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TECHNICAL NOTES

U.S. DEPARTMENT OF AGRICULTURE — SOIL CONSERVATION SERVICE

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ECONOMIC COMPARISONS OF RANGE AND FORESTRY

Throughout California there are many thousands of acres of brush-covered land. Much of this land could be used to produce grass for livestock or trees for wood products, if the brush were controlled and the land properly managed. The cost and probable returns from these two land uses will vary from place to place, depending on soil, climate, and other factors.

The attached paper, by Maurice L. Jernstedt, Agricultural Economist, was developed to compare alternate uses for a given site in the Sierra foothills near Jackson. At this location, forestry would be the most profitable use in the long run; however, pasture, while producing a smaller income each year, will return income almost immediately. Cost/benefit information of this kind will help landowners make proper decisions about land use. The techniques used in this comparison are described in "Economic Evaluation of Conservation," the Economic Section of the Farm and Ranch Planning Handbook.

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Attachment

ECONOMIC COMPARISONS OF RANGE AND FORESTRY

INTRODUCTION

Farm and ranch planners face a difficult decision when recommending land use for a "transition belt" in and around Jackson, California. The belt, approximately five to ten miles wide, can be used for either pasture or forestry uses. Ponderosa pine is better adapