,4,5-T	2.5	2.1	1.3	2.0	--	--
Chain	2,4,5-T	--	12.1	10.7	7.2	--	--
Root plow-seed[c]	Grub	2.6	3.8	4.0	3.7	0.8	1.9
Tree doze-seed	Grub	1.3	3.4	2.1	2.1	-1.5	2.0
Scalp-root plow-seed	2,4,5-T	--	2.4	--	--	--	--
Root plow-roller chop-seed[c]	Grub	2.0	2.6	1.6	3.2	--	--
Root plow-kleingrass	Grub	6.6	8.1	5.7	4.8	--	--
Typical counties		Donley	Callahan	Dickens	Hall	Coke	Sterling

[a] The rate of return considers all operating and investment capital in brush control and breeding livestock. Costs and returns were projected in constant 1978 dollars. Thus, annual rates of return do not include inflation impacts and are considered a real rate of return. An estimate of market or nominal rates of return may be made by adding an assumed inflation rate to the real rates. This process assumes inflation will affect costs and returns equally.

[b] All herbicides aerially applied at 0.5 lb/acre.

[c] Native mixture of adapted species.

rates of return produced from the "next best" chemical alternative, dicamba, varied from 8.5 to 12.5 percent on deep soils and from 0.8 to 3.5 percent on the shallow soils.

Chaining followed by maintenance treatment with aerially-applied 2,4,5-T (deep soils, dense canopy cover) produced annual rates of returns of 7.2 to 12.1 percent on the Rolling Plains (Table 15). Annual rates of returns from all other mechanical alternatives were less than 4 percent, except when root plowing was followed by establishment of kleingrass pastures.

Since the annual rates of return were based on cattle prices of 44 cents per pound, adjustment factors as discussed for the High Plains are needed to compare alternatives on the Rolling Plains when beef prices are in the range, 34 to 54 cents per pound. The adjustment factors are:

Alternative	Adjustment factor
2,4,5-T	0.65
2,4,5-T + dicamba	0.60
Dicamba	0.56
2,4,5-T + picloram	0.55
Tree doze	0.23
Root plow-seed (2,4,5-T as maintenance)	0.24
Tree doze-seed (2,4,5-T as maintenance)	0.23
Chain	0.51
Root plow-seed (grub as maintenance)	0.23
Tree doze-seed (grub as maintenance)	0.23

Scalp-root plow-seed	0.20
Root plow-roller chop-seed	0.22
Root plow-kleingrass	0.41

Treatment costs for chemical brush management alternatives evaluated on the Rolling Plains were the same as for the High Plains (Table 5). Costs for mechanical treatments varied from 8 dollars per acre (chaining) to 70 dollars per acre (scalp-root plow-seed), depending on treatment intensity (Table 16). No reduction in initial treatment cost was required to yield a 9 percent annual rate of return from herbicide applications for honey mesquite control on the Rolling Plains, except for aerial application of dicamba or 2,4,5-T + picloram to honey mesquite on the deep soils with relatively low production potential (Table 17). However, cost reductions were required for herbicide treatments to yield a 9 percent rate of return on shallow soils, except when 2,4,5-T was applied to dense honey mesquite stands. Except for chaining followed by aerial application of 2,4,5-T, cost reductions ranging from 6.56 to 41.28 dollars per acre were required for mechanical treatments to yield a 9 percent rate of return. The greatest cost reduction requirement was associated with the most intensive treatment, scalping-root plowing-seeding to a native range mixture, which was applicable only to the highest potential sites. In contrast, root plowing and establishment of kleingrass on the same site required 6.56 dollars per acre reduction in initial cost to yield a 9 percent annual rate of return.

In general, the brush management alternatives increased the annual net cash flow when applied for honey mesquite management on Rolling Plains rangeland (Table 18). Increased annual net cash flows from aerial

Texas Rolling Plains, 1978.[a]

Treatment[b]		Mesquite canopy cover by site and initial carrying capacity (acres/AU/yr)					
		Deep soils				Shallow soils	
		Moderate		Dense		Moderate	Dense
Initial	Maintenance	(29)	(25)	(30)	(42)	(31)	(35)
Tree doze	2,4,5-T	20.00	--	--	22.00	42.50	--
Root plow-seed[c]	2,4,5-T	45.00	55.00	45.00	45.00	--	--
Tree doze-seed[c]	2,4,5-T	32.00	30.00	40.00	35.00	--	--
Chain	2,4,5-T	--	8.00	12.00	12.00	--	--
Root plow-seed[c]	Grub	45.00	45.00	45.00	50.00	47.50	45.00
Tree doze-seed[c]	Grub	32.50	40.00	45.00	40.00	42.50	40.00
Scalp-root plow seed[c]	2,4,5-T	--	70.00	--	--	--	--
Root plow-roller chop-seed[c]	Grub	50.00	50.00	50.00	50.00	--	--
Root plow-kleingrass	Grub	50.00	55.00	55.00	55.00	--	--
Typical counties		Donley	Callahan	Dickens	Hall	Coke	Sterling

[a] Initial treatment costs do not include added breeding livestock investments.

[b] Herbicides aerially applied at 0.5 lb/acre.

[c] Native mixture of adapted species.

Table 17. Initial cost reduction ($/acre) required for selected honey mesquite alternatives to yield a 9% annual rate of return on the investment based on a cow-calf operations and $44/cwt cattle prices (1978 dollars) on the Rolling Plains of Texas, 1978.[a]

Treatment[b]		Mesquite canopy cover by site and initial carrying capacity (acres/AU/yr)					
		Deep soils				Shallow soils	
		Moderate	Dense			Moderate	Dense
Initial	Maintenance	(29)	(25)	(30)	(42)	(31)	(35)
2,4,5-T	2,4,5-T	0	0	0	0	1.02	0
2,4,5-T + dicamba	2,4,5-T + dicamba	0	0	0	0	2.00	1.35
Dicamba	Dicamba	0	0	0	0.36	4.42	3.79
2,4,5-T + picloram	2,4,5-T + picloram	0	0	0	0.09	5.15	3.89
Tree doze	2,4,5-T	8.01	--	--	9.31	29.50	--
Root plow-seed[c]	2,4,5-T	17.64	31.57	21.89	27.08	--	--
Tree doze-seed[c]	2,4,5-T	18.43	18.04	25.67	22.55	--	--
Chain	2,4,5-T	--	0	0	2.04	--	--
Root plow-seed[c]	Grub	26.59	22.22	20.65	26.29	33.90	29.24
Tree doze-seed[c]	Grub	20.76	21.44	29.10	24.14	32.77	25.75
Scalp-root plow-seed[c]	2,4,5-T	--	41.28	--	--	--	--
Root plow-roller chop-seed[c]	Grub	31.25	29.17	33.38	27.45	--	--
Root plow-Kleingrass	Grub	15.38	6.56	21.70	26.93	--	--
Typical counties		Donley	Hall	Dickens	Callahan	Coke	Sterling

[a] The net present value assumes a 9% interest charge for all added capital invested in brush control, increased breeding animals and operation expenses.

[b] Herbicides aerially applied at 0.5 lb/acre.

[c] Native mixture of adapted species.

Table 18. Increased annual net cash flow ($/acre) produced by selected honey mesquite control alternatives based on cow-calf operations and $44/cwt cattle prices (1978 dollars) over a 20-year planning period on the Texas Rolling Plains, 1978.[a]

Treatment[b] Initial	Treatment[b] Maintenance	Mesquite canopy cover by site and initial carrying capacity (acres/AU/yr): Deep soils, Moderate (29)	Deep soils, Dense (25)	Deep soils, Dense (30)	Deep soils, Dense (42)	Shallow soils, Moderate (31)	Shallow soils, Dense (35)
2,4,5-T	2,4,5-T	1.09	1.43	1.19	0.93	0.13	0.48
2,4,5-T + dicamba	2,4,5-T + dicamba	1.05	1.41	1.19	0.93	0.23	0.42
Dicamba	Dicamba	0.87	1.25	1.02	--	0.05	0.24
2,4,5-T + picloram	2,4,5-T + picloram	1.24	1.41	1.09	1.00	0.13	0.36
Tree doze	2,4,5-T	0.82	--	--	0.96	-0.14	--
Root plow-seed[c]	2,4,5-T	1.66	1.19	1.74	0.89	--	--
Tree doze-seed[c]	2,4,5-T	0.72	0.56	0.43	0.68	--	--
Chain	2,4,5-T	--	1.19	1.30	0.77	--	--
Root plow-seed[c]	Grub	1.09	1.59	1.68	1.95	0.34	0.82
Tree doze-seed[c]	Grub	0.34	1.35	0.97	0.76	-0.41	0.78
Scalp-root plow-seed[c]	2,4,5-T	--	1.55	--	--	--	--
Root plow-roller chop-seed[c]	Grub	0.90	1.21	0.78	1.60	--	--
Root plow-kleingrass	Grub	4.68	7.01	4.21	3.38	--	--
Typical counties		Donley	Callahan	Dickens	Hall	Coke	Sterling

[a] The net cash flow is total added cash sales ($44.00/cwt) less costs of brush control, added breeding livestock and increased annual operating costs plus the salvage value of cows and brush control (if applicable) at the end of the 20-year planning horizon. Interest charges were not included and the timing of cash flows was not considered.

[b] Herbicides aerially applied at 0.5 lb/acre.

[c] Native mixture of adapted species.

applications of 2,4,5-T ranged from 0.93 to 1.43 dollars per acre on deep soils, and from 0.13 to 0.48 dollar per acre on shallow soils. In comparison, annual net cash flows were increased by 0.87 to 1.25 dollars per acre on deep soils, and by 0.23 to 0.42 dollar per acre on shallow soils from aerial applications of dicamba for honey mesquite control. On the sites with highest production potential, increases in annual net cash flow exceeded 1.40 dollars per acre from all herbicide alternatives except dicamba (1.25 dollars per acre).

Of the mechanical alternatives evaluated on the Rolling Plains, root plowing followed by establishment of kleingrass pasture produced the greatest increases in annual net cash flow, from 3.38 to 7.01 dollars per acre, depending on site potential (Table 18). In contrast, root plowing and seeding to a native range mixture increased annual net cash flows by 1.09 to 1.95 dollars per acre on the deep soils. It must be emphasized, however, that these estimates do not consider potential economic interactions of the improved rangeland with associated unimproved management units within the ranching enterprise.

From 5 to 9 years were required to recover the initial investment for aerial application of 2,4,5-T on deep soils, and 12 to 13 years were required on shallow soils (Table 19). These recovery times were the best of the honey mesquite control alternatives evaluated. For example, from 11 to 13 years were required to recover the initial investment in dicamba applied to deep soils and from 17 to more than 20 years when shallow soils were treated. Since efficacy of the two herbicides were considered equal, this contrast indicates the economic sensitivity of rangeland enterprises to cost changes.

Table 19. Years required to recover initial investment in selected honey mesquite control alternatives and in livestock based on cow-calf operations and $44/cwt cattle prices (1978 dollars) on the Texas Rolling Plains, 1978.[a]

Treatment[b]		Mesquite canopy cover by site and initial carrying capacity (acres/AU/yr)					
		Deep soils				Shallow soils	
		Moderate	Dense			Moderate	Dense
Initial	Maintenance	(29)	(25)	(30)	(42)	(31)	(35)
2,4,5-T	2,4,5-T	6	5	8	9	13	12
2,4,5-T + dicamba	2,4,5-T + dicamba	9	5	9	11	20 +	13
Dicamba	Dicamba	12	11	11	13	20 +	17
2,4,5-T + picloram	2,4,5-T + picloram	11	10	12	14	20 +	16
Tree doze	2,4,5-T	16	--	--	17	20 +	--
Root plow-seed[c]	2,4,5-T	18	20	18	20 +	--	--
Tree doze-seed[c]	2,4,5-T	20	20	20 +	20 +	--	--
Chain	2,4,5-T	--	9	10	11	--	--
Root plow-seed[c]	Grub	20	16	15	18	20 +	20 +
Tree doze-seed[c]	Grub	18	18	20	20	20 +	20 +
Scalp-root plow-seed[c]	2,4,5-T	--	20	--	--	--	--
Root plow-roller chop-Seed[c]	Grub	20	19	20 +	19	--	--
Root plow-kleingrass	Grub	15	14	16	16	--	--
Typical counties		Donley	Callahan	Dickens	Hall	Coke	Sterling

[a] A 20-year planning horizon was utilized and no interest charges are included. The time period represents a "pay-back period" commonly used to evaluate investment opportunities. Salvage values of cows and brush control (if applicable) are not included as part of the pay-out period, but would represent gross returns to the operation at the time of "pay-back." A 20 + indicates greater than 20 years will be required to recover the investment.

[b] Herbicides aerially applied at 0.5 lb/acre.

[c] Native mixture of adapted species.

Herbicidal treatment of dense canopy covers of honey mesquite on the highest potential sites on the Rolling Plains was estimated to increase weaned calf production from 14.6 to 22 pounds per acre annually over the 20-year planning horizon (Table 20). On shallow soils, the expected average increase was 3.2 pounds of beef per acre annually. Of the mechanical alternatives evaluated, highest expected annual beef production occurred following root plowing and artificial seeding with a native range mixture (27.5 pounds per acre), or with kleingrass (61.0 pounds per acre).

Grand Prairie and Cross Timbers

The Grand Prairie covers about 7.0 million acres of which about 75 percent is undulating to hilly, deeply incised (locally stony) prairies. Thirty-eight percent of the region is native range (Table 1). Elevation is 600 to 1,000 feet, annual average rainfall is 30 to 35 inches, and the annual frost-free period is 230 to 240 days.

Upland soils are dark, deep to shallow and stony, calcareous clays with subsoils containing significant amounts of limestone. The bottomlands are minor areas of reddish brown, loamy to clayey, calcareous alluvial soils (Godfrey, Carter and McKee undated).

Vegetation of the uplands is tall bunchgrass, midgrasses, live oak (Quercus virginiana), and juniper (Juniperus spp.). The bottomlands support stands of hardwoods, primarily oaks (Quercus spp.), elms (Ulmus spp.) and pecan (Carya illinoiensis). Mesquite infests about 55 percent of the native range, primarily as moderate to dense canopy cover on deep range sites (Table

Godfrey, Carter and McKee (undated) separate the Cross Timbers into the East Cross Timbers and West Cross Timbers, whereas Gould (1975) discusses the region as a single entity. For the purposes of this

Table 20. Total weaned calf production (lb/acre/year)[a] from selected honey mesquite alternatives based on cow-calf operations on the Texas Rolling Plains, 1978.

Treatment[b]		Mesquite canopy cover by site and initial carrying capacity (acres/AU/yr)					
		Deep soils				Shallow soils	
		Moderate	Dense			Moderate	Dense
Initial	Maintenance	(29)	(42)	(30)	(25)	(31)	(35)
None (pretreatment)		12.7	8.6	12.4	14.6	11.7	10.4
2,4,5-T	2,4,5-T	18.4	14.2	18.8	22.0	14.1	14.0
2,4,5-T + dicamba	2,4,5-T + dicamba	18.4	14.2	18.8	22.0	14.1	14.0
Dicamba	Dicamba	18.4	14.2	18.8	22.0	14.1	14.0
2,4,5-T + picloram	2,4,5-T + picloram	20.1	15.6	20.0	22.0	15.0	14.8
Tree doze	2,4,5-T	18.5	14.5	--	--	17.3	--
Root plow-seed[c]	2,4,5-T	24.2	17.7	24.2	26.0	--	--
Tree doze-seed[c]	2,4,5-T	20.2	15.2	19.9	20.9	--	--
Chain	2,4,5-T	--	13.7	18.7	20.9	--	--
Root plow-seed[c]	Grub	23.1	22.6	24.4	27.5	18.9	19.0
Tree doze-seed[c]	Grub	19.8	17.1	21.4	26.1	18.7	18.6
Scalp-root plow-seed[c]	2,4,5-T	--	--	--	28.7	--	--
Root plow-roller chop-seed[c]	Grub	22.3	21.6	22.0	25.7	--	--
Root plow-kleingrass	Grub	45.7	36.1	43.1	61.0	--	--
Typical counties		Donely	Callahan	Dickens	Hall	Coke	Sterling

[a] A 20-year planning period was utilized to determine average production responses.

[b] Herbicides aerially applied at 0.5 lb/acre.

[c] Native mixture of adapted species.

research, it did not appear necessary to make a division and total area was estimated at roughly 3 million acres (Table 1).

Average annual rainfall is 28 to 35 inches, increasing eastward across the resource area. Topography is undulating to gently rolling with uplands supporting oak trees and tall bunchgrasses, and the bottomlands supporting hardwood stands dominated by oaks. Upland soils are light, slightly acid, loamy sands, and sandy loams. Bottomlands are minor areas of brown, slightly acid, loamy, alluvial soils.

Honey mesquite is a lesser problem in this area than are oaks. Moreover, aside from the East Texas Timberland, the Cross Timbers supports the least honey mesquite problem, based on acreage infested, of the Texas land resource areas (Table 1). About 95 percent of the ranch firms operate with cow herds of fewer than 200 head (Table 3).

Based on average acreages from 1973 to 1977, about 59,400 acres were treated annually with herbicides for brush control, and mechanical methods were applied to about 63,225 acres (Hoffman 1978). Thus, about 3 percent of the rangeland on the Grand Prairie and Cross Timbers receives brush control treatment annually.

Highest annual rates of return from honey mesquite control in the Grand Prairie and Cross Timbers land resource areas resulted from aerial applications of 2,4,5-T, regardless of site potential or canopy cover of mesquite (Table 21). In general, 2,4,5-T was followed by 2,4,5-T + dicamba and then 2,4,5-T + picloram when ranked relative to magnitude of annual rates of return. The lowest annual rates of return from herbicide alternatives resulted from aerial applications of dicamba or basal applications of 2,4,5-T.

... annual rates of return (%) from honey mesquite control investments based on cow-calf operations and $44/cwt cattle prices (1978 dollars) over a 20-year planning period on the Grand Prairie and Cross Timbers of Texas, 1978.[a]

Treatment[b]		Mesquite canopy cover by site and initial carrying capacity (acres/AU/year)							
		Grand Prairie						Cross Timbers	
		Deep soils				Shallow soils		Deep soils	
		Moderate		Dense		Moderate	Dense	Moderate	Dense
Initial	Maintenance	(21)	(24)	(22)	(26)	(25)	(22)	(24)	(26)
2,4,5-T	2,4,5-T	10.8	--	10.9	11.3	5.8	3.5	10.9	12.3
2,4,5-T (B)	2,4,5-T (B)	5.8	--	3.6	--	--	--	--	--
2,4,5-T + dicamba	2,4,5-T + dicamba	9.7	--	9.7	10.1	4.7	2.2	9.8	11.3
Dicamba	Dicamba	5.8	--	5.9	6.3	1.3	-1.7	6.1	8.2
2,4,5-T + picloram	2,4,5-T + picloram	6.3	--	7.4	9.4	4.0	3.6	--	--
Oil	Oil	7.9	--	--	4.7	3.8	--	7.4	4.8
Tree doze	Grub	--	1.8	--	--	0.9	--	--	--
Tree doze-seed[c]	Grub	2.6	4.7	1.0	0.7	--	-3.1	5.7	3.1
Tree doze-kleingrass	Grub	--	--	--	--	--	-	6.8	--
Root plow-seed[c]	Grub	--	--	--	4.3	--	-3.0	8.3	4.7
Root plow-roller chop-seed[c]	Grub	--	4.5	--	--	--	--	--	--
Root plow-rake-seed[c]	Grub	--	--	1.0	--	-.10	--	--	--
Root plow-kleingrass	Grub	--	2.7	--	--	--	--	7.0	--
Root plow-rake-kleingrass	Grub	--	--	--	4.1	--	--	--	2.6
Typical counties		Mills	Tarrant	Parker	Denton	Bosque	Erath	Wise	Wise

[a] The rate of return considers all operating and investment capital in brush control and breeding livestock. Cost and returns were projected in constant 1978 dollars. Thus, annual rates of return do not include inflation impacts and are considered real rates of return. An estimate of market or nominal rates of return may be made by adding an assumed inflation rate to the real rates. This process assumes inflation will affect costs and returns equally.

[b] Herbicides aerially applied at 0.67 lb/acre except 2,4,5-T + picloram at 0.5 lb/acre and 2,4,5-T (B) indicating basal sprays.

[c] Native mixture of adapted species.

All mechanical methods produced internal rates of return of less than 5 percent on deep soils on the Grand Prairie (Table 21). On shallow soils, negative annual rates of return resulted from all mechanical alternatives except tree dozing followed by grubbing which yielded only 0.9 percent (essentially a negative result if the potential impact of inflation is considered). Comparatively, the mechanical practices were more effective, based on annual rates of return, when applied to deep soils of the Cross Timbers. For example, root plowing and establishment of kleingrass pasture were estimated to produce a 2.7 percent annual rate of return on the Grand Prairie compared to a 7 percent return for the same practice in the Cross Timbers. Adjustment factors to compare annual rates of return when cattle prices range from 34 to 54 cents per pound, as discussed for the High Plains, are as follows:

Alternative	Adjustment factor: Grand Prairie	Adjustment factor: Cross Timbers
2,4,5-T	0.63	0.71
2,4,5-T (B)	0.39	--
2,4,5-T + dicamba	0.60	0.69
Dicamba	0.55	0.63
2,4,5-T + picloram	0.55	--
Oil	0.47	0.45
Tree doze	0.29	--
Tree doze-seed natives	0.24	0.31
Tree doze-kleingrass	--	0.54
Root plow-seed natives	0.26	0.37
Root plow-roller chop-seed natives	0.30	--

Root plow-rake-seed natives	0.23	--
Root plow-kleingrass	0.30	0.55
Root plow-rake-kleingrass	0.38	0.33

Since higher herbicide rates are generally required for honey mesquite control on the Grand Prairie and Cross Timbers, treatment costs were higher than for the Rolling Plains, Rolling Red Plains or High Plains land resource areas (Table 22). In addition, basal treatment with 2,4,5-T was given as one of the more popular practices for two site/honey mesquite canopy cover situations. Costs of basal treatment, because of labor and herbicide requirements, were 3 to 4 times the cost for broadcast 2,4,5-T applications to the same sites.

No cost reductions were required for aerial applications of 2,4,5-T or 2,4,5-T + dicamba on deep soils to yield a 9 percent annual rate of return in the Grand Prairie or Cross Timbers (Table 23). Cost reductions of 3.37 to 3.43 dollars per acre were required for aerial applications of dicamba to yield a 9 percent rate of return, and equivalent performance of 2,4,5-T + picloram would require cost reductions of 1.97 to 3.17 dollars per acre on deep sites of the Grand Prairie.

All brush management alternatives were estimated to require cost reductions to yield a 9 percent annual rate of return on shallow sites of the Grand Prairie (Table 23). Cost reductions for 2,4,5-T ranged from 3.04 to 4.17 dollars per acre whereas reductions of 4.30 to 5.43 dollars per acre were required for dicamba to yield a 9 percent annual rate of return.

All mechanical practices required a reduction in their initial cost, regardless of site potential/honey mesquite cover situation, to yield a 9 percent annual rate of return. The cost reductions to yield a 9 percent

Table 22. Initial costs[a] ($/acre) for selected honey mesquite control alternatives on the Grand Prairie and Cross Timbers of Texas, 1978.

Treatment[b]		Mesquite canopy cover by site and initial carrying capacity (acres/AU/year)							
		Grand Prairie						Cross Timbers	
		Deep soils				Shallow soils		Deep soils	
		Moderate		Dense		Moderate	Dense	Moderate	Dense
Initial	Maintenance	(21)	(24)	(22)	(26)	(25)	(22)	(24)	(26)
2,4,5-T	2,4,5-T	6.16	--	6.16	6.16	6.16	6.16	6.16	6.16
2,4,5-T (B)	2,4,5-T (B)	20.00	--	25.00	--	--	--	--	--
2,4,5-T + dicamba	2,4,5-T + dicamba	6.75	--	6.75	6.75	6.75	6.75	6.75	6.75
Dicamba	Dicamba	8.85	--	8.85	8.85	8.85	8.85	8.85	8.85
2,4,5-T + picloram	2,4,5-T + picloram	9.75	--	9.75	9.75	9.75	9.75	--	--
Oil	Oil	15.00	--	--	22.50	--	15.00	15.00	20.00
Tree doze	Grub	--	35.00	--	--	--	35.00	--	--
Tree doze-seed[c]	Grub	55.00	60.00	40.00	65.00	45.00	--	30.00	65.00
Tree doze-kleingrass	Grub	--	--	--	--	--	--	42.00	--
Root plow-seed[c]	Grub	--	--	--	46.00	--	50.00	21.00	46.00
Root plow-roller chop-seed[c]	Grub	--	42.00	--	--	--	--	--	--
Root plow-rake-seed[c]	Grub	--	--	75.00	--	40.00	--	--	--
Root plow-kleingrass	Grub	--	90.00	--	--	--	--	45.00	--
Root plow-rake-kleingrass	Grub	--	--	--	92.00	--	--	--	114.00
Typical counties		Mills	Tarrant	Parker	Denton	Bosque	Erath	Wise	Wise

[a] Initial treatment costs do not include added breeding livestock investments.

[b] Herbicides aerially applied at 0.67 lb/acre except 2,4,5-T + picloram at 0.5 lb/acre and 2,4,5-T (B) indicating basal sprays.

[c] Native mixture of adapted species.

Table 23. Initial cost reduction ($/acre) required for yielding a 9% annual rate of return on the investment in selected honey mesquite control alternatives and added breeding livestock based on cow-calf operations at $44/cwt cattle prices (1978 dollars) over a 20-year planning period on the Grand Prairie and Cross Timbers, 1978.[a]

Treatment[b]		Mesquite canopy cover by site and initial carrying capacity (acres/AU/year)							
		Grand Prairie						Cross Timbers	
		Deep soils				Shallow soils		Deep soils	
		Moderate		Dense		Moderate	Dense	Moderate	Dense
Initial	Maintenance	(21)	(24)	(22)	(26)	(25)	(22)	(24)	(26)
2,4,5-T	2,4,5-T	0	--	0	0	3.04	4.17	0	0
2,4,5-T (B)	2,4,5-T (B)	6.69	--	13.11	--	--	--	--	--
2,4,5-T + dicamba	2,4,5-T + dicamba	0	--	0	0	4.30	5.43	0	0
Dicamba	Dicamba	3.37	--	3.43	3.41	8.79	9.95	3.62	1.06
2,4,5-T + picloram	2,4,5-T + picloram	3.17	--	1.97	0	6.39	5.83	--	--
Oil	Oil	1.84	--	--	12.28	8.28	--	3.50	10.00
Tree doze	Grub	--	22.75	--	--	24.40	--	--	--
Tree doze-seed[c]	Grub	34.31	27.62	28.24	46.87	--	46.46	11.10	37.70
Tree doze-kleingrass	Grub	--	--	--	--	--	--	14.93	--
Root plow-seed[c]	Grub	--	--	--	24.21	--	40.36	1.78	21.34
Root plow-roller chop-seed[c]	Grub	--	21.29	--	--	--	--	--	--
Root plow-rake-seed[c]	Grub	--	--	50.60	--	32.19	--	--	--
Root plow-kleingrass	Grub	--	60.53	--	--	--	--	14.59	--
Root plow-rake-kleingrass	Grub	--	--	--	49.52	--	--	--	81.05
Typical counties		Mills	Tarrant	Parker	Denton	Bosque	Erath	Wise	Wise

[a] The net present value assumes a 9% interest charge for all added capital invested in brush control, increased breeding aniamls and operation expenses.

[b] Herbicides aerially sprayed at 0.67 lb/acre except 2,4,5-T + picloram at 0.5 lb/acre and 2,4,5-T (B) indicating basal sprays.

[c] Native mixture of adapted species.

annual return were estimated to range from 1.78 dollars per acre for root plowing and seeding a native range mixture in the Cross Timbers to 81.05 dollars per acre for root plowing, raking, and seeding kleingrass.

Increased annual net cash flow ranged from 0.28 to 1.70 dollars per acre from aerial applications of 2,4,5-T on the Grand Prairie or Cross Timbers, compared to -0.16 to 1.34 dollars per acre where dicamba was applied (Table 24). Increased annual net cash flow from aerial application of 2,4,5-T to deep soils of the Grand Prairie varied from 1.09 to 1.38 dollars per acre, and was 0.28 to 0.62 dollar per acre on shallow sites. Across all site and canopy cover situations on the Grand Prairie, average increased annual net cash flow from aerial applications of 2,4,5-T was 89 cents per acre. When dicamba was substituted for half of the 2,4,5-T, average annual net cash flow was reduced to 79 cents per acre, and was reduced to 85 cents per acre when picloram was combined with 2,4,5-T. Average annual net cash flow from aerial applications of dicamba was estimated to be 46 cents per acre, 48 percent less than when 2,4,5-T was applied alone. On deep soils of the Cross Timbers, average annual net cash flow from 2,4,5-T was 1.48 dollars per acre, 1.39 dollars per acre from 2,4,5-T + dicamba, and 1.08 dollars per acre from dicamba.

Greatest increases in annual net cash flow from mechanical methods on the Cross Timbers, 5.78 dollars per acre, occurred where the honey mesquite was root plowed and deep soils were seeded to kleingrass (Table 24). Root plowing, raking the debris, and seeding kleingrass on the Grand Prairie increased the annual net cash flow by 4.29 dollars per acre. The same mechanical treatment but artificially seeding with a native range mixture increased annual net cash flow by 53 cents per acre on deep soils but decreased cash flow by 2 cents per acre annually on shallow soils.

Table 24. Increased annual net cash flow ($/acre) produced from selected honey mesquite alternatives based on cow-calf operations at $44/cwt cattle prices (1978 dollars) over a 20-year planning period on the Grand Prairie and Cross Timbers, 1978.[a]

Treatment[b]		Mesquite canopy cover by site and initial carrying capacity (acres/AU/year)							
		Grand Prairie						Cross Timbers	
		Deep soils				Shallow soils		Deep soils	
		Moderate		Dense		Moderate	Dense	Moderate	Dense
Initial	Maintenance	(21)	(24)	(22)	(26)	(25)	(22)	(24)	(26)
2,4,5-T	2,4,5-T	1.06	--	1.09	1.38	0.62	0.28	1.26	1.70
2,4,5-T (B)	2,4,5-T (B)	1.23	--	0.92	--	--	--	--	--
2,4,5-T + dicamba	2,4,5-T + dicamba	0.97	--	1.01	1.28	0.52	0.19	1.15	1.62
Dicamba	Dicamba	0.68	--	0.71	0.90	0.17	-0.16	0.79	1.34
2,4,5-T + picloram	2,4,5-T + picloram	0.85	--	1.05	1.37	0.56	0.41	--	--
Oil	Oil	1.46	--	--	1.38	0.61		1.71	1.19
Tree doze	Grub	--	0.60	--	--	0.30	--	--	--
Tree doze-seed[c]	Grub	1.43	3.22	0.33	0.44	--	-1.15	2.00	2.07
Tree doze-kleingrass	Grub	--	--	--	--	--	--	5.22	--
Root plow-seed[c]	Grub	--	--	--	2.29	--	-0.83	2.49	2.48
Root plow-roller chop-seed[c]	Grub	--	2.24	--	--	--	--	--	--
Root plow-rake-seed[c]	Grub	--	--	0.53	--	.02	--	--	--
Root plow-kleingrass	Grub	--	2.90	--	--	--	--	5.78	--
Root plow-rake-kleingrass	Grub	--	--	--	4.29	--	--	--	3.61
Typical counties		Mills	Tarrant	Parker	Denton	Bosque	Erath	Wise	Wise

[a] The net cash flow is total added cash sales ($44/cwt) less costs of brush control, added breeding livestock and increased annual operating costs plus the salvage value of cows and brush control (if applicable) at the end of the 20 year planning horizon. Interest charges were not included and the timing of cash flows was not considered.

[b] Herbicides aerially sprayed at 0.67 lb/acre except 2,4,5-T + picloram at 0.5 lb/acre and 2,4,5-T (B) indicating basal sprays.

[c] Native mixture of adapted species.

From 9 to 19 years were required, depending on site potential, to recover the investment in aerial application of 2,4,5-T for honey mesquite control on the Grand Prairie, and Cross Timbers (Table 25). In comparison, from 14 to more than 20 years were required to recover the initial investment in dicamba, the only aerially-applied herbicide which did not contain 2,4,5-T. Time to recover the initial investment in mechanical methods for improvement of rangeland infested with honey mesquite ranged from 15 to more than 20 years on the Grand Prairies, and from 10 to more than 20 years in the Cross Timbers.

In general, there were relatively small production response differences within site/canopy cover situations to aerial applications of various herbicides on the Grand Prairie or Cross Timbers (Table 26). For example, on deep soils supporting moderate canopy covers of honey mesquite on the Grand Prairie, annual beef production ranged from 22.4 to 24.2 pounds per acre following herbicide treatment. However, production differences following treatment compared to pretreatment weaned calf production varied widely among sites. For example, following aerial application of 2,4,5-T, weaned calf production on deep soils was increased by 6 pounds per acre annually after moderate canopy covers were treated, and increased 7.1 to 9.9 pounds per acre after dense canopy covers were sprayed. Aerial spraying of honey mesquite on shallow soils increased annual weaned calf production, on the average, by 5.7 pounds per acre on the Grand Prairie.

Production responses to mechanical treatments for improvement of honey mesquite-infested rangeland varied widely on the Grand Prairie and Cross Timbers. Root plowing and seeding shallow soils supporting moderate mesquite canopies on the Grand Prairie produced 22.2 pounds per acre of beef annually, essentially equivalent to results from aerial spraying. However, establish-

Table 25. Years required to recover initial investments in selected honey mesquite control alternatives and livestock investments based on cow-calf operations at $44/cwt cattle prices (1978 dollars) on the Grand Prairie and Cross Timbers, 1978.[a]

Treatment[b]		Mesquite canopy cover by site and initial carrying capacity (acres/AU/year)							
		Grand Prairie						Cross Timbers	
		Deep soils				Shallow soils		Deep soils	
		Moderate		Dense		Moderate	Dense	Moderate	Dense
Initial	Maintenance	(21)	(24)	(22)	(26)	(25)	(22)	(24)	(26)
2,4,5-T	2,4,5-T	10	--	10	9	19	18	9	9
2,4,5-T (B)	2,4,5-T (B)	13	--	17	--	--	--	--	--
2,4,5-T + dicamba	2,4,5-T + dicamba	10	--	14	13	20	20	9	9
Dicamba	Dicamba	17	--	16	18	20 +	20 +	15	14
2,4,5-T + picloram	2,4,5-T + picloram	18	--	17	11	19	18	--	--
Oil	Oil	13	--	--	18	16	--	12	17
Tree doze	Grub	--	20 +	--	--	20 +	--	--	--
Tree doze-seed[c]	Grub	20	15	19	20 +	--	20 +	13	19
Tree doze-kleingrass	Grub	--	--	--	--	--	--	13	--
Root plow-seed[c]	Grub	--	--	--	19	--	20 +	10	18
Root plow-roller chop-seed[c]	Grub	--	17	--	--	--	--	--	--
Root plow-rake-seed[c]	Grub	--	--	20 +	--	20 +	--	--	--
Root plow-kleingrass	Grub	--	19	--	--	--	--	13	--
Root plow-rake-kleingrass	Grub	--	--	--	16	--	--	--	20 +
Typical counties		Mills	Tarrant	Parker	Denton	Bosque	Erath	Wise	Wise

[a] A 20-year planning horizon was utilized and no interest charges are included. The time period represents a "pay-back period" commonly used to evaluate investment opportunities. Salvage values of cows and brush control (if applicable) are not included as part of the pay-out period, but would represent gross returns to the operation at the time of "pay-back." A 20 + indicates greater than 20 years will be required to recover the investment.

[b] Herbicides aerially applied at 0.67 lb/acre except 2,4,5-T + picloram at 0.5 lb/acre and 2,4,5-T (B) indicating basal sprays.

[c] Native mixture of adapted species.

Table 26. Total weaned calf production (lb/acre/year) from selected honey mesquite control alternatives based on cow-calf operations on the Grand Prairie and Cross Timbers, 1978.[a]

Treatment[b]		Mesquite canopy cover by site and initial carrying capacity (acres/AU/year)							
		Grand Prairie						Cross Timbers	
		Deep soils				Shallow soils		Deep soils	
		Moderate		Dense		Moderate	Dense	Moderate	Dense
Initial	Maintenance	(21)	(24)	(22)	(26)	(25)	(22)	(24)	(26)
None (pretreatment)		16.4	14.3	15.7	13.2	13.5	15.7	13.9	12.8
2,4,5-T	2,4,5-T	22.4	--	22.8	23.1	20.3	20.3	23.2	22.9
2,4,5-T (B)	2,4,5-T (B)	26.1	--	26.2	--	--	--	--	--
2,4,5-T + dicamba	2,4,5-T + dicamba	22.4	--	22.8	23.1	20.3	20.3	23.2	22.9
Dicamba	Dicamba	22.4	--	22.8	23.1	20.3	20.3	23.2	22.9
2,4,5-T + picloram	2,4,5-T + picloram	24.2	--	24.5	23.7	20.9	21.9	--	--
Oil	Oil	26.3	--	--	28.5	21.6	--	25.2	24.9
Tree doze	Grub	--	25.3	--	--	22.7	--	--	--
Tree doze-seed[c]	Grub	32.8	38.0	24.2	25.5	--	22.5	27.5	32.6
Tree doze-kleingrass	Grub	--	--	--	--	--	--	61.3	--
Root plow-seed[c]	Grub	--	--	--	31.1	22.7	--	27.9	31.8
Root plow-roller chop-seed[c]	Grub	--	31.3	--	--	--	--	--	--
Root plow-rake-seed[c]	Grub	--	--	29.6	--	--	22.2	--	--
Root plow-kleingrass	Grub	--	49.1	--	--	--	--	66.6	--
Root plow-rake-kleingrass	Grub	--	--	--	57.5	--	--	--	61.6
Typical counties		Mills	Tarrant	Parker	Denton	Bosque	Erath	Wise	Wise

[a] A 20-year planning period was utilized to determine average production responses.

[b] Herbicides aerially applied at 0.67 lb/ acre except 2,4,5-T + picloram at 0.5 lb/acre and 2,4,5-T (B) indicating basal sprays.

[c] Native mixture of adapted species.

ment of tame pasture (kleingrass) on deep soils produced an estimated 57.4 pounds per acre per year of beef, an increase of 44.3 pounds per acre annually for the 20-year planning horizon, compared to pretreatment production.

North Central Prairies

The North Central Prairies, undulating prairies and nearly level valleys, cover about 6.5 million acres in the extreme north and central part of Texas (Figure 1). More than 3.5 million acres are used as native range (Table 1). Elevation is 900 to 1,400 feet, annual rainfall averages 20 to 30 inches, and the annual frost-free period is 225 to 240 days.

Upland soils support scrub oak, honey mesquite, and a mixture of mid- and tall-grasses. The upland soils are brown, sandy loam to silt loam and slightly acid over gray, neutral to alkaline, clayey subsoils (Godfrey, Carter and McKee undated). The bottomlands, minor areas of brown to dark gray, loamy and clayey, neutral to calcareous alluvial soils, support hardwoods and honey mequite. About 1.6 million acres of the native range, roughly 46 percent, support honey mesquite infestations. About 70 percent of this infestation occurs on range sites of higher production potential.

Most of the ranches, 96 percent, in the North Central Prairies and the closely associated Cross Timbers vegetation areas operate with fewer than 200 cows (Table 3). Only about 1 percent operate with 500 or more beef cows. These vegetation regions support 6.3 percent of the State's ranches and about 5 percent of the beef cow inventory.

Based on results of this study, the North Central Prairies vegetation region was one of the most profitable for honey mesquite control. Annual rates of return from aerial applications of 2,4,5-T ranged from

11.8 to 24.9 percent on deep soils, and from 8.2 to 23.4 percent on shallow soils (Table 27). Averaged across all soil/canopy cover situations for the North Central Prairies, rates of return were 16.4 percent from aerial applications of 2,4,5-T, 14.5 percent from 2,4,5-T + dicamba, 11.2 percent from 2,4,5-T + picloram, and 10.2 percent from applications of dicamba. The differential response among range sites related to soils was not as great for the North Central Prairies as for other land resource areas.

Mechanical practices, except chaining and seeding to a mixture of native grasses, produced less than 7 percent annual rates of return with several of the practices resulting in negative rates of return on shallow soils of the North Central Prairies (Table 27). Differential in site potential, deep versus shallow soils, was much more pronounced in the economic response to mechanical methods than to chemical alternatives. As with other land resource areas, root plowing and establishment of kleingrass pastures resulted in higher rates of return than from other mechanical practices. Establishment of bermudagrass pastures resulted in annual rates of return, 6.5 percent, approximately the same as for establishment of kleingrass pastures. If alternative rates of return are required for cattle prices ranging from 34 to 54 cents per pound, as discussed for the High Plains region, the following adjustment factors for the North Central Prairies may be utilized:

Alternative	Adjustment factor
2,4,5-T (B)	0.68
Chain	0.35
Chain-seed natives	0.66
Chain-rake-roller chop-seed natives	0.60

Table 27. Annual rates of return (%) from honey mesquite control alternatives based on cow-calf operations and $44/cwt cattle prices (1978 dollars) over a 20-year planning period on the North Central Priaires, 1978.[a]

Treatment[b]		Mesquite canopy cover by site and initial carrying capacity (acres/AU/yr)								
		Deep soils				Shallow soils				
		Moderate		Dense		Moderate			Dense	
Initial	Maintenance	(23)	(30)	(17)	(36.5)	(18)	(20)	(35)	(20)	(42)
2,4,5-T	2,4,5-T	11.8	14.4	24.9	14.1	16.4	21.8	8.2	23.4	12.7
2,4,5-T (B)	2,4,5-T (B)	7.8	--	--	--	--	9.3	--	6.8	--
2,4,5-T + dicamba	2,4,5-T + dicamba	9.8	12.6	23.3	12.1	14.4	19.7	6.1	21.4	10.7
Dicamba	Dicamba	5.7	8.6	19.2	7.9	10.3	15.0	1.9	16.7	6.7
2,4,5-T + picloram	2,4,5-T + picloram	7.4	10.9	20.1	12.2	9.8	15.0	2.5	16.4	6.9
Chain	2,4,5-T	--	--	--	--	--	8.2	--	--	--
Chain-seed[c]	2,4,5-T	--	--	11.0	--	--	--	--	--	--
Chain-rake-roller chop-seed[c]	2,4,5-T	--	4.0	--	4.7	--	--	--	--	--
Oil	2,4,5-T (B)	--	--	8.9	--	--	--	--	--	--
Oil	Oil	--	4.2	--	--	--	--	-0.4	--	--
Tree doze-seed[c]	Grub	--	--	1.5	--	--	1.7	--	--	--
Tree doze-rake-seed[c]	Grub	--	3.4	--	3.6	--	--	-0.6	--	-0.8
Tree doze-rake	2,4,5-T (B)	--	--	--	--	--	1.3	--	6.9	--
Tree doze	Grub	5.8	--	--	--	--	--	--	--	--
Tree doze-rake-kleingrass	Grub	--	6.2	--	--	1.6	--	--	--	--

Table 27. Continued.

Treatment[b]		Mesquite canopy cover by site and initial carrying capacity (Acres/AU/yr)								
		Deep soils				Shallow soils				
		Moderate		Dense		Moderate			Dense	
Initial	Maintenance	(23)[e]	(30)	(17)	(36.5)	(18)	(20)	(35)	(20)	(42)
Root plow-rake-kleingrass	Grub	--	6.3	--	--	--	--	--	--	--
Root plow-rake-Bermudagrass	Grub	--	4.3	--	6.5	--	--	--	--	--
Root plow-rake-seed[c]	Grub	--	--	--	2.8	--	--	-1.1	--	-1.0
Root plow-rake-seed[c]	2,4,5-T	--	3.4	1.2	--	--	--	--	--	--
Typical counties		Comanche	Montague	Palo Pinto	Jack	Brown	Erath	Stephens	San Saba	Archer

[a] The rate of return considers all operating and investment capital in brush control and breeding livestock. Costs and returns were projected in constant 1978 dollars. Thus, annual rates of return do not include inflation impacts and are considered real rates of return. An estimate of market or nominal rates of return may be made by adding an assumed inflation rate to the real rates. This process assumes inflation will affect costs and returns equally.

[b] Herbicides aerially applied at 0.67 lb/acre except 2,4,5-T and picloram which was applied at 0.5 lb/acre and 2,4,5-T (B) which indicates basal spray.

[c] Native mixture of adapted species.

Oil (2,4,5-T as maintenance)	0.62
Oil (oil as maintenance)	0.48
Tree doze-seed natives	0.45
Tree doze-rake-seed natives	0.31
Tree doze-rake	0.37
Tree doze	0.32
Tree doze-rake-kleingrass	0.23
Root plow-rake-kleingrass	0.20
Root plow-rake-Bermudagrass	0.25
Root plow-rake-seed natives (grub as maintenance)	0.31
Root plow-rake-seed natives (2,4,5-T as maintenance)	0.36

Costs of aerial herbicide treatments on the North Central Prairies were the same as for the Grand Prairies and Cross Timbers (Table 22). Cost of mechanical practices varied from 10.00 dollars per acre (chaining) to 70.00 dollars per acre (tree doze-rake-seed native grasses) on the North Central Prairie (Table 28). In only one case, the site with the lowest potential productivity, was a cost reduction required for aerial application of 2,4,5-T or 2,4,5-T + dicamba to yield a 9 percent annual rate of return (Table 29). However, except when applied to sites of highest potential production (initial carrying capacities of 20 acres per animal unit per year or higher), cost reductions were required before aerial applications of dicamba yielded a 9 percent annual rate of return. For example, a cost reduction of 3.31 dollars per acre would be required for 0.67 pound per acre of dicamba aerially applied to sites with pretreatment carrying capacity of 23 acres per animal unit per year to yield a 9 percent rate of return. Cost reductions were required of all mechanical practices,

Table 28. Initial costs ($/acre) of selected honey mesquite control alternatives evaluated for the North Central Prairies, Texas, 1978.[a]

Treatment[b]		Mesquite canopy cover by site and initial carrying capacity (acres/AU/yr)								
		Deep soils				Shallow soils				
		Moderate		Dense		Moderate			Dense	
Initial	Maintenance	(23)	(30)	(17)	(36.5)	(18)	(20)	(35)	(20)	(42)
2,4,5-T (B)	2,4,5-T (B)	20.00	--	--	--	--	20.00	--	30.00	--
Chain	2,4,5-T	--	--	--	--	--	10.00	--	--	--
Chain-seed[c]	2,4,5-T	--	--	21.00	--	--	--	--	--	--
Chain-rake-roller chop-seed[c]	2,4,5-T	--	30.00	--	30.00	--	--	--	--	--
Oil	2,4,5-T (B)	--	--	30.00	--	--	--	--	--	--
Oil	Oil	--	20.00	--	--	--	--	20.00	--	--
Tree doze-seed[c]	Grub	--	--	70.00	--	--	36.00	--	--	--
Tree doze-rake-seed[c]	Grub	--	48.00	--	45.00	--	--	45.00	--	50.00
Tree doze-rake	2,4,5-T (B)	--	--	--	--	--	46.00	--	31.00	--
Tree doze	Grub	35.00	--	--	--	--	--	--	--	--
Tree doze-rake-kleingrass	Grub	--	50.00	--	--	60.00	--	--	--	--
Root plow-rake-kleingrass	Grub	--	70.00	--	--	--	--	--	--	--
Root plow-rake-Bermudagrass	Grub	--	80.00	--	80.00	--	--	--	--	--
Root plow-rake-seed[c]	Grub	--	--	--	65.00	--	--	65.00	--	70.00
Root plow-rake-seed[c]	2,4,5-T	--	62.00	100.00	--	--	--	--	--	--
Typical counties		Comanche	Montague	Palo Pinto	Jack	Brown	Erath	Stephens	San Saba	Archer

[a] Initial treatment costs do not include added breeding livestock investments.

[b] Herbicides aerially applied at 0.67 lb/acre except 2,4,5-T + picloram which was applied at 0.5 lb/acre and 2,4,5-T (B) which indicates basal spray.

[c] Native mixture of adapted species.

Table 29. Initial cost reduction ($/acre) required for yielding a 9% annual rate of return on the investment in selected honey mesquite control alternatives and added breeding livestock based on a cow-calf operation and $44/cwt cattle prices (1978 dollars) over a 20-year planning period on the North Central Prairies[a], Texas, 1978.

Treatment[b]		Mesquite canopy cover by site and initial carrying capacity (acres/AU/yr)								
		Deep soils				Shallow soils				
		Moderate		Dense		Moderate			Dense	
Initial	Maintenance	(23)	(30)	(17)	(36.5)	(18)	(20)	(35)	(20)	(42)
2,4,5-T	2,4,5-T	0	0	0	0	0	0	0.48	0	0
2,4,5-T (B)	2,4,5-T (B)	2.58	--	--	--	--	0	--	6.05	--
2,4,5-T + dicamba	2,4,5-T + dicamba	0	0	0	0	0	0	1.97	0	0
Dicamba	Dicamba	3.31	0.36	0	1.26	0	0	5.59	0	2.24
2,4,5-T + picloram	2,4,5-T + picloram	1.71	0	0	0	0	0	5.45	0	2.16
Chain	2,4,5-T	--	--	--	--	--	0.84	--	--	--
Chain-seed[c]	2,4,5-T	--	--	0	--	--	--	--	--	--
Chain-rake-roller chop-seed[c]	2,4,5-T	--	14.62	--	12.36	--	--	--	--	--
Oil	2,4,5-T (B)	--	--	0.10	--	--	--	--	--	--
Oil	Oil	--	8.69	--	--	--	--	14.79	--	--
Tree doze-seed[c]	Grub	--	--	44.24	--	--	21.92	--	--	--
Tree doze-rake-seed[c]	Grub	--	24.11	--	22.26	--	--	33.94	--	38.04
Tree doze-rake	2,4,5-T (B)	--	--	--	--	--	29.39	--	6.01	--
Tree doze	Grub	11.20	--	--	--	--	--	--	--	--
Tree doze-rake-kleingrass	Grub	--	17.63	--	--	43.44	--	--	--	--

Table 29. Continued.

Treatment[b]		Mesquite canopy cover by site and initial carrying capacity (acres/AU/yr)								
		Deep soils				Shallow soils				
		Moderate		Dense		Moderate			Dense	
Initial	Maintenance	(23)	(30)	(17)	(36.5)	(18)	(20)	(35)	(20)	(42)
Root plow-rake-kleingrass	Grub	--	24.89	--	--	--	--	--	--	--
Root plow-rake-Bermudagrass	Grub	--	42.46	--	26.64	--	--	--	--	--
Root plow-rake-seed[c]	Grub	--	--	--	36.43	--	--	50.01	--	53.63
Root plow-rake-seed[c]	2,4,5-T	--	32.24	64.79	--	--	--	--	--	--
Typical counties		Comanche	Montague	Palo Pinto	Jack	Brown	Erath	Stephens	San Saba	Archer

[a] The net present value assumes a 9% interest charge for all added capital invested in brush control, increased breeding animals and operation expenses.

[b] Herbicides aerially applied at 0.67 lb/acre except 2,4,5-T + picloram which was applied at 0.5 lb/acre and 2,4,5-T (B) which indicates basal spray.

[c] Native mixture of adapted species.

except chaining and seeding native grasses, for a 9 percent annual rate of return to be realized. Cost reductions for mechanical practices ranged from 6.01 dollars per acre for tree dozing, raking and maintaining improvement with basal applications of 2,4,5-T on shallow sites with initial carrying capacities of 20 acres per animal unit per year to 64.79 dollars per acre for root plowing, raking and seeding native grasses on deep sites with initial carrying capacities of 17 acres per animal unit per year.

Averaged across all sites and canopy cover situations, increased annual net cash flows were 1.75 dollars per acre following aerial applications of 2,4,5-T, 1.61 dollars per acre following application of 2,4,5-T + dicamba, 1.31 dollars per acre following application of dicamba, and 1.53 dollars per acre following 2,4,5-T + picloram applications (Table 30). Increased annual net cash flow from mechanical practices ranged from -0.52 dollar per acre on the lower productivity soils to 7.50 dollars per acre when high potential sites were root plowed, raked and established to coastal Bermudagrass.

Average number of years required to recover the initial investment in aerial application of herbicides was 8.2 for 2,4,5-T, 9.6 for 2,4,5-T + dicamba, 12.7 for dicamba, and 12.4 for 2,4,5-T + picloram (Table 31). From 14 to more than 20 years were required to recover the initial investment in mechanical practices for honey mesquite control on the North Central Prairies.

Annual beef production under "brushy" conditions was 16.1 pounds per acre, and production responses were relatively high following honey mesquite control on the North Central Prairies (Table 32). Annual beef production following herbicidal mesquite control was as high as 37.9 pounds per acre, and as high as 74.5 pounds per acre where coastal Bermudagrass tame pastures

Table 30. Increased annual net cash flow ($/acre/year) from selected honey mesquite control alternatives based on cow-calf operation and $44/cwt cattle prices (1978 dollars) over a 20-year planning period on the North Central Prairies, Texas, 1978.[a]

Treatment[b]		Mesquite canopy cover by site and initial carrying capacity (acres/AU/yr)								
		Deep soils				Shallow soils				
		Moderate		Dense		Moderate			Dense	
Initial	Maintenance	(23)	(30)	(17)	(36.5)	(18)	(20)	(35)	(20)	(42)
2,4,5-T	2,4,5-T	1.05	1.42	3.33	1.52	1.73	2.40	0.58	2.56	1.13
2,4,5-T (B)	2,4,5-T (B)	1.73	--	--	--	--	1.93	--	1.88	--
2,4,5-T + dicamba	2,4,5-T + dicamba	0.91	1.29	3.20	1.35	1.59	2.25	0.44	2.43	1.00
Dicamba	Dicamba	0.62	1.02	2.91	1.00	1.28	1.96	0.16	2.15	0.73
2,4,5-T + picloram	2,4,5-T + picloram	0.87	1.31	3.30	1.78	1.26	2.02	0.22	2.20	0.79
Chain	2,4,5-T	--	--	--	--	--	0.87	--	--	--
Chain-seed[c]	2,4,5-T	--	--	2.34	--	--	--	--	--	--
Chain-rake-roller chop-seed[c]	2,4,5-T	--	1.22	--	1.33	--	--	--	--	--
Oil	2,4,5-T (B)	--	--	2.91	--	--	--	--	--	--
Oil	Oil	--	0.79	--	--	--	--	-0.05	--	--
Tree doze-seed[c]	Grub	--	--	0.87	--	--	0.50	--	--	--
Tree doze-rake-seed[c]	Grub	--	1.44	--	1.51	--	--	-0.20	--	-0.28
Tree doze-rake	2,4,5-T (B)	--	--	--	--	--	0.48	--	1.99	--
Tree doze	Grub	2.05	--	--	--	--	--	--	--	--
Tree doze-rake-kleingrass	Grub	--	4.33	--	--	1.05	--	--	--	--

Table 30. Continued.

Treatment[b]		Mesquite canopy cover by site and initial carrying capacity (acres/AU/yr)								
		Deep soils				Shallow soils				
		Moderate		Dense		Moderate			Dense	
Initial	Maintenance	(23)	(30)	(17)	(36.5)	(18)	(20)	(35)	(20)	(42)
Root plow-rake-kleingrass	Grub	--	6.20	--	--	--	--	--	--	--
Root plow-rake-Bermudagrass	Grub	--	4.13	--	7.50	--	--	--	--	--
Root plow-rake-seed[c]	Grub	--	--	--	1.68	--	--	-0.52	--	-0.50
Root plow-rake-seed[c]	2,4,5-T	--	2.00	0.97	--	--	--	--	--	--
Typical counties		Comanche	Montague	Palo Pinto	Jack	Brown	Erath	Stephens	San Saba	Archer

[a] The net cash flow is total added cash sales ($44.00/cwt) less costs of brush control, added breeding livestock and increased annual operating costs plus the salvage value of cows and brush control (if applicable) at the end of the 20-year planning horizon. Interest charges were not included and the timing of cash flows was not considered.

[b] Herbicides aerially applied at 0.67 lb/acre except 2,4,5-T + picloram which was applied at 0.5 lb/acre and 2,4,5-T (B) which indicates basal spray.

[c] Native mixture of adapted species.

Table 31. Years required to recover initial investments in selected honey mesquite control and livestock investment from cow-calf production based on $44/cwt (1978 dollars) cattle prices on the North Central Prairies, Texas, 1978.[a]

Treatment[b]		Mesquite canopy cover by site and initial carrying capacity (acres/AU/yr)								
		Deep soils				Shallow soils				
		Moderate		Dense		Moderate			Dense	
Initial	Maintenance	(23)	(30)	(17)	(36.5)	(18)	(20)	(35)	(20)	(42)
2,4,5-T	2,4,5-T	9	10	5	8	9	7	12	5	9
2,4,5-T (B)	2,4,5-T (B)	13	--	--	--	--	9	--	13	--
2,4,5-T + dicamba	2,4,5-T + dicamba	14	10	5	8	9	8	17	5	10
Dicamba	Dicamba	17	11	8	14	10	9	20	8	17
2,4,5-T + picloram	2,4,5-T + picloram	17	12	5	10	11	9	20 +	9	18
Chain	2,4,5-T	--	--	--	--	--	10	--	--	--
Chain-seed[c]	2,4,5-T	--	--	10	--	--	--	--	--	--
Chain-rake-roller chop-seed[c]	2,4,5-T	--	18	--	14	--	--	--	--	--
Oil	2,4,5-T (B)	--	--	9	--	--	--	--	--	--
Oil	Oil	--	17	--	--	--	--	20 +	--	--
Tree doze-seed[c]	Grub	--	--	20	--	--	18	--	--	--
Tree doze-rake-seed[c]	Grub	--	17	--	16	--	--	20 +	--	20 +
Tree doze-rake	2,4,5-T (B)	--	--	--	--	--	20 +	--	13	--
Tree doze	Grub	14	--	--	--	--	--	--	--	--
Tree doze-rake-kleingrass	Grub	--	13	--	--	20 +	--	--	--	--

Table 31. Continued.

Treatment[b] Initial	Maintenance	Deep soils, Moderate (23)	Deep soils, Moderate (30)	Deep soils, Dense (17)	Deep soils, Dense (36.5)	Shallow soils, Moderate (18)	Shallow soils, Moderate (20)	Shallow soils, Moderate (35)	Shallow soils, Dense (20)	Shallow soils, Dense (42)
		Mesquite canopy cover by site and initial carrying capacity (acres/AU/yr)								
Root plow-rake-kleingrass	Grub	--	13	--	--	--	--	--	--	--
Root plow-rake-Bermudagrass	Grub	--	19	--	15	--	--	--	--	--
Root plow-rake-seed[c]	Grub	--	--	--	19	--	--	20 +	--	20 +
Root plow-rake-seed[c]	2,4,5-T	--	18	20 +	--	--	--	--	--	--
Typical counties		Comanche	Montague	Palo Pinto	Jack	Brown	Erath	Stephens	San Saba	Archer

[a] A 20- year planning horizon was utilized and no interest charges are included. The time period represent a "pay-back period" commonly used to evaluate investment opportunities. Salvage values of cows and brush control (if applicable) are not included as part of the pay-out period, but would represent gross returns to the operation at the time of "pay-back." A 20 + indicates greater than 20 years will be required to recover the investment.

[b] Herbicides aerially applied at 0.67 lb/acre except 2,4,5-T + picloram which was applied at 0.5 lb/acre and 2,4,5-T (B) which indicates basal sprays.

[c] Native mixture of adapted species.

Table 32. Total weaned calf production (lb/acre/year) following application of selected honey mesquite control alternatives with a cow-calf operation over a 20-year planning period on the North Central Prairies, Texas, 1978.[a]

Treatment[b]		Mesquite canopy cover by site and initial carrying capacity (acres/AU/yr)								
		Deep soils				Shallow soils				
		Moderate		Dense		Moderate			Dense	
Initial	Maintenance	(23)	(30)	(17)	(36.5)	(18)	(20)	(35)	(20)	(42)
None (pretreatment)		16.0	13.1	22.8	10.7	21.8	19.5	11.2	19.6	9.4
2,4,5-T	2,4,5-T	23.0	20.2	36.0	19.7	30.2	28.8	15.8	28.9	15.8
2,4,5-T (B)	2,4,5-T (B)	26.6	--	--	--	--	29.8	--	29.2	--
2,4,5-T + dicamba	2,4,5-T + dicamba	23.0	20.2	36.0	19.7	30.2	28.8	15.8	28.9	15.8
Dicamba	Dicamba	23.0	20.2	36.0	19.7	30.2	28.8	15.8	28.9	15.8
2,4,5-T + picloram	2,4,5-T + picloram	24.0	21.5	37.9	21.9	30.9	29.4	16.1	29.3	16.4
Chain	2,4,5-T	--	--	--	--	--	25.1	--	--	--
Chain-seed[c]	2,4,5-T	--	--	34.2	--	--	--	--	--	--
Chain-rake-roller chop-seed[c]	2,4,5-T	--	23.2	--	20.6	--	--	--	--	--
Oil	2,4,5-T (B)	--	--	37.0	--	--	--	--	--	--
Oil	Oil	--	20.6	--	--	--	--	15.9	--	--
Tree doze-seed[c]	Grub	--	--	36.1	--	--	20.3	--	--	16.1
Tree doze-rake-seed[c]	Grub	--	24.0	--	22.1	--	--	16.7	29.7	--
Tree doze-rake	2,4,5-T (B)	--	--	--	--	--	27.3	--	--	--
Tree doze	Grub	29.7	--	--	--	--	--	--	--	--
Tree doze-rake-kleingrass	Grub	--	50.2	--	--	39.4	--	--	--	--

Table 32. Continued.

Treatment[b]		Mesquite canopy cover by site and initial carrying capacity (acres/AU/yr)								
		Deep soils				Shallow soils				
		Moderate		Dense		Moderate			Dense	
Initial	Maintenance	(23)	(30)	(17)	(36.5)	(18)	(20)	(35)	(20)	(42)
Root plow-rake-kleingrass	Grub	--	68.3	--	--	--	--	--	--	--
Root plow-rake-Bermudagrass	Grub	--	55.1	--	74.5	--	--	--	--	--
Root plow-rake-seed[c]	Grub	--	--	--	24.4	--	--	17.2	--	16.6
Root plow-rake-seed[c]	2,4,5-T	--	27.8	37.8	--	--	--	--	--	--
Typical counties		Comanche	Montague	Palo Pinto	Jack	Brown	Erath	Stephens	San Saba	Archer

[a] A 20-year planning period was utilized to determine the average production responses.

[b] Herbicides aerially applied at 0.67 lb/acre except 2,4,5-T + picloram which was applied at 0.5 lb/acre and 2,4,5-T (B) which indicates basal sprays.

[c] Native mixture of adapted species.

were established. On the average, herbicidal mesquite control with aerial applications of 2,4,5-T, 2,4,5-T + dicamba or dicamba was estimated to result in a total annual weaned beef production of 24.3 pounds per acre.

The 2,4,5-T + picloram combination was slightly more effective, relative to beef production, than other herbicide treatments resulting in an annual production of 25.3 pounds of beef per acre per year over the 20-year planning horizon.

Blackland Prairies

The Blackland Prairies occupy about 11.5 million acres (Table 1) and are typified by nearly level to rolling topography. Elevation is 250 to 700 feet, annual rainfall is 30 to 45 inches, and the annual frost free period is 230 to 280 days. Nearly half the area is cropland and a fourth is used as tame pasture and meadows. There are less than 1 million acres of rangeland.

Upland soils are dark, calcareous clays. Bottomland soils are reddish brown to dark gray, slightly acid to calcareous, alluvial loams to clays. The uplands support tallgrasses with scattered stands of honey mesquite and oaks, and the bottomlands support stands of oak, elm (Ulmus spp.). cottonwood, and native pecan. It is estimated that only about 538,000 acres of the Blacklands in native range are infested with mesquite. In addition, a considerable amount of abandoned cropland is being returned to native range use. Based on average annual brush control activities from 1973 to 1977, about 15,500 acres per year are treated with herbicides on the Blacklands, and mechanical methods are applied to nearly 38,000 acres each year.

Annual rates of return ranged from 10.9 to 13.5 percent and averaged about 12 percent for aerial application of 2,4,5-T for honey mesquite control on the Blackland Prairie (Table 33). Aerial applications of 2,4,5-T + dicamba yielded 9.9 to 12.5 percent annual rates of return on the investment in brush management. Dicamba, the "next best" alternative to 2,4,5-T (or herbicide mixtures based on 2,4,5-T), yielded 7.0 to 9.5 percent (average 8 percent) annual rates of return.

Mechanical treatments yielded annual rates of returns less than 5 percent with root plowing-seeding returning the highest (4.6 percent) rate on the investment (Table 33). Establishment of tame pastures to coastal Bermudagrass or kleingrass yielded annual rates of return only 3 to 4 percent, primarily because of the high cost of establishment (125.00 to 150.00 dollars per acre) and annual fertilizer requirements (Table 34). The following adjustment factors, as discussed for the High Plains, may be used to estimate rates of return form the honey mesquite alternatives within a range of cattle prices from 34 to 54 cents per pound:

Alternative	Adjustment factor
2,4,5-T	0.64
2,4,5-T (B)	0.28
2,4,5-T + dicamba	0.63
Dicamba	0.57
2,4,5-T + picloram	0.66
Shred	0.49
Oil	0.33
Tree doze-seed natives (2,4,5-T as maintenance)	0.20
Tree doze-seed natives (grub as maintenance)	0.27

Table 33. Annual rates of return (%) from selected honey mesquite control alternatives based on cow-calf production and $44/cwt cattle prices (1978 dollars) over a 20-year planning period on the Blackland Prairies, Texas, 1978.[a]

Treatment[b]		Mesquite canopy cover by site and initial carrying capacity (acres/AU/yr)				
		Deep soils				Shallow soils
		Moderate		Dense		Moderate-Dense
Initial	Maintenance	(15)	(22)	(22)	(25)	(20)
2,4,5-T	2,4,5-T	13.5	--	11.7	10.9	11.7
2,4,5-T (B)	2,4,5-T (B)	2.3	--	--	2.8	--
2,4,5-T + dicamba	2,4,5-T + dicamba	12.5	--	10.7	9.9	10.7
Dicamba	Dicamba	9.5	--	7.8	7.0	7.7
2,4,5-T + picloram	2,4,5-T + picloram	15.0	--	--	9.7	--
Shred	Shred	5.4	--	--	--	--
Oil	Oil	--	4.6	--	--	--
Tree doze-seed[c]	2,4,5-T (B)	-1.6	--	--	--	--
Tree doze-seed[c]	Grub	--	--	--	2.0	--
Tree doze-root plow-seed[c]	2,4,5-T	--	3.1	--	--	--
Tree doze-kleingrass	Grub	--	--	--	3.3	--
Root plow-seed[c]	Grub	--	--	--	4.6	--
Root plow-rake-seed[c]	2,4,5-T (B)	--	1.8	--	--	--
Root plow-rake-kleingrass	Grub	3.1	--	3.2	2.4	3.8
Root plow-rake-Bermudagrass	2,4,5-T (B)	2.1	--	3.6	1.7	3.0
Typical counties		Burleson	Bastrop	Madison	Hill	Robertson

[a] The rate of return considers all operating and investment capital in brush control and breeding livestock. Cost and returns were projected in constant 1978 dollars. Thus, annual rates of return do not include inflation impacts and are considered real rates of return. An estimate of market or nominal rates of return may be made by adding an assumed inflation rate to the real rates. This process assumes inflation will affect costs and returns equally.

[b] Herbicides aerially applied at 0.67 lb/acre except 2,4,5-T + picloram which was applied at 0.5 lb/acre and 2,4,5-T (B) which indicates basal spray.

[c] Native mixture of adapted species.

Table 34. Initial treatment costs ($/acre) for selected honey mesquite control alternatives on the Blackland Prairies, Texas, 1978.[a]

Treatment[b]		Mesquite canopy cover by site and initial carrying capacity (acres/AU/yr)				
		Deep soils				Shallow soils
		Moderate		Dense		Moderate-Dense
Initial	Maintenance	(15)	(22)	(22)	(25)	(20)
2,4,5-T (B)	2,4,5-T (B)	40.00	--	--	45.00	--
Shred	Shred	7.50	--	--	--	--
Oil	Oil	--	22.50	--	--	--
Tree doze-seed[c]	2,4,5-T (B)	70.00	--	--	--	--
Tree doze-seed[c]	Grub	--	--	--	65.00	--
Tree doze-root plow-seed[c]	2,4,5-T	--	80.00	--	--	--
Tree doze-kleingrass	Grub	--	--	--	90.00	--
Root plow-seed[c]	Grub	--	--	--	46.00	--
Root plow-rake-seed[c]	2,4,5-T (B)	--	80.00	--	--	--
Root plow-rake-kleingrass	Grub	100.00	--	125.00	135.00	115.00
Root plow-rake-Bermudagrass	2,4,5-T (B)	125.00	--	150.00	135.00	135.00
Typical counties		Burleson	Bastrop	Madison	Hill	Robertson

[a] Initial treatment costs do not include added breeding livestock investments.

[b] Herbicides aerially applied at 0.67 lb/acre except 2,4,5-T + picloram which was applied at 0.5 lb/acre and 2,4,5-T (B) which indicates basal spray.

[c] Native mixture of adapted species.

Tree doze-root plow-seed natives	0.28
Tree doze-kleingrass	0.44
Root plow-seed natives	0.31
Root plow-rake-seed natives	0.30
Root plow-rake-kleingrass	0.33
Root plow-rake-Bermudagrass	0.36

The cost of herbicide alternatives was the same as for the Grand Prairies and Cross Timbers (Table 22). No reduction in initial cost of aerial applications of 2,4,5-T, 2,4,5-T + dicamba, or 2,4,5-T + picloram were required to yield a 9 percent annual rate of return for honey mesquite control on the Blackland Prairies (Table 35). However only on the more productive sites did applications of dicamba yield a 9 percent annual rate of return without necessitating a reduction in treatment costs. With other canopy cover/site situations, cost reductions of 1.70 to 2.86 dollars per acre were required for dicamba to yield a 9 percent annual rate of return.

All mechanical treatments required a reduction in initial costs to yield a 9 percent annual rate of return (Table 35). The more intensive treatments such as root plowing, raking, and establishment of coastal Bermudagrass pastures required reductions of as much as 119.53 dollars per acre, a 90 percent reduction in initial costs, in order to recover the investment and yield a 9 percent annual rate of return.

Aerial applications of 2,4,5-T generated increased annual net cash flows of 1.46 to 1.94 dollars per acre for the investment in honey mesquite control on the Blackland Prairies (Table 36). All other herbicides aerially applied, generated positive increased annual net cash flows, and averaged 1.58 dollars per acre for 2,4,5-T + dicamba, 1.30 dollars per acre for

Table 35. Cost reduction ($/acre) of initial treatments for yielding a 9% annual rate of return on the investment in honey mesquite control and added breeding livestock based on cow-calf operations and $44/cwt cattle prices (1978 dollars) over a 20-year planning period on the Blackland Prairies, Texas, 1978.[a]

Treatment[b] Initial	Maintenance	Mesquite canopy cover by site and initial carrying capacity (acres/AU/yr) — Deep soils — Moderate (15)	Deep soils — Moderate (22)	Deep soils — Dense (22)	Deep soils — Dense (25)	Shallow soils — Moderate-Dense (20)
2,4,5-T	2,4,5-T	0	--	0	0	0
2,4,5-T (B)	2,4,5-T (B)	24.66	--	--	26.98	--
2,4,5-T + dicamba	2,4,5-T + dicamba	0	--	0	0	0
Dicamba	Dicamba	0	--	1.73	2.86	1.70
2,4,5-T + picloram	2,4,5-T + picloram	0	--	--	0	--
Shred	Shred	4.02	--	--	--	--
Oil	Oil	--	9.30	--	--	--
Tree doze-seed[c]	2,4,5-T (B)	56.98	--	--	--	--
Tree doze-seed[c]	Grub	--	--	--	43.31	--
Tree doze-root plow-seed[c]	2,4,5-T	--	45.93	--	--	--
Tree doze-kleingrass	Grub	--	--	--	69.33	--
Root plow-seed[c]	Grub	--	--	--	22.34	--
Root plow-rake-seed[c]	2,4,5-T (B)	--	50.13	--	--	--
Root plow-rake-kleingrass	Grub	63.09	--	72.12	102.28	68.65
Root plow-rake-Bermudagrass	2,4,5-T (B)	93.38	--	88.45	119.53	97.22
Typical counties		Burleson	Bastrop	Madison	Hill	Robertson

[a] The net present value assumes a 9% interest charge for all added capital invested in brush control, increased breeding animals and operation expenses.

[b] Herbicides aerially applied at 0.67 lb/acre except 2,4,5-T + picloram which was applied at 0.5 lb/acre and 2,4,5-T (B) which indicates basal spray.

[c] Native mixture of adapted species.

Table 36. Increased annual net cash flow ($/acre) from selected honey mesquite alternatives based on cow-calf operations at $44/cwt cattle prices (1978 prices) over a 20-year planning horizon on the Blackland Prairies, Texas, 1978.[a]

Treatment[b]		Mesquite canopy cover by site and initial carrying capacity (acres/AU/yr)				
		Deep soils				Shallow soils
		Moderate		Dense		Moderate-Dense
Initial	Maintenance	(15)	(22)	(22)	(25)	(20)
2,4,5-T	2,4,5-T	1.94	--	1.70	1.46	1.52
2,4,5-T (B)	2,4,5-T (B)	0.88	--	--	1.28	--
2,4,5-T + dicamba	2,4,5-T + dicamba	1.86	--	1.62	1.39	1.44
Dicamba	Dicamba	1.56	--	1.34	1.13	1.18
2,4,5-T + picloram	2,4,5-T + picloram	3.06	--	--	1.82	--
Shred	Shred	0.67	--	--	--	--
Oil	Oil	--	1.00	--	--	--
Tree doze-seed[c]	2,4,5-T (B)	-0.80	--	--	--	--
Tree doze-seed[c]	Grub	--	--	--	1.28	--
Tree doze-root plow-seed[c]	2,4,5-T	--	2.54	--	--	--
Tree doze-kleingrass	Grub	--	--	--	4.34	--
Root plow-seed[c]	Grub	--	--	--	2.52	--
Root plow-rake-seed[c]	2,4,5-T (B)	--	1.19	--	--	--
Root plow-rake-kleingrass	Grub	3.58	--	4.03	4.07	5.42
Root plow-rake-Bermudagrass	2,4,5-T (B)	3.01	--	6.28	3.02	5.21
Typical counties		Burleson	Bastrop	Madison	Hill	Robertson

[a] The net cash flow is total added cash sales ($44/cwt) less costs of brush control, added breeding livestock and increased annual operating costs plus the salvage value of cows and brush control (if applicable) at the end of the 20-year planning horizon. Interest charges were not included and the timing of cash flows was not considered.

[b] Herbicides aerially applied at 0.67 lb/acre except 2,4,5-T + picloram which was applied at 0.5 lb/acre and 2,4,5-T (B) which indicates basal spray.

[c] Native mixture of adapted species.

dicamba, and 2.44 dollars per acre for 2,4,5-T + picloram. All mechanical practices resulted in increased annual net cash flows except tree dozing and seeding to a native range mixture. The greatest increase in annual net cash flow occurred following root plowing, raking and establishment of Bermudagrass or kleingrass pastures.

From 9 to 11 years were required to break even on investments in aerial applications of 2,4,5-T while 13 to 17 years were required to recover initial investment in dicamba for honey mesquite control on the Blackland Prairies (Table 37). All but two of the mechanical alternatives required at least 20 years to break even on the investment. These extensive payback period requirements increase problems for the land manager in securing capital to undertake such range improvements.

Total annual weaned calf production over the 20-year planning period was nearly doubled by the herbicide treatments and increased more than six times by the more intensive mechanical alternatives compared to pre-treatment production levels (Table 38). There was little difference in annual beef production among the aerial herbicide treatments which averaged 28.2 pounds per acre across all site/mesquite canopy cover situations, compared to 13.9 pounds per acre, on the average, before treatment of the honey mesquite.

Although establishment and maintenance costs were high, exceptionally high average annual beef production levels resulted from the tame pasture alternatives (Table 38). On the most productive sites, those with carrying capacity of 1 animal unit per 22 acres before treatment, establishment of Bermudagrass increased the average annual beef production to 93.6 pounds per acre, and kleingrass pastures produced 56.9 pounds per acre, compared to 14.1 pounds per acre before treatment. These high production responses help

Table 37. Years required to recover the initial investment in honey mesquite control and additional breeding livestock from cow-calf operation based on $44/cwt cattle prices (1978 dollars) over a 20-year planning period on the Blackland Prairies, Texas.[a]

Treatment[b]		Mesquite canopy cover by site and initial carrying capacity (acres/AU/yr)				
		Deep soils				Shallow soils
		Moderate		Dense		Moderate-Dense
Initial	Maintenance	(15)	(22)	(22)	(25)	(20)
2,4,5-T	2,4,5-T	9	--	9	10	11
2,4,5-T (B)	2,4,5-T (B)	20 +	--	--	19	--
2,4,5-T + dicamba	2,4,5-T + dicamba	9	--	9	11	12
Dicamba	Dicamba	13	--	14	16	17
2,4,5-T + picloram	2,4,5-T + picloram	9	--	--	10	--
Shred	Shred	15	--	--	--	--
Oil	Oil	--	15	--	--	--
Tree doze-seed[c]	2,4,5-T (B)	20 +	--	--	--	--
Tree doze-seed[c]	Grub	--	--	--	20 +	--
Tree doze-root plow-seed[c]	2,4,5-T	--	20	--	--	--
Tree doze-kleingrass	Grub	--	--	--	20 +	--
Root plow-seed[c]	Grub	--	--	--	18	--
Root plow-rake-seed[c]	2,4,5-T (B)	--	20	--	--	--
Root plow-rake-kleingrass	Grub	20	--	20	20 +	19
Root plow-rake-Bermudagrass	2,4,5-T (B)	20 +	--	20	20 +	20 +
Typical counties		Burleson	Bastrop	Madison	Hill	Robertson

[a] A 20-year planning horizon was utilized and no interest charges are included. The time period represents a "pay-back period" commonly used to evaluate investment opportunities. Salvage values of cows and brush control (if applicable) are not included as part of the pay-out period, but would represent gross returns to the operation at the time of "pay-back." A 20 + indicates greater than 20 years will be required to recover the investment.

[b] Herbicides aerially applied at 0.67 lb/acre except 2,4,5-T + picloram which was applied at 0.5 lb/acre and 2,4,5-T (B) which indicates basal spray.

[c] Native mixture of adapted species.

Table 38. Total weaned calf production (lb/acre/year) from selected honey mesquite control alternatives based on cow-calf operations on the Blackland Prairies, Texas, 1978.[a]

Treatment[b]		Mesquite canopy cover by site and initial carrying capacity (acres/AU/yr)				
		Deep soils				Shallow soils
		Moderate		Dense		Moderate-Dense
Initial	Maintenance	(15)	(22)	(22)	(25)	(20)
None (pretreatment)		20.5	13.4	14.1	12.2	9.2
2,4,5-T	2,4,5-T	41.5	--	24.2	21.3	24.5
2,4,5-T (B)	2,4,5-T (B)	44.7	--	--	24.4	--
2,4,5-T + dicamba	2,4,5-T + dicamba	41.5	--	24.2	21.3	24.5
Dicamba	Dicamba	41.5	--	24.2	21.3	24.5
2,4,5-T + picloram	2,4,5-T + picloram	36.7	--	--	24.7	--
Shred	Shred	27.2	--	--	--	--
Oil	Oil	--	21.4	--	--	--
Tree doze-seed[c]	2,4,5-T (B)	31.1	--	--	--	--
Tree doze-seed[c]	Grub	--	--	--	30.7	--
Tree doze-root plow-seed[c]	2,4,5-T	--	37.7	--	--	--
Tree doze-kleingrass	Grub	--	--	--	77.2	--
Root plow-seed[c]	Grub	--	--	--	30.9	--
Root plow-rake-seed[c]	2,4,5-T (B)	--	36.3	--	--	--
Root plow-rake-kleingrass	Grub	57.0	--	56.9	82.4	66.9
Root plow-rake-Bermudagrass	2,4,5-T (B)	69.9	--	93.6	77.7	90.8
Typical counties		Burleson	Bastrop	Madison	Hill	Robertson

[a] A 20-year planning period was utilized to determine the average production response.

[b] Herbicides aerially applied at 0.67 lb/acre except 2,4,5-T + picloram which was applied at 0.5 lb/acre and 2,4,5-T (B) which indicates basal spray.

[c] Native mixture of adapted species.

explain the application of mechanical practices to more than twice the acreage treated with herbicides. Moreover, the production of herbicide sensitive crops on the Blackland Prairies is a constraint on chemical brush control on rangeland.

Texas Claypan

The Texas Claypan covers 8.5 million acres of nearly level to gently rolling land in the east central portion of the State (Figure 1). Originally Post Oak Savannah, it is often referred to as the "post oak belt." Elevation is 200 to 500 feet, annual rainfall is 30 to 45 inches and the annual frost-free period is 235 to 280 days.

The uplands are typified by gray, slightly acid, sandy loams over mottled or red, firm, clayey subsoils. Reddish brown to dark gray, slightly acid to calcareous, loamy to clayey alluvial soils are common on bottomlands.

Only about 11 percent of the Texas claypan is still in native vegetation (Table 1). Row crop agriculture, tame pasture and more recently, urban development, account for most of the land use. Few ranches operate with cow herds larger than 200 head (Table 3). Vegetation is dominated by scattered stands of post oak (Quercus stellata), blackjack oak (Quercus marilandica) and mid and tallgrasses. The primary brush problems are post oak and blackjack oak in association with yaupon (Ilex vomitoria), winged elm (Ulmus alata) and various other woody species in an east Texas "mixed-brush" complex. Honev mesquite occurs on about 33 percent of the rangeland, primarily on abandoned cropland which has been allowed to revegetate naturally (Table 1). Most of the mesquite stands are almost pure, even-aged, and of moderate canopy cover. Also, most of the mesquite infestations occupy relatively small blocks of land, usually less than 150 acres, which has some bearing on choice of treatment for range improvement. Therefore, compared to vegetation regions previously discussed, relatively few alternatives were evaluated for honey mesquite control on the Texas Claypan. According to Hoffman (1978), from 1973 through 1977, about 13,300 acres were treated annually with herbicides for brush control on the Texas Claypan, and about 44,350 acres received mechanical treatment. The preference for mechanical brush control is indicative of the annual rate of conversion of rangeland to tame pasture on the Texas Claypan.

Annual rates of return were higher from aerial applications of herbicides than from the mechanical alternatives (Table 39). Averaged across canopy cover/site situations, annual rates of returns from aerial application of herbicides were 11.9 percent for 2,4,5-T, 10.9 percent for 2,4,5-T + dicamba, 9.3 percent for 2,4,5-T + picloram, and 8.3 percent for dicamba. Tree dozing followed by basal 2,4,5-T sprays produced negative rates of return (average -3.1 percent). On the average, establishment of tame pasture yielded only 1.9 percent annual rate of return. Annual rates of return from the alternatives can be estimated for cattle prices of 34 to 54 cents per pound, as discussed for the High Plains, by applying the following adjustment factors:

Alternative	Adjustment factor
2,4,5-T	0.63
2,4,5-T + dicamba	0.61
Dicamba	0.57
2,4,5- T + picloram	0.59
Tree doze	0.21
Root plow-rake-kleingrass	0.31
Root plow-rake-Bermudagrass	0.27

Table 39. Annual rates of return (%) from selected honey mesquite control alternatives based on cow-calf production at $44/cwt cattle prices (1978 dollars) over a 20-year planning period on the Texas Claypan, 1978.[a]

Treatment[b]		Mesquite canopy cover by site and initial carrying capacity (acres/AU/yr)			
		Deep soils		Shallow soils	
		Moderate	Dense	Moderate	Dense
Initial	Maintenance	(15)	(22)	(20)	(20)
2,4,5-T	2,4,5-T	13.1	14.0	9.2	11.4
2,4,5-T + dicamba	2,4,5-T + dicamba	12.1	13.4	7.9	10.5
Dicamba	Dicamba	9.4	11.5	4.4	7.7
2,4,5-T + picloram	2,4,5-T + picloram	10.6	11.7	6.1	8.8
Tree doze	2,4,5-T (B)	-3.9	-2.3	--	--
Root plow-rake-kleingrass	2,4,5-T (B)	2.6	2.3	--	--
Root plow-rake-Bermudagrass[c]	2,4,5-T (B)	2.8	1.9	0.9	0.9
Typical counties		Brazos	Lee	Brazos	Austin

[a]The rate of return considers all operating and investment capital in brush control and breeding livestock. Costs and returns were projected in constant 1978 dollars. Thus, annual rates of return do not include inflation impacts and are considered a real rate of return. An estimate of market or nominal rates of return may be made by adding an assumed inflation rate to the real rates. This process assumes inflation will affect costs and returns equally.

[b]Herbicides aerially applied at 0.67 lb/acre except 2,4,5-T + picloram which was applied at 0.5 lb/acre and 2,4,5-T (B) which indicates basal spray.

[c]Tame pasture established to coastal Bermudagrass.

The low annual rates of returns from the mechanical practices can be attributed to the relatively high initial costs for establishment of coastal Bermudagrass or kleingrass tame pastures, and the high cost of annual fertilizer and other maintenance practices (Table 40). Average initial cost for establishment of tame pastures ranged from 115 to 160 dollars per acre. The cost for herbicides was the same as for the Grand Prairies and Cross Timbers (Table 22). Since most of the deep, productive agricultural soils are established to row crops or as small grains pasture, the "better" rangeland soils also require annual inputs of fertilizer to maintain productivity, especially for tame pastures.

No reduction in costs were required for aerial applications of 2,4,5-T to yield a 9 percent annual rate of return on the investment (Table 41). No cost reduction was required for the other herbicide alternatives to yield a 9 percent annual rate of return when honey mesquite infestations on deep soils were treated. However, reductions in initial treatment costs were required for all mechanical alternatives to yield a 9 percent annual rate of return, ranging from 58.67 dollars per acre for tree dozing maintained by basal sprays on deep soils to 120.11 dollars per acre for establishment of coastal Bermudagrass in the Lee county area.

All honey mesquite control alternatives increased annual net cash flows, except tree dozing maintained by basal sprays of 2,4,5-T, on the Texas Claypan (Table 42). Annual net cash flows, averaged across treatments, were 1.62 dollars per acre for aerial applications of 2,4,5-T, 1.56 dollars per acre for 2,4,5-T + dicamba, 1.34 dollars per acre for dicamba, and 1.50 dollars per acre for 2,4,5-T + picloram. Negative annual cash flows resulted from tree dozing followed by basal spraying of honey mesquite on deep sites. Establishment of tame pasture on deep soils

Table 40. Initial costs ($/acre) of honey mesquite control alternatives evaluated for the Texas Claypan, 1978.[a]

Treatment[b]		Mesquite canopy cover by site and initial carrrying capacity (acres/AU/yr)			
		Deep soils		Shallow soils	
Initial	Maintenance	Moderate (15)	Dense (22)	Moderate (20)	Dense (20)
Tree doze	2,4,5-T (B)	70.00	90.00	--	--
Root plow-rake-kleingrass	2,4,5-T (B)	115.00	115.00	--	--
Root plow-rake-Bermudagrass[c]	2,4,5-T (B)	150.00	160.00	150.00	150.00
Typical counties		Brazos	Lee	Brazos	Austin

[a] Initial treatment costs do not include added breeding livestock investments.

[b] Herbicides aerially applied at 0.67 lb/acre except 2,4,5-T + picloram which was applied at 0.5 lb/acre and 2,4,5-T (B) which indicates basal spray.

[c] Tame pasture established to coastal Bermudagrass.

Table 41. Initial cost reduction ($/acre) required for yielding a 9% annual rate of return on the investment in honey mesquite control and added breeding livestock based on a cow-calf operation and $44/cwt cattle prices (1978 dollars) over a 20-year planning period on the Texas Claypan, 1978.[a]

Treatment[b]		Mesquite canopy cover by site and initial carrying capacity (acres/AU/yr)			
		Deep soils		Shallow soils	
		Moderate	Dense	Moderate	Dense
Initial	Maintenance	(15)	(22)	(20)	(20)
2,4,5-T	2,4,5-T	0	0	0	0
2,4,5-T + dicamba	2,4,5-T + dicamba	0	0	0.75	0
Dicamba	Dicamba	0	0	3.74	1.41
2,4,5-T + picloram	2,4,5-T + picloram	0	0	2.77	0.19
Tree doze	2,4,5-T (B)	58.67	75.50	--	--
Root plow-rake-kleingrass	2,4,5-T (B)	79.90	84.85	--	--
Root plow-rake-Bermudagrass[c]	2,4,5-T (B)	103.12	120.11	116.00	117.00
Typical counties		Brazos	Lee	Brazos	Austin

[a] The net present value assumes a 9% interest charge for all added capital invested in brush control, increased breeding animals and operation expenses.

[b] Herbicides aerially applied at 0.67 lb/acre except 2,4,5-T + picloram which was applied at 0.5 lb/acre and 2,4,5-T (B) which indicates basal spray.

[c] Tame pasture established to coastal Bermudagrass.

Table 42. Increased annual net cash-flow ($/acre/year) produced by selected honey mesquite control alternatives based on cow-calf operations and $44/cwt cattle prices (1978 dollars) over a 20-year planning period on the Texas Claypan, 1978.[a]

Treatment[b] Initial	Maintenance	Mesquite canopy cover by site and initial carrying capacity (acres/AU/yr) Deep soils Moderate (15)	Deep soils Dense (22)	Shallow soils Moderate (20)	Shallow soils Dense (20)
2,4,5-T	2,4,5-T	1.75	2.92	0.63	1.17
2,4,5-T + dicamba	2,4,5-T + dicamba	1.67	2.86	0.57	1.12
Dicamba	Dicamba	1.42	2.66	0.36	0.93
2,4,5-T + picloram	2,4,5-T + picloram	1.72	2.56	0.60	1.13
Tree doze	2,4,5-T (B)	-1.51	-1.42	--	--
Root plow-rake-kleingrass	2,4,5-T (B)	3.49	3.10	--	--
Root plow-rake-Bermudagrass[c]	2,4,5-T (B)	4.87	3.36	1.46	1.41
Typical counties		Brazos	Lee	Brazos	Austin

[a] The net cash flow is total added cash sales ($44/cwt) less costs of brush control, added breeding livestock and increased annual operating costs plus the salvage value of cows and brush control (if applicable) at the end of the 20-year planning horizon. Interest charges were not included, and the timing of cash flows was not considered.

[b] Herbicides aerially applied at 0.67 lb/acre except 2,4,5-T + picloram which was applied at 0.5lb/acre and 2,4,5-T (B) which indicates basal spray.

[c] Tame pasture established to coastal Bermudagrass.

resulted in an average annual cash flow increase of 3.30 dollars per acre for kleingrass and 4.12 dollars per acre for coastal Bermudagrass. Thus, comparing the least effective herbicide relative to increasing annual net cash flow, dicamba, to the most effective mechanical conversion, establishment of coastal Bermudagrass, there was only a 1.44 dollar per acre difference annually over the 20-year planning horizon. Yet, establishment of the tame pasture initially cost 143.65 dollars per acre more than the herbicide treatment. Moreover, annual maintenance costs for the tame pasture option would more than equal total cost for herbicide treatment, based on 1978 prices.

From 9 to 14 years were required to recover the initial investment in aerial applications of 2,4,5-T or 2,4,5-T + dicamba for honey mesquite control on the Texas Claypan (Table 43). The break-even periods for dicamba ranged from 10 to 15 years, and 10 to 17 years were required for recovering the initial investment in 2,4,5-T + picloram. Time required to recover the initial investment in tame pasture establishment exceeded 20 years in all cases.

Aerial applications of herbicides for honey mesquite control on the Texas Claypan increased weaned calf production by more than 61 percent, producing an average of 25.3 pounds of beef per acre annually (Table 44). Tame pasture alternatives increased weaned calf production from 15.6 pounds per acre annually to an average 61.8 pounds per acre per year on Bermudagrass pastures.

East Texas Timberland

The East Texas Timberlands, about 15 million acres of mostly forested lands, occupy the extreme eastern part of the State (Figure 1). Honey

Table 43. Years required to recover the initial investment in honey mesquite control and additional livestock based on cow-calf operations and $44/cwt cattle prices (1978 dollars) on the Texas Claypan, 1978.[a]

Treatment[b]		Mesquite canopy cover by site and initial carrying capacity (acres/AU/yr)			
		Deep soils		Shallow soils	
Initial	Maintenance	Moderate (15)	Dense (22)	Moderate (20)	Dense (20)
2,4,5-T	2,4,5-T	10	9	14	14
2,4,5-T + dicamba	2,4,5-T + dicamba	10	9	14	14
Dicamba	Dicamba	12	10	15	15
2,4,5-T + picloram	2,4,5-T + picloram	10	10	17	15
Tree doze	2,4,5-T (B)	20 +	20 +	--	--
Root plow-rake-kleingrass	2,4,5-T (B)	20 +	20 +	--	--
Root plow-rake-Bermudagrass[c]	2,4,5-T (B)	20 +	20 +	20 +	20 +
Typical counties		Brazos	Lee	Brazos	Austin

[a] A 20-year planning horizon was utilized and no interest charges are included. The time period represents a "pay-back period" commonly used to evaluate investment opportunities. Salvage vlaues of cows and brush control (if applicable) are not included as part of the pay-out period, but would represent gross returns to the operation at the time of "pay-back." A 20 + indicates greater than 20 years will be required to recover the investment.

[b] Herbicides aerially applied at 0.67 lb/acre except 2,4,5-T + picloram which was applied at 0.5 lb/acre and 2,4,5-T (B) which indicates basal spray.

[c] Tame pasture established to coastal Bermudagrass.

Table 44. Total weaned calf production (lb/acre/year) from selected honey mesquite control alternatives based on cow-calf production on the Texas Claypan, 1978.[a]

Treatment[b] Initial	Maintenance	Deep soils Moderate (15)	Deep soils Dense (22)	Shallow soils Moderate (20)	Shallow soils Dense (20)
		Mesquite canopy cover by site and initial carrying capacity (acres/AU/yr)			
None (pretreatment)		19.6	13.5	14.7	14.7
2,4,5-T	2,4,5-T	30.0	30.2	18.8	21.6
2,4,5-T + dicamba	2,4,5-T + dicamba	30.0	30.2	18.8	21.6
Dicamba	Dicamba	30.0	30.2	18.8	21.6
2,4,5-T + picloram	2,4,5-T + picloram	30.3	30.0	20.0	22.9
Tree doze	2,4,5-T (B)	28.5	25.2	--	--
Root plow-rake-kleingrass	2,4,5-T (B)	61.0	59.5	--	--
Root plow-rake-Bermudagrass[c]	2,4,5-T (B)	76.3	68.8	50.8	51.2
Typical counties		Brazos	Lee	Brazos	Austin

[a] A 20-year planning period was utilized to determine the average production responses.

[b] Herbicides aerially applied at 0.67 lb/acre except 2,4,5-T + picloram which was applied at 0.5 lb/acre and 2,4,5-T (B) which indicates basal spray.

[c] Tame pasture established to coastal Bermudagrass.

mesquite is not considered a problem in this land resource area. Only about 1 percent of the resource area is native range although grazeable forest offer a valuable forage resource (Table 1). Most brush control activity occurs on forested lands, and mechanical methods are applied to greater acreages than are herbicides in East Texas. For example, herbicides were applied to an average of about 7,500 acres annually from the periods 1973 through 1977 in contrast to application of various mechanical methods to more than 32,600 acres annually (Hoffman 1978). It is estimated that relatively few acres of the native range along the western edge of the East Texas Timberlands support honey mesquite stands. As on the Texas Claypan, most of the mesquite stands are located on abandoned cropland. Although an exact estimate was difficult to obtain, apparently most of the mesquite infestation is of light to moderate canopy cover (Table 1).

Greatest annual rates of return were yielded by aerial applications of 2,4,5-T (13 percent) followed by 2,4,5-T + dicamba (11.2 percent) and dicamba (8.2 percent) for honey mesquite control in the East Texas Timberland (Table 45). Dicamba was the only herbicide treatment that required an initial cost reduction to yield a 9 percent annual rate of return on the investment. Herbicide treatments increased the annual net cash flow by 1.15 to 1.58 dollars per acre and increased weaned calf production from 19.9 pounds per acre per year on mesquite-infested land to 30 pounds per acre annually. The only mechanical alternative evaluated for conversion of mesquite infested rangeland in East Texas, establishment of Bermudagrass pastures, generated a 4.6 percent annual rate of return. These analyses were conducted with beef prices of 44 cents per pound. To estimate annual rates of return among alternatives within the range of beef prices of 34 to 54 cents per pound, the following adjustment factors, as discussed for the High Plains, apply to East Texas:

Table 45. Annual rates of return (%), initial treatment costs ($/acre), reduction in initial treatment costs ($/acre) required to yield a 9% annual rate of return, increased annual net cash flow ($/acre), years required to recover initial investment in brush control and livestock, and total weaned calf production (lb/acre/year) from selected honey mesquite control alternatives based on cow-calf production and $44/cwt cattle prices (1978 dollars) over a 20-year planning period on East Texas Timberlands, based on deep sites, 1978.[a]

Treatment[c]		Economic variable[b]					
Initial	Maintenance	Annual rate of return	Initial treatment cost	Required cost reduction of treatment	Treatment annual net cash flow	Years to break even	Weaned calf production
None (pretreatment)		--	--	--	--	--	19.9
2,4,5-T	2,4,5-T	13.0	6.16	0	1.58	10	30.0
2,4,5-T + dicamba	2,4,5-T + dicamba	11.2	6.75	0	1.43	11	30.0
Dicamba	Dicamba	8.2	8.85	0.95	1.15	12	30.0
Root plow-rake-Bermudagrass	2,4,5-T (B)	4.6	115.00	83.87	6.17	18	62.1

[a] All estimates average of moderate to dense canopy cover, initial carrying capacity, 15 acres/AU/year.

[b] Basis for variables explained in footnotes (a) of tables 39-44, respectively. Leon is a typical county.

[c] Herbicides aerially applied at 0.67 lb/acre except 2,4,5-T (B) which indicates basal spray.

Alternative	Adjustment factor
2,4,5-T	0.70
2,4,5-T + dicamba	0.66
Dicamba	0.63
Root plow-rake-Bermudagrass	0.28

Rio Grande Plain

The Rio Grande Plain (South Texas Plain) occupies 20.5 million acres of nearly level to rolling brushy plain, more than 72 percent of which is used primarily as range (Table 1). Elevation ranges from sea level to 1,000 feet, annual rainfall is 18 to 30 inches, and the annual frost-free period is 260 to 340 days.

Upland soils are dark, calcareous to neutral clayey soils over firm clayey subsoils. The bottom lands are typified by brown to gray, calcareous silt loams to clayey, alluvial soils (Godfrey, Carter and McKee Undated).

The Rio Grande Plain contains 15.3 percent of the beef cows in Texas and 9.3 percent of the ranch firms. Of significance is that 60 percent of the cows are located in herds of 200 cows or more with nearly 40 percent of the cows in the regions being located in herds of 500 or more. These cow herds are owned by 12 percent of the total ranch firms in the region (Table 3). This indicates that brush control may be relatively less subject to cash flow constraints compared to other regions.

The south Texas mixed brush complex has been described in detail by Scifres (1979a). Although mesquite is a dominant of most mixed brush stands, this analysis was concentrated on rangeland where mesquite is the primary problem; that is, occuring in essentially pure stands. The uplands on the Rio Grande Plain are dominated by thorny mixed brush of which honey mesquite is usually a major species. Understory vegetation is generally typified by short and midgrasses and diverse populations of forbs. Bottomlands support heavy stands of honey mesquite and other brush and hardwoods. It is estimated that honey mesquite is a management problem on over 85 percent of the Rio Grande Plain rangeland (Table 1). Although almost half of this infestation is considered to be "light" because honey mesquite is only a part of the mixed-brush complex, about half of the infestation is represented by moderate to dense canopy covers. The most severe infestations occur primarily on highly productive sites with only the shallow, rocky ridges being essentially free of mesquite. Severity of the brush problem is indicated by common reference to the Rio Grande Plain as the "brush country" of Texas. According to Hoffman (1978), from 1973 through 1977, an average of 55,380 acres were treated annually with herbicides, and 214,190 acres were treated annually with mechanical brush control methods.

Only deep range sites were evaluated in this evaluation of the Rio Grande Plain. Annual rates of return, based on applications of 2,4,5-T for honey mesquite control on the more productive sites of the Rio Grande Plain, were 8.1 to 21.8 percent (Table 46). These high rates of return are indicative of the production potential of deep soils in South Texas. Much of the Rio Grande Plain has the capability of producing agronomic crops and vegetables, limited only by a ready supply of water of acceptable quality. In contrast to 2,4,5-T, annual rates of return from dicamba ranged from 2.9 to 16.6 percent.

Table 46. Annual rates of return (%) from selected honey mesquite control alternatives on deep sites based on cow-calf operations and $44/cwt cattle prices (1978 dollars) over a 20-year planning period on the Rio Grande Plain, Texas, 1978.[a]

Treatment[b]		Canopy cover and initial carrying capacity (acres/AU/yr)					
		Moderate			Dense		
Initial	Maintenance	(15)	(22)	(32)	(18)	(25)	(40)
2,4,5-T	2,4,5-T	12.6	12.2	10.3	21.8	15.0	8.1
2,4,5-T + dicamba	2,4,5-T + dicamba	11.6	10.9	8.8	20.5	13.6	6.8
Dicamba	Dicamba	8.6	6.9	4.7	16.6	9.3	2.9
2,4,5-T + picloram	2,4,5-T + picloram	9.5	8.7	6.7	17.7	9.5	2.7
Shred	Shred	--	--	--	6.7	--	--
Chain-root plow-seed[c]	2,4,5-T + picloram	--	--	--	--	0.6	3.3
Root plow-seed[c]	2,4,5-T + picloram	--	3.2	5.2	--	--	--
Root plow-rake-Bermuda	Grub	--	--	--	4.0	--	--
Root plow-rake-buffelgrass	Grub	--	--	3.7	--	--	--
Typical counties		Gonzales	Willacy	Jim Hogg	Goliad	Willacy	Zapata

[a] The rate of return considers all operating and investment capital in brush control and breeding livestock. Costs and returns were projected in constant 1978 dollars. Thus, annual rates of return do not include inflation impacts and are considered real rates of return. An estimate of market or nominal rates of return may be made by adding an assumed inflation rate to the real rates. This process assumes inflation will affect costs and returns equally.

[b] Herbicides aerially applied at 0.67 lb/acre except 2,4,5-T + picloram which was applied at 0.5 lb/acre.

[c] Native mixture of adapted species.

Shredding, a suggested alternative in only one mesquite canopy cover/ site situation, yielded a 8.7 percent annual rate of return (Table 46). Projects involving artificial seeding yielded the lowest rates of return, primarily because of the high initial costs of mechanical methods required for land preparation. Two tame pasture situations involving establishing buffelgrass (Cenchrus ciliaris) and coastal Bermudagrass were evaluated. Buffelgrass was estimated to yield a 3.7 percent annual rate of return while coastal Bermudagrass generated a 4.0 percent annual rate of return. Considerable acreages of these forages have been established in the Rio Grande Plain which indicate there may be significant complementary economic benefits not included in this study that should be considered by ranch management considering adoption of a tame pasture alternative. The tame pasture situations were assumed to require an intensive level of management with annual inputs of fertilizer and cultural practices as required for maintenance of productivity. Adjustment factors for estimating annual rates of return, as discussed for the High Plains, for beef prices of 34 to 54 cents per pound, are presented for the Rio Grande Plain:

Alternative	Adjustment factor
2,4,5-T	0.55
2,4,5-T + dicamba	0.53
Dicamba	0.47
2,4,5-T + picloram	0.56
Shred	0.47
Chain-root plow-seed natives	0.19
Root plow-seed natives	0.28
Root plow- rake-Bermudagrass	0.42
Root plow -rake-buffelgrass	0.34

Costs for herbicide treatment on the Rio Grande Plain were the same as for the Cross Timbers (Table 22). Cost of root plowing and reseeding two rangeland situations were estimated to be 53.00 dollars per acre (Table 47). On more dense stands, root plowing and chaining increased the average initial treatment costs to 65.00 dollars per acre. The establishment of tame pastures ranged from 80.00 to 100.00 dollars per acre for buffelgrass and coastal Bermudagrass respectively.

No reduction in initial treatment costs were required for aerial applications of 2,4,5-T or 2,4,5-T + dicamba to yield a 9 percent annual rate of return when stocking rates were 25 acres per animal unit or less. Dicamba, in four of six situations, required a cost reduction to yield a 9 percent annual rate of return. A picloram and 2,4,5-T mixture required a cost reduction in three of six situations. Mechanical practices involving root plowing required cost reduction of 19.26 to 44.00 dollars per acre to yield a 9 percent return. Tame pastures required cost reductions from 46.33 to 61.81 dollars per acre in order to yield 9 percent. This would represent a 62 percent initial cost reduction for Bermudagrass and a 58 percent reduction for buffelgrass establishment (Table 48).

Based on the canopy cover situations evaluated, aerial application of 2,4,5-T increased the annual net cash flow by 0.69 to 3.03 dollars per acre (Table 49). Application of dicamba for honey mesquite control increased the annual net cash flow by 0.31 to 2.68 dollars per acre. Increases in annual net cash flow following application of mechanical methods varied from 0.31 to 2.72 dollars per acre. Tame pasture establishment increased net cash flows from 3.39 to 5.32 dollars per acre for buffelgrass and coastal Bermudagrass, respectively.

From 5 to 18 years were required to recover the initial investment in herbicides, except 2,4,5-T + picloram which required 6 to 20 years (Table 50). From 14 to more than 20 years were required to recover the initial

Table 47. Initial treatment costs ($/acre) for selected honey mesquite control alternatives on deep sites on the Rio Grande Plains, Texas, 1978.[a]

Treatment[b]		Canopy cover and initial carrying capacity (acres/AU/yr)					
		Moderate			Dense		
Initial	Maintenance	(15)	(22)	(32)	(18)	(25)	(40)
Shred	Shred	--	--	--	6.00	--	--
Chain-root plow-seed[c]	2,4,5-T + picloram	--	--	--	--	65.00	65.00
Root plow-seed[c]	2,4,5-T + picloram	--	53.00	53.00	--	--	--
Root plow-rake-Bermudagrass	Grub	--	--	--	100.00	--	--
Root plow-rake-buffelgrass	Grub	--	--	80.00	--	--	--
Typical counties		Gonzales	Willacy	Jim Hogg	Goliad	Willacy	Zapata

[a] Initial treatment costs do not include added breeding livestock investments.

[b] Herbicides aerially applied at 0.67 lb/acre except 2,4,5-T + picloram which was applied at 0.5 lb/acre.

[c] Native mixture of adapted species.

Table 48. Initial cost reduction ($/acre) for yielding a 9% annual rate of return on the investment in selected honey mesquite control alternatives on deep sites and added breeding livestock based on cow-calf production and $44/cwt cattle prices (1978 dollars) over a 20-year planning period on the Rio Grande Plain, Texas, 1978.[a]

Treatment[b]		Canopy cover and initial carrying capacity (acres/AU/yr)					
		Moderate			Dense		
Initial	Maintenance	(15)	(22)	(32)	(18)	(25)	(40)
2,4,5-T	2,4,5-T	0	0	0	0	0	.69
2,4,5-T + dicamba	2,4,5-T + dicamba	0	0	.11	0	0	1.85
Dicamba	Dicamba	0.57	2.40	0	0	0	6.00
2,4,5-T + picloram	2,4,5-T + picloram	0	0.30	2.27	0	0	6.26
Shred	Shred	--	--	--	0.44	--	--
Chain-root plow-seed[c]	2,4,5-T + picloram	--	--	--	--	44.00	33.51
Root plow-seed[c]	2,4,5-T + picloram	--	26.87	19.26	--	--	--
Root plow-rake-Bermudagrass	Grub	--	--	--	61.81	--	--
Root plow-rake-buffelgrass	Grub	--	--	46.33	--	--	--
Typical counties		Gonzales	Willacy	Jim Hogg	Goliad	Willacy	Zapata

[a] The net present value assumes a 9% interest charge for all added capital invested in brush control, increased breeding animals and operation expenses.

[b] Herbicides aerially applied at 0.67 lb/acre except 2,4,5-T + picloram which was applied at 0.5 lb/acre.

[c] Native mixture of adapted species.

Table 49. Increased annual net cash flow ($/acre) from selected honey mesquite alternatives on deep sites based on cow-calf operations and $44/cwt cattle prices (1978 dollars) over a 20-year planning period on the Rio Grande Plain, Texas, 1978.[a]

Treatment[b]		Canopy cover and initial carrying capacity (acres/AU/yr)					
		Moderate			Dense		
Initial	Maintenance	(15)	(22)	(32)	(18)	(25)	(40)
2,4,5-T	2,4,5-T	1.72	1.27	.92	3.03	1.51	.69
2,4,5-T + dicamba	2,4,5-T + dicamba	1.64	1.18	.83	2.95	1.43	.61
Dicamba	Dicamba	1.35	.87	.52	2.68	1.12	.31
2,4,5-T + picloram	2,4,5-T + picloram	1.39	1.07	0.69	2.97	1.22	1.22
Shred	Shred	--	--	--	1.15	--	--
Chain-root plow-seed[c]	2,4,5-T + picloram	--	--	--	--	0.31	1.94
Root plow-seed[c]	2,4,5-T + picloram	--	1.52	2.72	--	--	--
Root plow-rake-Bermudagrass	Grub	--	--	--	5.32	--	--
Root plow-rake-buffelgrass	Grub	--	--	3.39	--	--	--
Typical counties		Gonzales	Willacy	Jim Hogg	Goliad	Willacy	Zapata

[a] The net cash flow is total added cash sales ($44/cwt) less costs of brush control, added breeding livestock and increased annual operating costs plus the salvage value of cows and brush control (if applicable) at the end of the 20-year planning horizon. Interest charges were not included and the timing of cash flows was not considered.

[b] Herbicides aerially applied at 0.67lb/acre except 2,4,5-T + picloram which was applied at 0.5 lb/acre.

[c] Native mixture of adapted species.

Table 50. Years required to recover initial investment in selected honey mesquite control alternatives on deep sites and livestock based on a cow-calf production and $44/cwt cattle prices (1978 dollars) on the Rio Grande Plain, Texas, 1978.[a]

Treatment[b]		Canopy cover and initial carrying capacity (acres/AU/yr)					
		Moderate			Dense		
Initial	Maintenance	(15)	(22)	(32)	(18)	(25)	(40)
2,4,5-T	2,4,5-T	10	9	13	5	8	14
2,4,5-T + dicamba	2,4,5-T + dicamba	10	9	15	5	9	15
Dicamba	Dicamba	11	16	17	8	14	18
2,4,5-T + picloram	2,4,5-T + picloram	12	12	13	6	11	20
Shred	Shred	--	--	--	15	--	--
Chain-root plow-seed[c]	2,4,5-T + picloram	--	--	--	--	20 +	18
Root plow-seed[c]	2,4,5-T + picloram	--	17	14	--	--	--
Root plow-rake-Bermudagrass	Grub	--	--	--	17	--	--
Root plow-rake-buffelgrass	Grub	--	--	19	--	--	--
Typical counties		Gonzales	Willacy	Jim Hogg	Goliad	Willacy	Zapata

[a] A 20-year planning horizon was utilized and no interest charges are included. The time period represents a "pay-back period" commonly used to evaluate investment opportunities. Salvage values of cows and brush control (if applicable) are not included as part of the pay-out period, but would represent gross returns to the operation at the time of "pay-back." A 20 + indicates greater than 20 years will be required to recover the investment.

[b] Herbicides aerially applied at 0.67 lb/acre except 2,4,5-T + picloram which was applied at 0.5 lb/acre.

[c] Native mixture of adapted species.

investment in treatments involving mechanical treatments on the Rio Grande Plain. Root plowing and other mechanical methods are commonly used for brush management on the Rio Grande Plain. During the past 5 years, about four times more rangeland was treated mechanically than with herbicides. One reason for the greater use of mechanical methods is that conventional herbicides are generally only partially effective for control of many of the woody species associated with mesquite in the mixed brush complex (Scifres 1979b).

Averaged across the situations evaluated, pretreatment annual calf production averaged 13.8 pounds per acre (Table 51). Following treatment with 2,4,5-T, it was estimated that the rangeland would produce an average 20.9 pounds per acre annually of beef representing a 51 percent increase in production. In contrast, root plowing-seeding treatments increased production by an average of 116 percent on applicable sites. Annual productivity was higher on tame pastures ranging from 43.8 to 76.9 pounds per acre for buffelgrass and coastal Bermudagrass, respectively. These livestock production estimates indicate the relatively high production potential for the region

Coast Prairie

The Coast Prairie represents about 9.5 million acres of nearly level plain in the extreme southeastern portion of Texas (Figure 1). Elevation ranges from sea level to 250 feet, and annual rainfall is from 28 to 56 inches. Soils are dark, neutral to slightly acid clay loams and clays in the northern portion and light, acid sands and darker loamy to clayey soils in the southern portion (Coastal Bend) (Godfrey, Carter and McKee undated). Higher rainfall, an annual frost-free period of 240 to

Table 51. Total weaned calf production (lb/acre/year) from selected honey mesquite control alternatives on deep sites on the Rio Grande Plain, Texas, 1978.[a]

Treatment[b]		Canopy cover and initial carrying capacity (acres/AU/yr)					
		Moderate			Dense		
Initial	Maintenance	(15)	(22)	(32)	(18)	(25)	(40)
None (pretreatment)		19.2	14.8	10.1	17.9	12.8	8.1
2,4,5-T	2,4,5-T	29.0	21.3	15.0	29.4	18.6	12.2
2,4,5-T + dicamba	2,4,5-T + dicamba	29.0	21.3	15.0	29.4	18.6	12.2
Dicamba	Dicamba	29.0	21.3	15.0	29.4	18.6	12.2
2,4,5-T + picloram	2,4,5-T + picloram	29.0	22.1	15.3	30.5	19.2	12.6
Shred	Shred	--	--	--	27.1	--	--
Chain-root plow-seed[c]	2,4,5-T + picloram	--	--	--	--	22.0	22.6
Root plow-seed[c]	2,4,5-T + picloram	--	28.2	25.5	--	--	--
Root plow-rake-Bermudagrass	Grub	--	--	--	76.9	--	--
Root plow-rake-buffelgrass	Grub	--	--	43.8	--	--	--
Typical counties		Gonzales	Willacy	Jim Hogg	Goliad	Willacy	Zapata

[a] A 20-year planning period was utilized to determine the average production responses.

[b] Herbicides aerially applied at 0.67 lb/acre except 2,4,5-T + picloram which was applied at 0.5 lb/acre.

[c] Native mixture of adapted species.

320 days, and productive soils lend high agricultural productivity to many areas of this resource area.

Native vegetation of the uplands on the Coastal Prairie are typified by live oak savannah and honey mesquite-dominated mixed brush with mid- to tall grasses in the herbaceous layer. Nearly 2 million acres, about 20 percent of the land resource, is used as range (Table 1). Pure stands of honey mesquite are rare and, mesquite generally is not a serious problem for the region. Mesquite occurs primarily as a component of "chaparral," a mixed, thorny brush complex often composed of 10 or more woody species. It also reinvades rangeland rapidly following application of brush management methods. Therefore, most of the mesquite infestation is classified as light to moderate infestation.

Although Hoffman (1978) estimated that about 21,000 acres were treated annually with herbicides from 1973 through 1977 on the Coast Prairie, aerial application of herbicides on much of the land resource is seriously constrained by the intensive use of the areas for row-crop agriculture (Scifres 1979b). Therefore, treatments such as oiling and mechanical methods often are used. For example, mechanical methods were applied to about 47,000 acres annually from 1973 to 1977 on the Coast Prairie (Hoffman 1978). Moreover, the high rainfall and fertile soils of the area lend considerable flexibility in the choice between tame pasture conversion and improvement of the rangeland. However, annual rates of return for the treatment alternatives evaluated in this study were surprisingly low (Table 52). Highest annual rates of return, 4 to 6.5 percent, were generated by oiling. The low annual rates of return were attributed largely to the high initial treatment cost, from 30.00 to

Table 52. Economic and production responses to selected honey mesquite control alternatives on the Coast Prairie, Texas, 1978.[a]

Canopy cover and initial carrying capacity (acres/AU/yr)	Pre-treatment	Honey mesquite control alternative (initial/maintenance treatments): Oil/oil	Tree doze/oil	Tree doze/shred	Root plow-rake-seed[b]/oil	Root plow-rake-kleingrass/oil	Root plow-rake Bermudagrass/oil
				Annual rates of return (%)[c]			
Moderate (12)	--	6.5	0.2	--	1.1	2.2	2.5
Dense (15)	--	4.0	--	-2.5	1.0	--	--
				Initial treatment costs ($/acre)[d]			
Moderate (12)	--	30.00	80.00	--	110.00	115.00	150.00
Dense (15)	--	50.00	--	100.00	140.00	--	--
				Required reduction in initial costs ($/acre)[e]			
Moderate (12)	--	7.65	57.36	--	72.80	81.08	102.61
Dense (15)	--	25.49	--	89.34	101.69	--	--
				Increased annual net cash flow ($/acre)[f]			
Moderate (12)	--	1.86	0.13	--	0.97	2.73	4.26
Dense (15)	--	2.09	--	-1.85	1.31	--	--
				Years required to recover investment[g]			
Moderate (12)	--	13	20 +	--	20 +	20 +	20 +
Dense (15)	--	15	--	20 +	20 +	--	--
				Total weaned calf production (lb/acre/year)[h]			
Moderate (12)	24.0	37.4	39.3	--	46.4	44.1	72.1
Dense (15)	19.2	37.1	--	36.1	49.7	--	--

Table 52. Continued.

[a] Typical county is Victoria.

[b] Native mixture of adapted species.

[c] Considers all operating and investment capital in brush control and breeding livestock. Costs and returns projected in constant 1978 dollars. Thus, annual rates of return do not include inflation impacts and are considered real rates of return. Market or nominal rates of return may be estimated by adding an assumed inflation rate to the real rates; however, such a process assumes that inflation will affect costs and returns equally.

[d] Initial treatment costs do not include added breeding livestock investments.

[e] The net-present value assumes a 9% interest charge for all capital invested in brush control, increased breeding animals, and operation expenses.

[f] The net cash flow is total added cash sales at 0.44 dollar per pound less costs of brush control, added breeding livestock, and increased annual operating costs plus the salvage value of cows and brush control (if applicable at the end of the 20-year planning period. Interest charges were not included, and the timing of cash flows was not considered.

[g] Based on a 20-year planning period without interest charges included. Represents "pay-back" period commonly used to evaluate investment opportunities. Salvage values of cows and brush control (if applicable) are not included as a part of the pay-out period, but would represent gross returns to the operation at the time of "pay-back." A 20 + indicates greater than 20 years required to recover the investment.

[h] Average production responses based on a 20-year planning period.

150.00 dollars per acre for the alternatives evaluated. Therefore, reductions in initial treatment costs to achieve a 9 percent annual rate of return ranged from 7.65 to 102.61 dollars per acre. It would be expected that unless livestock prices are maintained at a relatively high level, increasing energy costs will continually erode profitability of present brush management practices for the Coast Prairie. Increased annual net cash flows from the brush management alternatives evaluated ranged from -1.85 to 4.26 dollars per acre. Oiling required from 13 to 15 years to pay back the original investment, and the payback period for all mechanical practices exceeded the 20-year planning horizon. Factors for adjusting annual rates of return, as discussed for the High Plains, when cattle prices ranged from 34 to 54 cents per pound, are:

Alternative	Adjustment factor
Oil	0.39
Tree doze (oil as maintenance)	0.23
Tree doze (shred as maintenance)	0.23
Root plow-rake-seed natives	0.24
Root plow-rake-kleingrass	0.26
Root plow-rake-Bermudagrass	0.29

Edwards Plateau

The Edwards Plateau covers about 24 million acres (Godfrey, Carter and McKee undated) of which 93 percent is rangeland (Table 1). The land is deeply dissected, covered with brush and the area is often referred to as the "Hill Country." Elevation is 1,200 to 3,000 feet, annual rainfall is 12 to 32 inches and the annual frost-free period is 220 to 260 days.

Upland soils are dark, calcareous clays and clay loams which are shallow with frequent rocky outcrops. Vegetation is dominated by live oak, shinnery oak, junipers and honey mesquite. The area becomes desert shrub on the western edge as it joins the Trans-Pecos. Oak and pecan are common on the bottomlands, especially in the eastern portion of the resource area. The Edwards Plateau region (including the Central Basin) has approximately 6.8 percent of the cows in the state but is the major location of the sheep and goat industry in the state (Table 3). Sixty-two percent of the cows in the region are in herds of 200 cows or fewer which represents 90 percent of the ranch firms of the region (Table 3). It is significant to note that Table 3 represents cows only, and the relative proportions of larger herd sizes based on animal units could be expected to be higher than reported.

Honey mesquite infests almost 60 percent of the rangeland on the Edwards Plateau (Table 1). However, 48 percent of the infestation is of light canopy cover and occurs primarily in mixture with other woody species. Mesquite stands of moderate to dense canopy covers are confined primarily to the deep range sites. According to Hoffman (1978), from 1973 through 1978 there was an average of 144,200 acres annually treated with herbicides for brush control on the Edwards Plateau. During that same time period, 130,050 acres per year were treated with mechanical methods.

The Edwards Plateau varies so widely in environmental and edaphic conditions that it could be evaluated as several sub-regions. However, for purposes of this report, it may be adequate to emphasize only that the western part of the Edwards Plateau is essentially the same as the

Trans-Pecos, the southern part grades into the Rio Grande Plain and the northern portion into the Rolling Plains. Therefore, site potential varies widely, with initial (pretreatment) carrying capacities on the deep sites ranging from 18 to 20 acres per animal unit per year in the eastern part of the region to 120 to 159 acres per animal unit yearlong in the western portion.

On shallow sites with dense canopy covers of honey mesquite, aerial application of 2,4,5-T ranged from 7.3 to 23.2 percent annual rate of return (Table 53). In comparison, annual rates of return for moderate canopy cover on shallow sites ranged from 4.3 to 16.6 percent. Thus, the economic potential of any given treatment varies widely with site condition on the Edwards Plateau. However, averaging across sites allows a direct comparison among herbicides. Average annual rates of return were 11.9 percent for aerial applications of 2,4,5-T, 10.8 percent for 2,4,5-T + dicamba, 7.7 percent for 2,4,5-T + picloram and 7.9 percent for dicamba.

Annual rates of return for mechanical practices ranged from -1.4 to 5.2 percent (Table 53). The highest annual rates of return were generated by seeding projects which included raking following the initial land preparation of range sites with high production potential.

Within a canopy cover situation, rates of return were uniformily higher on deep than on shallow sites (Table 54). Averaged across moderate canopy cover situations on deep soils, average annual rate of return for aerial application of 2,4,5-T was 12.8 percent compared to 10.3 percent on shallow soils, 11.8 percent for 2,4,5-T + dicamba compared to an average 9.2 percent on shallow soils, 8.7 percent for dicamba compared to 6.0 percent

Table 53. Annual rates of return (%) of selected honey mesquite control alternatives on shallow soils based on cow-calf production and $44/cwt cattle prices (1978 dollars) over a 20-year planning period on the Edwards Plateau, Texas, 1978.[a]

Treatment[b] Initial	Treatment[b] Maintenance	Canopy cover and initial carrying capacity (acres/AU/yr): Moderate (26)	Moderate (32)	Moderate (44)	Dense (20)	Dense (36)	Dense (50)
2,4,5-T	2,4,5-T	16.6	10.1	4.3	23.2	10.1	7.3
2,4,5-T + dicamba	2,4,5-T + dicamba	15.6	8.9	3.2	21.8	9.1	6.4
Dicamba	Dicamba	12.4	5.7	0	17.8	7.6	3.7
2,4,5-T + picloram	2,4,5-T + picloram	12.0	8.2	-0.5	15.4	6.8	4.2
Tree doze	Grub	--	--	--	1.6	--	--
Tree doze-seed[c]	Grub	--	--	0.8	--	--	--
Tree doze-rake-seed[c]	Grub	4.8	1.3	0.2	--	4.0	-1.1
Root plow-rake-seed[c]	Grub	5.2	--	-0.4	--	--	-1.4
Root plow-roller chop-seed[c]	Grub	--	2.3	--	--	2.2	--
Typical counties		Menard	Schleicher	Midland	Menard	Kimble	Taylor

[a] The rate of return considers all operating and investment capital in brush control and breeding livestock. Costs and returns were projected in constant 1978 dollars. Thus, annual rates of return do not include inflation impacts and are considered real rates of return. An estimate of market or nominal rates of return may be made by adding an assumed inflation rate to the real rates. This process assumes inflation will affect costs and returns equally.

[b] Herbicides aerially applied at 0.5 lb/acre.

[c] Native mixture of adapted species.

Table 54. Annual rates of return (%) of selected honey mesquite control alternatives on deep soils based on cow-calf production and $44/cwt cattle prices (1978 dollars) over a 20-year planning period on the Edward Plateau, Texas, 1978.[a]

Treatment[b]		Canopy cover and initial carrying capacity (acres/AU/yr)							
		Moderate				Dense			
Initial	Maintenance	(17)	(24)	(39)	(120)	(25)	(42)	(50)	(150)
2,4,5-T	2,4,5-T	25.5	12.8	0.2	7.6	24.6	5.7	-3.0	7.9
2,4,5-T + dicamba	2,4,5-T + dicamba	24.2	11.9	-0.8	6.6	23.5	4.7	-3.9	6.9
Dicamba	Dicamba	20.5	9.2	-3.6	3.7	20.2	1.8	-6.7	4.2
2,4,5-T + picloram	2,4,5-T + picloram	21.6	10.7	-4.4	4.7	20.6	0.9	--	--
2,4,5-T + picloram	2,4,5-T	--	--	--	--	--	--	0.6	4.6
Tree doze-rake-kleingrass	2,4,5-T	--	--	--	--	6.9	--	--	--
2,4,5-T-chain	2,4,5-T	--	--	--	--	--	--	6.1	--
Shred	Shred	--	5.8	--	--	--	--	--	--
Oil	Oil	--	10.6	-3.4	--	4.0	--	--	--
Tree doze	Grub	--	--	2.1	1.5	--	--	--	2.2
Tree doze-seed[c]	Grub	3.7	--	--	--	3.1	--	--	1.1
Tree doze-rake-seed[c]	Grub	--	3.0	0	--	4.2	-1.1	--	--
Root plow	Grub	7.9	--	--	--	6.5	--	--	--
Root plow-seed[c]	Grub	--	4.6	--	--	--	0	--	--
Root plow-rake-seed[c]	Grub	--	3.4	-0.6	--	3.1	-	1.4	--
Root plow-roller chop-seed[c]	Grub	--	3.0	--	0.5	--	--	1.0	0.7
Typical counties		Real	Kimble	Howard	Brewster	Concho	Taylor	Midland	Pecos

[a] The rate of return considers all operating and investment capital in brush control and breeding livestock. Costs and returns were projected in constant 1978 dollars. Thus, annual rates of return do not include inflation impacts and are considered real rates of return. An estimate of market or nominal rates of return may be made by adding an assumed inflation rate to the real rates. This process assumes inflation will affect costs and returns equally.

[b] Herbicides aerially applied at 0.5 lb/acre.

[c] Native mixture of adapted species.

on shallow soils, and 9.3 percent for 2,4,5-T + picloram compared to 6.6 percent on shallow soils.

The highest annual rate of return from mechanical practices applied to deep soils was 7.9 percent for root plowing of the site with highest production potential (Table 54). Establishment of kleingrass generated a 6.9 percent annual rate of return for the single situation for which it was evaluated. In contrast to other vegetation regions, oiling generated a 10.6 percent annual rate of return in one case on the Edwards Plateau. However, it resulted in a -3.4 percent rate of return on a site of lower production potential. To estimate annual rates of return of the selected honey mesquite alternatives within the range of prices, 34 to 54 cents per pound, the following adjustment factors, as discussed for the High Plains, are presented:

Alternative	Adjustment factor
2,4,5-T	0.57
2,4,5-T + dicamba	0.56
Dicamba	0.50
2,4,5-T + picloram	0.52
2,4,5-T + picloram (2,4,5-T as followup)	0.37
Tree doze-rake-kleingrass	0.48
2,4,5-T-chain	0.37
Shred	0.51
Oil	0.30
Tree doze	0.24
Tree doze-seed	0.21
Tree doze-rake-seed	0.20
Root plow	0.28

Root plow-seed	0.20
Root plow-rake-seed	0.19
Root plow-roller chop-seed	0.20

Costs of herbicide treatments on the Edwards Plateau were the same as for the High Plains (Table 5). Costs for mechanical practices varied with the specific mesquite canopy cover/site potential situation (Tables 55 and 56). For the 14 situations evaluated, a cost reduction was required for seven of the cases if a 9 percent annual rate of return was to be generated from aerial application of 2,4,5-T (Tables 57 and 58). These cost reduction requirements ranged from 0.35 to 5.00 dollars per acre, from 15 to 91 percent of the original treatment cost. A cost reduction was required for 2,4,5-T + dicamba in eight of the 14 honey mesquite control situations and nine of the situations when dicamba or 2,4,5-T + picloram were used. However, cost reductions were required for all mechanical practices to yield a 9 percent annual rate of return, some requiring reductions of more than 50.00 dollars per acre.

Increased annual net cash flow across the 14 range site/mesquite canopy cover situations averaged 1.11 dollars per acre for aerial application of 2,4,5-T, with one situation resulting in a negative cash flow (Tables 59 and 60). The overall average increased annual net cash flow for 2,4,5-T + dicamba was 1.05 dollars per acre with negative values for two situations where potential productivity was relatively low. Aerial application of dicamba generated an average annual increase in net cash flow of 0.88 dollar per acre with one situation resulting in no increase in net cash flow and two situations being negative. The

Table 55. Initial treatment costs ($/acre)[a] for selected honey mesquite control alternatives applied to shallow soils on the Edwards Plateau, Texas, 1978.

Treatment[b]		Canopy cover and initial carrying capacity (acres/AU/yr)					
		Moderate			Dense		
Initial	Maintenance	(26)	(32)	(44)	(20)	(36)	(50)
Tree doze	Grub	--	--	--	50.00	--	--
Tree doze-seed[c]	Grub	--	--	25.00	--	--	--
Tree doze-rake-seed[c]	Grub	56.00	40.00	45.00	--	40.00	55.00
Root plow-rake-seed[c]	Grub	68.00	--	70.00	--	--	70.00
Root plow-roller chop-seed[c]	Grub	--	45.00	--	--	45.00	--
Typical counties		Menard	Schleicher	Midland	Menard	Kimble	Taylor

[a] Initial treatment costs do not include added breeding livestock investments.

[b] Herbicides aerially applied at 0.5 lb/acre.

[c] Native mixture of adapted species.

Table 56. Initial treatment costs ($/acre)[a] for selected honey mesquite control alternatives applied to deep soils on the Edwards Plateau, Texas, 1978.

Treatment[b]		Canopy cover and initial carrying capacity (acres/AU/yr)							
		Moderate				Dense			
Initial	Maintenance	(17)	(24)	(39)	(120)	(22)	(42)	(50)	(150)
Tree doze-rake-kleingrass	2,4,5-T	--	--	--	--	70.00	--	--	--
2,4,5-T-chain	2,4,5-T	--	--	--	--	--	--	5.50	--
Shred	Shred	--	10.00	--	--	--	--	--	--
Oil	Oil	--	30.00	20.00	--	27.50	--	--	--
Tree doze	Grub	--	--	25.00	16.00	--	--	--	20.00
Tree doze-seed[c]	Grub	40.00	--	--	--	45.00	--	--	30.00
Tree doze-rake-seed[c]	Grub	--	42.00	50.00	--	45.00	55.00	--	--
Root plow	Grub	30.00	--	--	--	30.00	--	--	--
Root plow-seed[c]	Grub	--	75.00	--	--	--	70.00	--	--
Root plow-rake-seed[c]	Grub	--	75.00	65.00	--	75.00	--	50.00	--
Root plow-roller chop-seed[c]	Grub	--	45.00	--	35.60	--	--	50.00	35.60
Typical counties		Real	Kimble	Howard	Brewster	Concho	Taylor	Midland	Pecos

[a] Initial treatment costs do not include added breeding livestock investments.

[b] Herbicides aerially applied at 0.5 lb/acre.

[c] Native mixture of adapted species.

Table 57. Initial cost reduction ($/acre) for yielding a 9% annual rate of return on the investment in selected honey mesquite control alternatives and added breeding livestock based on cow-calf production and $44/cwt cattle prices (1978 dollars) over a 20-year planning period on shallow soils on the Edwards Plateau, Texas, 1978.[a]

Treatment[b]		Canopy cover and initial carrying capacity (acres/AU/yr)					
		Moderate			Dense		
Initial	Maintenance	(26)	(32)	(44)	(20)	(36)	(50)
2,4,5-T	2,4,5-T	0	0	2.27	0	0	1.16
2,4,5-T + dicamba	2,4,5-T + dicamba	0	0.06	2.91	0	0	1.91
Dicamba	Dicamba	0	2.63	5.11	0	1.34	4.49
2,4,5-T + picloram	2,4,5-T + picloram	0	0.81	7.03	0	2.22	4.69
Tree doze	Grub	--	--	--	31.22	--	--
Tree doze-seed[c]	Grub	--	--	18.46	--	--	--
Tree doze-rake-seed[c]	Grub	24.01	27.47	33.02	--	21.81	42.10
Root plow-rake-seed[c]	Grub	26.76	--	53.13	--	--	54.42
Root plow-roller chop-seed[c]	Grub	--	28.41	--	--	29.28	--
Typical counties		Menard	Schleicher	Midland	Menard	Kimble	Taylor

[a] The net present value assumes a 9% interest charge for all added capital invested in brush control, increased breeding animals and operation expenses.

[b] Herbicides aerially applied at 0.5 lb/acre.

[c] Native mixture of adapted species.

Table 58. Initial cost reduction ($/acre) for yielding a 9% annual rate of return on the investment in selected honey mesquite control alternatives and added breeding livestock based on cow-calf production and $44/cwt cattle prices (1978 dollars) over a 20-year planning period on deep soils on the Edwards Plateau, Texas, 1978.[a]

Treatment[b]		Canopy cover and initial carrying capacity (acres/AU/yr)							
		Moderate				Dense			
Initial	Maintenance	(17)	(24)	(39)	(120)	(22)	(42)	(50)	(150)
2,4,5-T	2,4,5-T	0	0	5.00	0.93	0	1.99	5.34	0.85
2,4,5-T + dicamba	2,4,5-T + dicamba	0	0	5.86	1.69	0	2.74	6.07	1.63
Dicamba	Dicamba	0	0	8.78	4.27	0	5.31	8.60	4.34
2,4,5-T + picloram	2,4,5-T + picloram	0	0	10.08	4.40	0	6.72	--	--
2,4,5-T + picloram	2,4,5-T	--	--	--	--	--	--	7.00	4.50
Tree doze-rake-kleingrass	2,4,5-T	--	--	--	--	21.50	--	--	--
2,4,5-T-chain	2,4,5-T	--	--	--	--	--	--	1.92	--
Shred	Shred	--	5.57	--	--	--	--	--	--
Oil	Oil	--	0	16.72	--	11.72	--	--	--
Tree doze	Grub	--	--	15.81	10.21	--	--	--	12.29
Tree doze-seed[c]	Grub	21.80	--	--	--	23.78	--	--	21.36
Tree doze-rake-seed[c]	Grub	--	24.82	35.85	--	19.02	42.47	--	--
Root plow	Grub	3.36	--	--	--	7.35	--	--	--
Root plow-seed[c]	Grub	--	33.83	--	--	--	51.18	--	--
Root plow-rake-seed[c]	Grub	--	35.19	49.90	--	39.83	--	33.48	--
Root plow-roller chop-seed[c]	Grub	--	26.20	--	25.12	--	--	34.21	25.10
Typical counties		Real	Kimble	Howard	Brewster	Concho	Taylor	Midland	Pecos

[a] The net present value assumes a 9% interest charge for all added capital invested in brush control, increased breeding animals and operation expenses.

[b] Herbicides aerially applied at 0.5 lb/acre.

[c] Native mixture of adapted species.

Table 61. Increased annual net cash flow ($/acre) from selected heavy mechanical alternatives applied to shallow soils based on cow-calf production and $44/cwt cattle prices (1978 dollars) over a 20-year planning period on the Edwards Plateau, Texas, 1978.[a]

Treatment[b] Initial	Maintenance	Moderate (26)	Moderate (32)	Moderate (44)	Dense (20)	Dense (36)	Dense (50)
		Canopy cover and initial carrying capacity (acres/AU/yr)					
2,4,5-T	2,4,5-T	1.83	0.74	0.20	2.49	0.71	0.57
2,4,5-T + dicamba	2,4,5-T + dicamba	1.77	0.68	0.16	2.43	0.66	0.52
Dicamba	Dicamba	1.57	0.49	0	2.23	0.78	0.35
2,4,5-T + picloram	2,4,5-T + picloram	1.60	0.97	-0.04	2.03	0.66	0.44
Tree doze	Grub	--	--	--	0.68	--	--
Tree doze-seed[c]	Grub	--	--	0.20	--	--	--
Tree doze-rake-seed[c]	Grub	2.90	0.49	0.11	--	2.00	-0.43
Root plow-rake-seed[c]	Grub	3.94	--	-0.17	--	--	-0.68
Root plow-roller chop-seed[c]	Grub	--	1.02	--	--	0.98	--
Typical counties		Menard	Schleicher	Midland	Menard	Kimble	Taylor

[a] The net cash flow is total added cash sales ($44/cwt) less costs of brush control, added breeding livestock and increased annual operating costs plus the salvage value of cows and brush control (if applicable) at the end of the 20-year planning horizon. Interest charges were not included and the timing of cash flows was not considered.

[b] Herbicides aerially applied at 0.5 lb/acre.

[c] Native mixture of adapted species.

Table 60. Increased annual net cash flow ($/acre) from selected honey mesquite alternatives applied to deep soils based on cow-calf production and $44/cwt cattle prices (1978 dollars) over a 20-year a 20-year planning period on the Edwards Plateau, Texas, 1978.[a]

Treatment[b]		Canopy cover and initial carrying capacity (acres/AU/yr)							
		Moderate				Dense			
Initial	Maintenance	(17)	(24)	(39)	(120)	(22)	(42)	(50)	(150)
2,4,5-T	2,4,5-T	2.80	1.29	0.01	0.57	3.37	0.38	-0.14	0.66
2,4,5-T + dicamba	2,4,5-T + dicamba	2.75	1.24	-0.05	0.52	3.30	0.33	-0.19	0.61
Dicamba	Dicamba	2.56	1.04	-0.26	0.32	3.10	0.15	-0.38	0.41
2,4,5-T + picloram	2,4,5-T + picloram	2.76	1.54	-0.34	0.53	3.89	0.08	--	--
2,4,5-T + picloram	2,4,5-T	--	--	--	--	--	--	0.05	0.49
Tree doze-rake-kleingrass	2,4,5-T	--	--	--	--	7.93	--	--	--
2,4,5-T-chain	2,4,5-T	--	--	--	--	--	--	0.46	--
Shred	Shred	--	1.22	--	--	--	--	--	--
Oil	Oil	--	3.89	-0.43	--	0.92	--	--	--
Tree doze	Grub	--	--	0.49	0.21	--	--	--	0.43
Tree doze-seed[c]	Grub	1.65	--	--	--	1.18	--	--	0.32
Tree doze-rake-seed[c]	Grub	--	1.32	0.02	--	1.70	-0.41	--	--
Root plow	Grub	2.53	--	--	--	1.93	--	--	--
Root plow-seed[c]	Grub	--	3.84	--	--	--	0.03	--	--
Root plow-rake-seed[c]	Grub	--	3.65	-0.26	--	2.06	--	0.62	--
Root plow-roller chop-seed[c]	Grub	--	1.31	--	-0.90	--	--	0.43	0.23
Typical counties		Real	Kimble	Howard	Brewster	Concho	Taylor	Midland	Pecos

[a] The net cash flow is total added cash sales ($/cwt) less costs of brush control, added breeding livestock and increased annual operating costs plus the salvage value of cows and brush control (if applicable) at the end of the 20-year planning horizon. Interest charges were not included and the timing of cash flows was not considered.

[b] Herbicides aerially applied at 0.5 lb/acre.

[c] Native mixture of adapted species.

2,4,5-T + picloram combination was evaluated for 12 range site/honey mesquite canopy cover situations. Average increased annual net cash flow for 2,4,5-T + picloram was 1.18 dollars per acre with negative cash flows resulting from two of the 12 situations. The greatest increase in annual net cash flow from mechanical alternatives, 7.13 dollars per acre, was produced by establishment of tame pastures with kleingrass.

Payback periods ranged from 5 to more than 20 years for aerial application of 2,4,5-T (average of 12.8 years) (Tables 61 and 62). The shortest payback periods occurred when the herbicide was applied to the sites with highest production potential (initial carrying capacity of 17 to 22 acres per animal unit). With the situations of greatest production potential, payback for aerial application of 2,4,5-T + dicamba or dicamba also required 5 years. Payback periods for mechanical methods ranged from 12 or more than 20 years.

Total annual weaned calf production, averaged across all situations, was 9.8 pounds per acre before treatment whereas it averaged 15.6 pounds per acre following aerial application of 2,4,5-T, 2,4,5-T + dicamba or dicamba (Tables 63 and 64). Based on twelve situations involving aerial application of 2,4,5-T + picloram, annual average weaned calf production was 17.9 pounds per acre. However, annual average weaned calf production ranged from 7.5 pounds per acre to 30.6 pounds per acre following spraying, depending on range site potential, initial mesquite canopy cover, and herbicide(s) applied. Annual total weaned calf production, averaged across all situations using mechanical treatments increased from 9.8 pounds per acre to 21.1 pounds per acre. Production ranged from 6.5 to 77.5 pounds per acre depending on range site potential, initial mesquite canopy cover and mechanical treatment applied.

Table 61. Years required to recover initial investment in selected honey mesquite alternatives and livestock on shallow soils and cow-calf production from $44/cwt cattle prices (1978 dollars) on the Edwards Plateau, Texas, 1978.[a]

Treatment[b]		Canopy cover and initial carrying capacity (acres/AU/yr)					
		Moderate			Dense		
Initial	Maintenance	(26)	(32)	(44)	(20)	(36)	(50)
2,4,5-T	2,4,5-T	10	12	16	8	11	13
2,4,5-T + dicamba	2,4,5-T + dicamba	10	12	17	8	11	18
Dicamba	Dicamba	11	19	20	8	13	20 +
2,4,5-T + picloram	2,4,5-T + picloram	12	14	20 +	10	14	20
Tree doze	Grub	--	--	--	20 +	--	--
Tree doze-seed[c]	Grub	--	--	20 +	--	--	--
Tree doze-rake-seed[c]	Grub	18	20 +	20+	--	20 +	20 +
Root plow-rake-seed[c]	Grub	17	--	20 +	--	20 +	--
Root plow-roller chop-seed[c]	Grub	--	20 +	--	--	20 +	--
Typical counties		Menard	Schleicher	Midland	Menard	Kimble	Taylor

[a] A 20-year planning horizon was utilized and no interest charges are included. The time period represents a "pay-back period" commonly used to evaluate investment opportunities. Salvage values of cows and brush control (if applicable) are not included as part of the pay-out period, but would represent gross returns to the operation at the time of "pay-back." A 20 + indicates greater than 20 years will be required to recover the investment.

[b] Herbicides aerially applied at 0.5 lb/acre.

[c] Native mixture of adapted species.

Table 62. Years required to recover initial investment in selected honey mesquite alternatives and livestock on deep soils and cow-calf production from $44/cwt cattle prices (1978 dollars) on the Edwards Plateau, Texas, 1978.[a]

Treatment[b] Initial	Maintenance	Canopy cover and initial carrying capacity (acres/AU/yr) Moderate (17)	(24)	(39)	(120)	Dense (22)	(42)	(50)	(150)
2,4,5-T	2,4,5-T	5	11	20 +	13	5	19	20 +	16
2,4,5-T + dicamba	2,4,5-T + dicamba	5	11	20 +	15	5	19	20 +	17
Dicamba	Dicamba	5	12	20 +	20 +	7	20 +	20 +	20 +
2,4,5-T + picloram	2,4,5-T + picloram	6	13	20 +	17	5	20 +	--	--
2,4,5-T + picloram	2,4,5-T	--	--	--	--	--	--	20	19
Tree doze-rake-kleingrass	2,4,5-T	--	--	--	--	13	--	--	--
2,4,5-T-chain	2,4,5-T	--	--	--	--	--	--	17	--
Shred	Shred	--	16	--	--	--	--	--	--
Oil	Oil	--	9	20 +	--	16	--	--	--
Tree doze	Grub	--	--	18	20 +	--	--	--	20 +
Tree doze-seed[c]	Grub	19	--	--	--	16	--	--	20 +
Tree doze-rake-seed[c]	Grub	--	19	20 +	--	17	20 +	--	--
Root plow	Grub	13	--	--	--	14	--	--	--
Root plow-seed[c]	Grub	--	18	--	--	--	20 +	--	--
Root plow-rake-seed[c]	Grub	--	18	20 +	--	17	--	20 +	--
Root plow-roller chop-seed[c]	Grub	--	18	--	20 +	--	--	20 +	20 +
Typical counties		Real	Kimble	Howard	Brewster	Concho	Taylor	Midland	Pecos

[a] A 20-year planning horizon was utilized and no interest charges are included. The time period represent a "pay-back period" commonly used to evaluate investment opportunities. Salavage values of cows and brush control (if applicable) are not included as part of the pay-out period, but would represent gross returns to the operation at the time of "pay-back." A 20 + indicates greater than 20 years will be required to recover the investment.

[b] Herbicides aerially applied at 0.5 lb/acre.

[c] Native mixture of adapted species.

Table 63. Total weaned calf production (lb/acre/year) from selected honey mesquite alternatives applied to shallow soils of cow-calf operations of the Edwards Plateau, Texas, 1978.[a]

Treatment[b]		Canopy cover and initial carrying capacity (acres/AU/yr)					
		Moderate			Dense		
Initial	Maintenance	(26)	(32)	(44)	(20)	(36)	(50)
None (pretreatment)		13.3	10.9	7.9	16.6	9.1	6.6
2,4,5-T	2,4,5-T	21.7	15.8	10.3	25.2	14.9	10.3
2,4,5-T + dicamba	2,4,5-T + dicamba	21.7	15.8	10.3	25.3	14.9	10.8
Dicamba	Dicamba	21.7	15.8	10.3	25.3	14.9	10.8
2,4,5-T + picloram	2,4,5-T + picloram	22.2	17.1	10.8	25.6	15.1	11.8
Tree doze	Grub	--	--	--	25.0	--	--
Tree doze-seed[c]	Grub	--	--	12.7	--	--	--
Tree doze-rake-seed[c]	Grub	30.0	18.9	13.6	--	18.0	17.5
Root plow-rake-seed[c]	Grub	36.6	--	14.1	--	--	14.9
Root plow-roller chop-seed[c]	Grub	--	21.2	--	--	19.7	--
Typical counties		Menard	Schleicher	Midland	Menard	Kimble	Taylor

[a] A 20-year planning period was utilized to determine the average production responses.

[b] Herbicides aerially applied at 0.5 lb/acre.

[c] Native mixture of adapted species.

Table 64. Total weaned calf production (lb/acre/year) from selected honey mesquite alternatives applied to deep soils of cow-calf operations of the Edwards Plateau, Texas, 1978.[a]

Treatment[b]		Canopy cover and initial carrying capacity (acres/AU/yr)							
		Moderate				Dense			
Initial	Maintenance	(17)	(24)	(39)	(120)	(22)	(42)	(50)	(150)
None (pretreatment)		18.4	11.9	8.5	2.8	15.0	7.9	6.6	2.2
2,4,5-T	2,4,5-T	28.1	19.6	11.2	7.4	27.2	11.3	8.5	7.5
2,4,5-T + dicamba	2,4,5-T + dicamba	28.1	19.6	11.2	7.4	27.2	11.3	8.5	7.5
Dicamba	Dicamba	28.1	19.6	11.2	7.4	27.2	11.3	8.5	7.5
2,4,5-T + picloram	2,4,5-T + picloram	28.3	22.0	11.5	7.9	30.6	11.8	--	--
2,4,5-T + picloram	2,4,5-T	--	--	--	--	--	--	9.1	7.5
Tree doze-rake-kleingrass	2,4,5-T	--	--	--	--	77.5	--	--	--
2,4,5-T-chain	2,4,5-T	--	--	--	--	--	--	9.7	--
Shred	Shred	--	24.4	--	--	--	--	--	--
Oil	Oil	--	30.8	11.4	--	22.4	--	--	--
Tree doze	Grub	--	--	15.0	--	--	--	--	7.3
Tree doze-seed[c]	Grub	29.7	--	--	6.5	25.0	--	--	7.8
Tree doze-rake-seed[c]	Grub	--	23.9	15.3	--	24.9	15.2	--	--
Root plow	Grub	29.5	--	--	--	24.4	--	--	--
Root plow-seed[c]	Grub	--	34.7	--	--	--	16.8	--	--
Root plow-rake-seed[c]	Grub	--	34.2	16.3	--	30.0	--	15.4	--
Root plow-roller chop-seed[c]	Grub	--	23.2	--	8.6	--	--	15.0	8.1
Typical counties		Real	Kimble	Howard	Brewster	Concho	Taylor	Midland	Pecos

[a] A 20-year planning period was utilized to determine the average production responses.

[b] Herbicides aerially applied at 0.5 lb/acre.

[c] Native mixture of adapted species

Central Basin

The Central Basin occupies 1.5 million acres of rolling to hilly and stony land in central Texas of which about 27 percent is rangeland (Table 1). Elevation is 1,000 to 1,800 feet, annual rainfall is 25 to 30 inches and the annual frost-free period is 220 to 230 days.

The upland soils are reddish brown to brown, neutral to slightly acid and most are gravelly and stony, shallow sandy loams over granite. Bottomlands are dark gray, neutral to calcareous alluvial soils which support hardwoods. Upland vegetation is dominated by honey mesquite, live oak, post oak and sodgrasses to tall grasses. Honey mesquite is a management problem on about 97 percent of the rangeland in the Central Basin and occurs primarily on the range sites of relatively high production potential (Table 1). Characteristics of ranch firms are discribed as part of the Edwards Plateau discussion.

Average annual rates of return for aerial applications of 2,4,5-T, based on two production situations, was 11.1 percent (Table 65). Average annual rate of return from aerial applications of 2,4,5-T + dicamba was 10 percent, 6.9 percent from dicamba only, and 6.1 percent from 2,4,5-T + picloram. Mechanical practices resulted in 0.7 to 2.7 percent annual rates of return, based on cattle prices of 44 cents per pound. To estimate annual rates of return for other than 44 cents per pound, as discussed for the High Plains, the following adjustment factors may be used for cattle prices ranging from 34 to 54 cents per pound:

Table 65. Annual rates of return (%) from selected honey mesquite control on two canopy cover situations on deep sites based on cow-calf production and $44/cwt cattle prices (1978 dollars) on the Central Basin, Texas, 1978.[a]

Treatment[b] Initial	Maintenance	Canopy cover and initial carrying capacity (acres/AU/yr) Moderate (20)	Dense (22)
2,4,5-T	2,4,5-T	8.1	14.1
2,4,5-T (B)	2,4,5-T (B)	-0.2	4.2
2,4,5-T + dicamba	2,4,5-T + dicamba	7.0	13.0
Dicamba	Dicamba	3.8	9.9
2,4,5-T + picloram	2,4,5-T + picloram	4.7	7.5
Tree doze-seed[c]	Grub	0.7	2.7
Root plow-rake-seed[c]	Grub	1.7	2.7
Typical county		Llano	Llano

[a] A 20-year planning horizon was utilized to estimate annual production changes.

[b] Herbicide treatments aerially applied at 0.5 lb/acre except 2,4,5-T (B) which indicates basal spray.

[c] Native mixture of adapted species.

Alternative	Adjustment factor
2,4,5-T	0.60
2,4,5-T(B)	0.33
2,4,5-T + dicamba	0.58
Dicamba	0.52
2,4,5-T + picloram	0.43
Tree doze-seed natives	0.22
Root plow-rake-seed natives	0.23

Only in three situations were cost reductions not required for the honey mesquite control alternatives to yield a 9 percent annual rate of return (Table 66). Annual increases in net cash flows ranged from -0.03 to 1.85 dollars per acre (Table 67). Aerial applications of 2,4,5-T required 9 to 15 years for recovery of the investment, and from 10 to 20 years were required for the other broadcast herbicide treatments (Table 68). Mechanical methods required from 19 to more than 20 years to recover the initial investment in treatment. Weaned calf production was increased by 36 to 47 percent following aerial application of herbicides, compared to pretreatment production on brush covered pastures. Highest annual average weaned calf production, 31.8 pounds per acre, represented a 101 percent increase over pretreatment production levels, was produced by root plowing and seeding adapted species (Table 69).

Table 66. Initial treatment cost and cost reduction ($/acre) for yielding a 9% annual rate of return on the investment in selected honey mesquite alternatives and added breeding livestock based on cow-calf production and $44/cwt cattle prices (1978 dollars) on deep sites on the Central Basin, Texas, 1978.[a]

Treatment[b] Initial	Maintenance	Initial treatment cost	Canopy cover and initial carrying capacity (acres/AU/yr) Moderate (20)	Dense (22)
2,4,5-T	2,4,5-T	5.50	0.62	0
2,4,5-T (B)	2,4,5-T (B)	20.00	16.16	11.43
2,4,5-T + dicamba	2,4,5-T + dicamba	5.95	1.46	0
Dicamba	Dicamba	7.50	4.36	0
2,4,5-T + picloram	2,4,5-T + picloram	9.75	4.01	1.66
Tree doze-seed[c]	Grub	40.00	28.98	24.16
Root plow-rake-seed[c]	Grub	75.00	47.19	43.47
Typical county		Llano	Llano	Llano

[a] The net present value assumes a 9% interest charge for all added capital invested in brush control and additional breeding animals and operation expenses. Calculations based on a 20-year planning horizon.

[b] Herbicide treatments aerially applied at 0.5 lb/acre except 2,4,5-T (B) which indicates basal spray.

[c] Native mixture of adapted species.

Table 67. Increased annual net cash flow ($/acre) resulting from investment in selected honey mesquite control alternatives based on cow calf production alternatives based on cow-calf production and $44/cwt cattle prices (1978 dollars) over a 20-year planning horizon on deep sites on the Central Basin, Texas, 1978.[a]

Treatment[b]		Canopy cover and initial carrying capacity (acres/AU/yr)	
Initial	Maintenance	Moderate (20)	Dense (22)
2,4,5-T	2,4,5-T	0.62	1.32
2,4,5-T (B)	2,4,5-T (B)	-.03	1.02
2,4,5-T + dicamba	2,4,5-T + dicamba	0.56	1.26
Dicamba	Dicamba	0.35	1.07
2,4,5-T + picloram	2,4,5-T + picloram	0.47	0.90
Tree doze-seed[c]	Grub	0.26	1.07
Root plow-rake-seed[c]	Grub	1.09	1.85
Typical county		Llano	Llano

[a] The net cash flow is total added cash sales less costs of brush control, added breeding livestock and increased annual operating costs plus the salvage value of cows and brush control (if applicable) at the end of the 20 year planning horizon. Interest charges were not included and the timing of cash flows was not considered.

[b] Herbicide treatments aerially applied at 0.5 lb/acre except 2,4,5-T (B) which indicates basal spray.

[c] Native mixture of adapted species.

Table 68. Years required to recover initial investment in selected honey mesquite control alternatives and livestock based on cow-calf production and $44/cwt cattle prices (1978 dollars) on deep sites in the Central Basin, Texas, 1978.[a]

Treatment[b]		Canopy cover and initial carrying capacity (acres/AU/yr)	
Initial	Maintenance	Moderate (20)	Dense (22)
2,4,5-T	2,4,5-T	15	9
2,4,5-T (B)	2,4,5-T (B)	20 +	18
2,4,5-T + dicamba	2,4,5-T + dicamba	16	10
Dicamba	Dicamba	18	11
2,4,5-T + picloram	2,4,5-T + picloram	20	17
Tree doze-seed[c]	Grub	20 +	19
Root plow-rake-seed[c]	Grub	20	18
Typical county		Llano	Llano

[a] A 20-year planning horizon was utilized and no interest charges are included. The time period represents a "pay-back period" commonly used to evaluate investment opportunities. Salvage values of cows and brush control (if applicable) are not included as part of the pay-out period, but would represent gross returns to the operation at the time of "pay-back." A 20 + indicates greater than 20 years will be required to recover the investment.

[b] Herbicide treatments aerially applied at 0.5 lb/acre except 2,4,5-T (B) which indicates basal spray.

c Native mixture of adapted species.

Table 69. Total weaned calf production (lb/acre/year) from selected honey mesquite control alternatives on deep sites in the Central Basin, Texas, 1978.[a]

Treatment[b]		Canopy cover and initial carrying capacity (acres/AU/yr)	
Initial	Maintenance	Moderate (20)	Dense (22)
None (pretreatment)		16.6	15.0
2,4,5-T	2,4,5-T	21.1	22.0
2,4,5-T (B)	2,4,5-T (B)	23.2	23.4
2,4,5-T + dicamba	2,4,5-T + dicamba	23.2	22.0
Dicamba	Dicamba	23.2	22.0
2,4,5-T + picloram	2,4,5-T + picloram	22.2	22.4
Tree doze-seed[c]	Grub	25.0	25.5
Root plow-rake-seed[c]	Grub	31.8	31.8
Typical county		Llano	Llano

[a] A 20-year planning period was utilized to determine the average production responses.

[b] Herbicide treatments aerially applied at 0.5 lb/acre except 2,4,5-T (B) which indicates basal spray.

[c] Native mixture of adapted species.

Trans-Pecos

The Trans Pecos covers 18 million acres (Table 1) of mountain ranges interspersed with basins and plateaus in the western part of the State (Figure 1). Elevation ranges from 2,500 to 8,751 feet, and annual average rainfall is generally less than 12 inches. Annual frost-free period is 220 to 245 days.

About 88 percent of the Trans-Pecos is native range of which roughly 62 percent is infested with honey mesquite (Table 1). Most of the infestation is light canopy cover, scattered plants of honey mesquite occurring in association with other species. However, deep bottomland sites may support dense canopy covers of relatively large honey mesquite plants. Upland vegetation is dictated by altitude ranging from desert scrub to pinon and ponderosa pines (Pinus ponderosa Laws). The bottomlands are used extensively for grazing and support honey mesquite-desert scrub type vegetation. Soils vary widely from clays to sands depending on site. From 1973 through 1977, herbicides were applied to an average of 20,120 acres annually, and 23,015 acres were treated each year with mechanical methods (Hoffman 1978).

The Trans-Pecos is somewhat unique in that 75 percent of the cows in the region are located in herds of 200 cows or more. Given the average for the state is 37 percent of the cows being in herds of 200 cows or more, the region can be characterized by large ranches which represent 26 percent of the ranch firms in the region. For the state, there are but 7 percent of the ranch firms that have 200 cows or more (Table 3).

Economic responses to brush control in the Trans-Pecos, as with the Edwards Plateau, were extremely variable which reflects the large differences among range sites in production potential. On deep sites that support 1 animal unit per 60 to 80 acres prior to treatment, annual rates of return from aerial applications of 2,4,5-T averaged 6.4 percent (Table 70). On sites which initially supported 1 animal unit per 200 to 250 acres prior to treatment, aerial application of 2,4,5-T resulted in an average -0.45 percent annual rate of return. In comparison, aerial applications of dicamba to the more productive sites generated an average 2.5 percent annual rate of return, and a -3.6 percent rate of return when applied to the less productive sites. Economic evaluation of brush management practices for the Trans-Pecos was complicated in that the lowlands and drainageways support most of the grazing livestock but may represent a relatively small portion of the land area in any specific management unit. Since the amount of lowland sites varies among management units, it is not possible to evaluate the economic impact of treating only the bottomland sites. To estimate annual rates of return among alternatives discussed for the High Plains for cattle prices in the range, 34 to 54 cents per pound, the following adjustment factors are presented:

Alternative	Adjustment factor
2,4,5-T	0.48
2,4,5-T + dicamba	0.46
Dicamba	0.42
2,4,5-T + picloram	0.42
Tree doze	0.26
Tree doze-seed natives	0.21
Tree doze-roller chop-seed natives	0.20
Root plow-roller chop-seed natives	0.21

Treatment costs for aerial herbicide application in the Trans-Pecos were the same as for the High Plains (Table 5). Costs for mechanical

Table 70. Annual rates of return (%) from selected honey mesquite control alternatives based on cow-calf production and $44/cwt cattle prices (1978 dollars) over a 20-year planning period in the Trans-Pecos, Texas, 1978.[a]

Treatment[b]		Canopy cover by site and initial carrying capacity (acres/AU/yr)							
		Deep soils							Shallow soils
		Moderate				Dense			Mod-Dense
Initial	Maintenance	(60)	(70)	(100)	(200)	(80)	(150)	(250)	(65)
2,4,5-T	2,4,5-T	11.7	-3.3	9.8	-0.8	10.9	10.2	-0.1	-4.4
2,4,5-T + dicamba	2,4,5-T + dicamba	10.7	-4.3	8.7	-1.5	10.0	9.2	-1.0	-5.4
Dicamba	Dicamba	7.5	-7.0	5.9	-3.7	7.1	6.2	-3.4	-8.3
2,4,5-T + picloram	2,4,5-T + picloram	6.5	-3.5	4.7	-5.4	6.4	4.7	-4.6	--
Tree doze	2,4,5-T	7.5	--	5.0	-0.8	1.9	2.5	-2.8	--
Tree doze-seed[c]	2,4,5-T	--	--	--	--	2.2	1.9	-1.9	--
Tree doze-roller chop-seed[c]	2,4,5-T	--	--	--	--	--	--	--	0.7
Root plow-roller chop-seed[c]	2,4,5-T	--	--	--	--	2.9	1.9	--	--
Root plow-roller chop-seed[c]	Grub	--	2.0	--	--	--	--	--	--
Typical counties		Jeff Davis	Ector	Hudspeth	El Paso	Presidio	Loving	El Paso	Crane

[a] The rate of return considers all operating and investment capital in brush control and breeding livestock. Costs and returns were projected in constant 1978 dollars. Thus, annual rates of return do not include inflation impacts and are considered real rates of return. An estimate of market or nominal rates of return may be made by adding an assumed inflation rate to the real rates. This process assumes inflation will affect costs and returns equally.

[b] Herbicides aerially applied at 0.5 lb/acre.

[c] Native mixture of adapted species.

alternatives varied from 16 to 45 dollars per acre (Table 71). In four of the eight broad situations evaluated, cost reductions were required for aerial applications of 2,4,5-T to yield a 9 percent annual rate of return (Table 72). In two cases, the required cost reduction was greater than the initial treatment cost and subsequent treatments were required to be reduced. Although simple averages do not effectively relate treatment effectiveness on an absolute basis, they are useful for comparative purposes. Average initial cost reductions for aerial application of 2,4,5-T was 2.78 dollars per acre, 3.21 dollars per acre for 2,4,5-T + dicamba, 5.70 dollars per acre for dicamba and 6.89 dollars per acre for 2,4,5-T + picloram to yield a 9 percent annual rate of return on the investment in honey mesquite control on the Trans-Pecos.

In 16 of the 31 situations evaluated, aerial applications of herbicides resulted in a positive increased annual net cash flow (Table 73). Average increased annual net cash flow across all mesquite infestation/site situations was 45 cents per acre for aerial application of 2,4,5-T, 39 cents per acre for 2,4,5-T + dicamba, 19 cents per acre for dicamba and 23 cents for 2,4,5-T + picloram (used in seven of the eight situations). Because of high treatment costs (Table 71), mechanical alternatives resulted in low annual rates of return (Table 70), and yielded relatively small increases in annual net cash flow (Table 73).

Time to recover the initial investment ranged from 9 to more than 20 years from aerial applications of 2,4,5-T (Table 74). From 15 to more than 20 years were required to recover the initial investment in dicamba, and pay back period generally exceeded 20 years for the mechanical practices.

Annual weaned calf production before treatment, and averaged across

Table 71. Initial treatment costs ($/acre) of selected honey mesquite control alternatives in the Trans-Pecos, Texas, 1978.[a]

Treatment[b]		Canopy cover by site and initial carrying capacity (acres/AU/yr)							
		Deep soils							Shallow soils
		Moderate				Dense			Mod-Dense
Initial	Maintenance	(60)	(70)	(100)	(200)	(80)	(150)	(250)	(65)
Tree doze	2,4,5-T	16.00	--	16.00	16.00	20.00	20.00	20.00	--
Tree doze-seed[c]	2,4,5-T	--	--	--	--	28.00	30.00	28.00	--
Tree doze-roller chop-seed[c]	2,4,5-T	--	--	--	--	--	--	--	35.00
Root plow-roller chop-seed[c]	2,4,5-T	--	--	--	--	45.00	35.60	--	--
Root plow-roller chop-seed[c]	Grub	--	45.00	--	--	--	--	--	--
Typical counties		Jeff Davis	Ector	Hudspeth	El Paso	Presidio	Loving	El Paso	Crane

[a] Initial treatment costs do not include added breeding livestock investments.

[b] Herbicaides aerially applied at 0.5 lb/acre.

[c] Native mixture of adapted species.

Table 72. Initial cost reduction ($/acre) required for yielding a 9% annual rate of return on the investment in selected honey mesquite control alternatives and added breeding livestock based on cow-calf production and $44/cwt cattle prices (1978 dollars) over a 20-year planning period in the Trans-Pecos, Texas, 1978.[a]

Treatment[b]		Canopy cover by site and initial carrying capacity (acres/AU/yr)							
		Deep soils							Shallow soils
		Moderate				Dense			Mod-Dense
Initial	Maintenance	(60)	(70)	(100)	(200)	(80)	(150)	(250)	(65)
2,4,5-T	2,4,5-T	0	5.27	0	6.15	0	0	5.26	5.57
2,4,5-T + dicamba	2,4,5-T + dicamba	0	6.02	0.22	7.02	0	0	6.05	6.33
Dicamba	Dicamba	1.46	8.60	3.22	10.02	1.91	2.63	8.79	8.93
2,4,5-T + picloram	2,4,5-T + picloram	2.83	9.13	4.88	12.42	3.03	4.69	11.26	--
Tree doze	2,4,5-T	2.49	--	6.34	12.36	12.00	11.79	17.17	--
Tree doze-seed[c]	2,4,5-T	--	--	--	--	17.72	18.93	23.42	--
Tree doze-roller chop-seed[c]	2,4,5-T	--	--	--	--	--	--	--	24.00
Root plow-roller chop-seed[c]	2,4,5-T	--	--	--	--	25.37	22.55	--	--
Root plow-roller chop-seed[c]	Grub	--	27.94	--	--	--	--	--	--
Typical counties		Jeff Davis	Ector	Hudspeth	El Paso	Presidio	Loving	El Paso	Crane

[a] The net present value assumes a 9% interest charge for all added captial invested in brush control, increased breeding animals and operation expenses.

[b] Herbicides aerially applied at 0.5 lb/acre.

[c] Native mixture of adapted species.

Table 73. Increased annual net cash flow ($/acre) yielded by selected honey mesquite control alternatives based on cow-calf production and $44/cwt cattle prices (1978 dollars) over a 20-year planning period in the Trans-Pecos, Texas, 1978.[a]

Treatment[b]		Canopy cover by site and initial carrying capacity (acres/AU/yr)							
		Deep soils							Shallow soils
		Moderate				Dense			Mod-Dense
Initial	Maintenance	(60)	(70)	(100)	(200)	(80)	(150)	(250)	(65)
2,4,5-T	2,4,5-T	1.12	-0.15	0.94	-0.05	1.05	0.90	0	-0.19
2,4,5-T + dicamba	2,4,5-T + dicamba	1.06	-0.21	0.89	-0.11	0.99	0.84	-0.06	-0.25
Dicamba	Dicamba	0.84	-0.40	0.68	-0.31	0.79	0.64	-0.26	-0.45
2,4,5-T + picloram	2,4,5-T + picloram	0.83	-0.26	0.59	-0.51	0.83	0.57	-0.41	--
Tree doze	2,4,5-T	1.29	--	0.82	-0.09	0.36	0.47	-0.39	--
Tree doze-seed[c]	2,4,5-T	--	--	--	--	0.60	0.54	-0.39	--
Tree doze-roller chop-seed[c]	2,4,5-T	--	--	--	--	--	--	--	0.22
Root plow-roller chop-seed[c]	2,4,5-T	--	--	--	--	1.25	0.64	--	--
Root plow-roller chop-seed[c]	Grub	--	0.84	--	--	--	--	--	--
Typical counties		Jeff Davis	Ector	Hudspeth	El Paso	Presidio	Loving	El Paso	Crane

[a] The net cash flow is total added cash sales ($44/cwt) less costs of brush control, added breeding livestock and increased annual operating costs plus the salvage value of cows and brush control (if applicable) at the end of the 20-year planning horizon. Interest charges were not included and the timing of cash flows was not considered.

[b] Herbicides aerially applied at 0.5 lb/acre.

[c] Native mixture of adapted species.

Table 74. Years required to recover the initial investment in selected honey mesquite control alternatives and livestock based on cow-calf production and $44/cwt cattle prices (1978 dollars) in the Trans-Pecos, Texas, 1978.[a]

Treatment[b]		Canopy cover by site and initial carrying capacity (acres/AU/yr)							
		Deep soils							Shallow soils
		Moderate				Dense			Mod-Dense
Initial	Maintenance	(60)	(70)	(100)	(200)	(80)	(150)	(250)	(65)
2,4,5-T	2,4,5-T	9	20 +	13	20 +	11	11	20 +	20 +
2,4,5-T + dicamba	2,4,5-T + dicamba	13	20 +	14	20 +	11	15	20 +	20 +
Dicamba	Dicamba	15	20 +	16	20 +	17	17	20 +	20 +
2,4,5-T + picloram	2,4,5-T + picloram	17	20 +	19	20 +	19	20	20 +	--
Tree doze	2,4,5-T	15	--	16	20 +	20	19	20 +	--
Tree doze-seed[c]	2,4,5-T	--	--	--	--	20	20 +	20 +	--
Tree doze-roller chop-seed[c]	2,4,5-T	--	--	--	--	--	--	--	20 +
Root plow-roller chop-seed[c]	2,4,5-T	--	--	--	--	17	20 +	--	--
Root plow-roller chop-seed[c]	Grub	--	20 +	--	--	--	--	--	--
Typical counties		Jeff Davis	Ector	Hudspeth	El Paso	Presidio	Loving	El Paso	Crane

[a] A 20-year planning horizon was utilized and no interest charges are included. The time period represents a "pay-back period" commonly used to evaluate investment opportunities. Salvage values of cows and brush control (if applicable) are not included as part of the pay-out period, but would represent gross returns to the operation at the time of "pay-back." A 20 + indicates greater than 20 years will be required to recover the investment.

[b] Herbicides aerially applied at 0.5 lb/acre.

[c] Native mixture of adapted species.

all situations in the Trans Pecos, was 3.6 pounds per acre (Table 75). Aerial application of 2,4,5-T, 2,4,5-T + dicamba or dicamba increased annual average production to 7.6 pounds per acre. Mechanical treatments increased total production to 9.1 pounds per acre representing a 153 percent increase in productivity. However, it must be recognized that in any given situation, a relative smaller portion of the land supports the majority of the grazing animals on the Trans-Pecos. The lowlands with deep soils and a good probability for collecting runoff produce most of the range forage but may represent less than 20 percent of the land area. This analysis assumed overall treatment of the management unit, not just treatment of key sites.

Table 75. Total weaned calf production (lb/acre/yr) from selected honey mesquite control alternatives in the Trans-Pecos, Texas, 1978.[a]

Treatment[b]		Canopy cover by site and initial carrying capacity (acres/AU/yr) — Deep soils: Moderate				Deep soils: Dense			Shallow soils: Mod-Dense
Initial	Maintenance	(60)	(70)	(100)	(200)	(80)	(150)	(250)	(65)
None (pretreatment)		5.6	4.9	3.3	1.7	4.2	2.2	1.3	5.2
2,4,5-T	2,4,5-T	12.1	6.5	9.1	4.1	10.8	7.8	3.9	6.3
2,4,5-T + dicamba	2,4,5-T + dicamba	12.1	6.5	9.1	4.1	10.8	7.8	3.0	6.8
Dicamba	Dicamba	12.1	6.5	9.1	4.1	10.8	7.8	3.0	6.8
2,4,5-T + picloram	2,4,5-T + picloram	12.7	6.7	9.6	4.2	11.8	8.6	4.1	--
Tree doze	2,4,5-T	12.7	--	9.0	4.3	9.2	7.6	3.7	--
Tree doze-seed[c]	2,4,5-T	--	--	--	--	10.8	8.6	4.2	--
Tree doze-roller chop-seed[c]	2,4,5-T	--	--	--	--	--	--	--	10.9
Root plow-roller chop-seed[c]	2,4,5-T	--	--	--	--	14.8	8.9	--	--
Root plow-roller chop-seed[c]	Grub	--	13.7	--	--	--	--	--	--
Typical counties		Jeff Davis	Ector	Hudspeth	El Paso	Presidio	Loving	El Paso	Crane

[a] A 20-year planning period was utilized to determine the average production responses.

[b] Herbicides aerially applied at 0.5 lb/acre.

[c] Native mixture of adapted species.

DISCUSSION

These analyses are most applicable for evaluation of alternatives for improving honey mesquite-infested rangeland at the firm level and do not consider total industry supply impacts. They may be most useful when results from the selected alternatives are viewed on a comparative rather than an absolute basis in the decision-making processes.

The assessment of relative profitability among the alternatives considered each mesquite canopy cover/range site/major land resource area situation as an isolated entity. Thus, application of the results will require adjustment for the relative proportions within a management unit. Moreover, the approach for this study does not consider interaction of treated with untreated management units within the ranch firm. Ignoring potential economic synergisms among management units receiving different treatments may result in conservative estimates of profitability.

Because of differences in requirements of management at the firm level, no single economic criterion was felt to be the "best" for realistic comparisons among treatment alternatives. For example, use of annual rate of return as the indicator of economic efficiency at the firm level does not necessarily consider management investment criteria for increasing cash flow, amount of capital available for investment, limitations on payback period, and risk or uncertainty of the investment. Economic criteria must be matched with short and long term management goals for final judgment of acceptability of any alternative. Therefore, our analyses include several economic criteria for comparative evaluation of the treatment alternatives.

One of the uses of economic analyses is to evaluate the impact of constraining or eliminating use of any given practice. Presently, the potential for elimination of the herbicide 2,4,5-T serves as a good example. Since there are production response differences and differences in producer needs and objectives, it is not possible to identify and single "best treatment" at the ranch firm level. However, based on these analyses of alternatives identified in our survey, aerial application of 2,4,5-T was generally the most profitable treatment for improvement of rangeland infested with honey mesquite.

Utilizing the highest annual rate of return for aerial application of 2,4,5-T from each vegetation region, the estimated statewide average annual rate of return was 15.9 percent. Returns from application of the "next best" herbicide alternative, dicamba, averaged 11.4 percent. Thus, shifting to the "next best" economic alternative would result in a reduction of about 28 percent in the annual rate of return for herbicidal control of honey mesquite.

The highest annual rate of return for a specific resource situation involving the use of 2,4,5-T over the 20-year planning horizon was approximately 25 percent, although zero and negative rates of return occurred in a few instances. Generally the order, based on decreasing annual rates of return, of herbicides was 2,4,5-T >2,4,5-T + dicamba >dicamba, >2,4, 5-T + picloram. However, there were specific situations where 2,4,5-T + picloram, was more profitable than the use of dicamba. Because production responses to the herbicides were the same with the exception of 2,4,5-T + picloram which controls a broader spectrum of associated species than the other chemical alternatives, the ranking relative to economic efficiency followed treatment costs. Although aerial application of herbicides generated relatively high annual rates of return on the investment, resultant increases in annual net cash flow were generally not as high as when mechanical land conversions were applied to the more productive sites.

Mechanical methods were characterized by relatively high initial costs and lower annual rates of return than obtained from herbicides but generally generated greater increases in annual net cash flow than herbicide use. For example, selecting the "best" mechanical treatment (highest rate of return) from each resource region resulted in an average rate of return of 5.7 for mechanical treatments. When the establishment of tame pasture to kleingrass or coastal Bermudagrasswas selected an an alternative net cash flows were considerably higher than obtained from herbicides because of the intensive production requirements. Annual maintenance costs were less when native grasses were utilized for seeding projects; however, annual rates of return and increases in annual net cash flows from native seedings were usually lower than when tame pastures were established.

Because of relatively high initial treatment costs without concomitant production increases, mechanical practices such as tree dozing not followed by artificial seeding produced low annual rates of return and would not be considered as being economically feasible by ranch managers. The relatively low-cost mechanical method of chaining, used in a treatment sequence with aerial spraying, was competitive with spraying in most cases.

For the 44 dollar per hundredweight situation presented in this study, herbicides generally have the economic potential of generating acceptable rates of return (9 percent was selected as "acceptable" for this study) without initial treatment cost reductions. However, for the "better" mechanical treatments, initial costs would have to be reduced approximately

50 percent (or more in many specific cases) in order to yield a 9 percent annual rate of return. Thus, mechanical treatments may not be adopted by ranch managers in the future unless government "cost sharing" (or other means to reduce initial costs) are continued and perhaps increased due to the energy price impact on the projected cost of mechanical treatments.

Performance of the honey mesquite control alternatives varied among major land resource areas. However, the variation appears to be related to rather broad differences in rainfall and soils which allows logical combination of similar major land resource regions to simplify discussion. For example, the brush problem of northwest Texas (High Plains, Rolling Plains, Rolling Red Plains) is predominantly honey mesquite. This region supports almost 30 percent of the honey mesquite-infested acreage on Texas rangeland. Based on average response across all situations evaluated for the region, aerial application of 2,4,5-T for honey mesquite control generated an average annual return of 11.5 percent and averaged 9.3 percent for mesquite control with all aerially-applied herbicides (50 situations). Average annual net cash flow was increased by 0.82 dollar per acre. In comparison, mechanical conversion by root plowing honey mesquite-infested sites and seeding a mixture of native grasses in northwest Texas generated an average annual rate of return of 2.4 percent but increased average annual net cash flow by 1.20 dollars per acre. Moreover, the mechanical conversion was applied to only the more productive sites compared to the more extensive use of herbicides. Mechanical conversion of honey mesquite-dominated sites to tame pastures requires even more careful selection of sites and will require more intensive cultural inputs, especially of fertilizer, than conversion by seeding native forage species. However, establishment of kleingrass pastures on applicable sites using root plowing for brush control resulted in an average annual rate of return of 5.9 percent, and increased annual net cash flow by an average of 4.85 dollars per acre. This indicates that if mechanical treatments are to be utilized, ranch managers may need to consider complete conversion to tame pastures and intensify livestock use rather than simply improving native range.

Payback period for the investment in establishing kleingrass pasture ranged from 12 to 20 years compared to 15 to more than 20 years for root plowing and establishing native grasses, and 5 to more than 20 years for aerial spraying as averaged across results from all herbicides (payback ranged from 5 to 13 years for application of 2,4,5-T).

Based on these results, it appears that honey mesquite control with herbicides has greatest economic potential on an extensive basis in northwest Texas and on sites not capable of supporting tame pasture. An acceptable annual rate of return on the investment, assumed to be 9 percent for this study, is possible from treating most sites infested with honey mesquite. Since initial treatment costs are relatively low, a given acreage can be treated with a considerably smaller amount of investment capital, compared to costs of mechanical methods. This consideration could reduce risk to the ranch manager because he would have more cash and credit reserves by using herbicides than he would with mechanical alternatives. However, if the investment in herbicides and kleingrass establishment meets the managers minimum acceptable rate of return, it must be realized that about 6 acres of mesquite must be aerially sprayed to increase annual net cash flow to the firm that can be increased from establishing 1 acre to kleingrass. Therefore, establishment of tame pastures to adapted sites may allow significant increases in the net cash flow of the firm if the management is willing to accept a relatively low rate of return on the investment. More research is needed to optimize the proportion of acreage for treatment with aerial application of herbicide in relation to that which should be established to tame pasture.

Northcentral-central Texas (North Central Prairie, Cross Timbers, Grand Prairie Blackland Prairies and Texas Claypan) is an agriculturally productive area of the State on which honey mesquite control practices are relatively profitable ventures. For example, average rates of return over the 24 situations for aerial application of 2,4,5-T was 12.9 percent and averaged 8.5 percent across all herbicides (92 analyses). Root plowing and seeding native grasses resulted in an average annual rate of return of 3.8 percent, and root plowing followed by establishment of kleingrass pastures generated a 3.7 annual rate of return, based on 44 cents per pound beef prices, 1978 costs, and a 20-year planning horizon. Increased annual net cash flow was 1.56 dollars per acre from 2,4,5-T and averaged 1.39 dollars per acre from all herbicides, 1.64 dollars per acre from root plowing and seeding native grasses and 4.10 dollars per acre from establishment of kleingrass pastures. Thus, based on annual rates of return and potential for increasing net cash flow, use of herbicides for mesquite control appears to be a relatively profitable venture for ranch managers to consider in northcentral and central Texas. However, herbicide use is constrained, much more severely than in northwest Texas, by the proximity of susceptible crops to rangeland needing improvement. Therefore, complete land conversion to tame pasture may be justified.

Primary use of herbicides in South Texas is on the Rio Grande Plain rather than the Coast Prairie where it is constrained by susceptible crop production. Herbicides generated higher annual rates of return and slightly smaller increases in annual net cash flows than root plowing, and seeding to native grasses. For example, herbicide application for honey mesquite control increased annual net cash flows by an average of 1.99 dollars per acre compared to 2.12 dollars per acre for root plowing and seeding. This responsiveness is indicative of the production potential of native forage stands on the Rio Grande Plain.

In southcentral Texas, the Edwards Plateau and Central Basin, average annual rate of return from aerial applications of 2,4,5-T for honey mesquite control was 10.9 percent, and averaged 8.8 percent across all herbicide alternatives. Annual rates of return from aerial spraying exceeded that from mechanical practices. For example, on the average, root plowing, raking, and seeding to native grasses generated annual rates of return of about 2.8 percent when applied to deep soils. A 6.3 percent rate of return resulted from utilizing the same mechanical practices to establish kleingrass pastures. However, establishment of kleingrass pasture increased annual net cash flow by 6.20 dollars per acre compared to an average increase of 1.75 dollars per acre following aerial application of 2,4,5-T.

Annual rates of return in arid far west Texas from aerial application of 2,4,5-T for honey mesquite control, averaged 4.3 percent, and ranged from -4.4 to 11.7 percent. Although unweighted averages are being used for comparison, they indicate the need for treatment only on the most productive range sites with deeper soils that receive runoff water. Annual rate of return, averaged across all herbicides, was 2.4 percent. Root plowing, roller chopping and seeding adapted sites to native grasses generated a 2 percent rate of return. Often a relatively small proportion of any given management unit treated in the Trans Pecos produced most of the response to a treatment; however, the evaluation of these small, but highly productive sites was not feasible as a part of this study.

It should be emphasized that ranch firm managers should select brush management practices on criteria other than an annual rate of return. Given a minimum acceptable annual rate of return, minimal limitations on investment capital, an acceptable risk return level and a need for well-defined annual net cash flow, a producer could justify a practice with a lower percentage yield, but one that would allow a greater absolute value of net ranch returns over time. Thus, a producer might prefer a mechanical practice if it met his minimum level of return and yielded a higher net cash flow than a herbicide practice.

Another important question in selecting a brush management alternative relates to capital requirements. Dicamba is projected to require 36 percent more investment capital per acre than 2,4,5-T, assuming elimination of other herbicides would not result in a price increase in dicamba. These increases in capital investment, based on any given cattle market price framework, would cause corresponding increases in the time required to recover the investment in the treatment. This consideration is significant in that borrowing for brush management may present problems to Texas Ranch firms since the pay out period for any given practice may exceed the pay back period. Thus, cash flow problems could be anticipated if shifts to more expensive treatments were demanded, particularly for the small operators. In Texas, 93 percent of all ranch firms operate with fewer than 200 cows. Cash flow problems could be amplified for this group by elimination of the more profitable honey mesquite control practices. Larger operations can more easily shift cash flows to finance range improvements than can small operators who by necessity consume a larger portion of the cash flow.

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APPENDIX

Definition of Terms

1. Animal unit. Considered to be one mature (1000 lb.) cow with calf or the equivalent based upon average daily forage consumption of 26 lb/day of dry matter.
2. Animal-unit month (A.U.M.). The amount of feed or forage required by an animal unit for one month, i.e. one month's grazing for one animal unit.
3. Break-even analysis. A technique used to identify the minimum quantity of output that would be necessary for recovery of a given investment and its related operating cost.
4. Browse (n). That part of leaf and twig growth of shrubs, woody vines and trees available for animal consumption. (v) To consume browse, cf. graze woody plants.
5. Brush. A growth of shrubs or small trees usually undesirable for livestock or timber management but which may sometimes be of value for browse and/or for watershed protection.
6. Brush control. Reduction of brush to reduce its competition with more desirable species (for grazing) for space, moisture, light, and nutrients.
7. Brush management. Management and manipulation of brush stands to achieve specific management objectives, brush control is one brush management technique.
8. Brushland. An area covered primarily with brush.
9. Calf crop. The number of calves weaned from a given number of cows bred usually expressed in percent.
10. Canopy. The vertical projection downward of the aerial portion of shrubs and trees, usually expressed as percent of ground so occupied.

11. Capital budgeting. The addition of assets to a business.

12. Carrying capacity. The maximum stocking rate possible without inducing damage to vegetation or related resources. It may vary from year to year on the same area because of fluctuating forage production.

13. Class of animal. Age and/or sex group of a kind of animal. Example: cow, calf, yearling, ewe, fawn, etc.

14. Constant dollars. Dollars of constant purchasing power. The current market value divided by a price index provides an estimate of purchasing power for the base year of a given price index.

15. Credit. An individual's borrowing capacity. The ability to secure money, goods or services in the present against the promise to pay for them in the future.

16. Deferment. Delay or discontinuance of livestock grazing on an area for an adequate period of time to provide for plant reproduction, establishment of new plants, or restoration of vigor of existing plants. cf. deferred grazing.

17. Depreciation. The allocation over time of the cost of an asset which will be used up over a long period of time.

18. Discount rate. An interest rate used in the capital budgeting process that represents the maximum rate of return the investment could earn in its most favorable alternative use.

19. Economic efficiency. The relationship between cost of production and the combination of resources to produce a given level of output. Maximum economic efficiency occurs at the point of maximum production for a given level of expenditure.

20. Economic enterprise. A ranch business of sufficient resources to provide an accepted standard of living for a family.

21. Effective precipitation. That portion of total precipitation that becomes available for plant growth. It does not include precipitation lost to deep percolation below the root zone or to surface runoff or to evaporation.

22. Financial risk. The impact that the increased use of credit may have on the firms potential gain or loss of equity. As the level of borrowing increases, financial risk increases and unfavorable events have a greater impact on the business than do favorable events.

23. Fixed cost. Costs which continue over a specified time period regardless of what happens to the level of production.

24. Forage. All browse and herbaceous foods that are available to grazing animals.

25. Game. Wildlife species so designated by law and the harvest of which is regulated by law.

26. Grassland. Land on which grasses are the dominant plant cover.

27. Grazing distribution. Dispersion of livestock grazing within a management unit or area.

28. Grazing management. The manipulation of livestock grazing to accomplish a desired result.

29. Grazing management plan. A program of action designed to secure the best practicable use of the forage resources.

30. Grazing unit. An area of rangeland, public or private, which is grazed as an entity.

31. Internal rate of return. That rate of annual return which results in a zero net present value of a given investment over a given planning horizon.

32. Kind of animal. An animal species or species group such as sheep, cattle, goats, deer, horses, elk, antelope, etc.

33. Liquidity. Relates to the firm's capacity to generate sufficient cash to meet its financial commitments as they fall due.

34. Net cash flow. Total cash inflows less all cash outflows for a specific period of time. It represents a flow of cash that can be withdrawn by the owner or reinvested in the business.

35. Net present value. A technique utilized for evaluating the economic feasibility of a given investment. The technique relies on net cash flows and accounts for differences in the timing of the flows by use of an appropriate discount rate.

36. Overgrazing. Continued overuse creating a deteriorated range.

37. Overstocking. Placing a given number of animals on an area that will result in overuse if continued to the end of the planned grazing period.

38. Overuse. Utilizing an excessive amount of the current year's (vegetation) growth which, if continued, will result in overgrazing and range deterioration.

39. Partial budget. A technique to identify the net economic benefits arising from a given change in a business organization.

40. Pasture. A grazing area enclosed and separated from other areas by a fence.

41. Pasture, tame. Grazing lands, planted to primarily introduced or domesticated native forage species, that receive periodic renovation and/or cultural treatments such as tillage, fertilization, mowing, weed control, and irrigation.

42. Planning horizon. The length of time used for evaluating a given investment decision.

43. Proper grazing. The act of continuously obtaining proper use.

44. Proper stocking. Placing a number of animals on a given area that will result in proper use at the end of the planned grazing period. Continued proper stocking will lead to proper grazing.

45. Proper use. A degree and time of use of current year's growth which, if continued, will either maintain or improve the range condition consistent with conservation of other natural resources.

46. Range. Embraces rangelands and also many forestlands which support an understory or periodic cover of herbaceous or shrubby vegetation amenable to certain range management principles or practices.

47. Range condition. The current productivity of a range relative to what that range is naturally capable of producing.

48. Rangeland. Land on which the native vegetation (climax or natural potential) is predominantly grasses, grass-like plants, forbs or shrubs suitable for grazing or browsing use. Includes lands revegetated naturally or artificially to provide a forage cover that is managed like native vegetation. Rangelands include natural grasslands, savannahs, shrublands, most deserts, tundra, alpine communities, coastal marshes and wet meadows.

49. Range site. A distinctive kind of rangeland, which in the absence of adnormal disturbance and physical site deterioration, has potential to support a native plant community typified by an association of species different from that of other sites. This differentiation is based upon signficant differences in kind or proportion of species, or total productivity.

50. Risk-return preference. A managerial behavioral characteristic which is used to explain logical investment choices given a high return--high risk investment choice versus a lower return--lower risk choice.

51. Salvage value. Useful life of an investment which remains at the end of a given planning horizon.

52. Savannah. A grassland with scattered trees, whether as individuals or clumps; often a transitional type between true grassland and forest.

53. Sodgrass. Stoloniferous or rhizomatous grass which forms a sod or turf.

54. Stocking rate. The area of land which the operator has alloted to each animal-unit for the entire grazable period of the year.

55. Variable cost. A financial input requirement that changes with changes in production over a specified planning period.

56. Yearlong grazing. Continuous grazing for a calendar year.

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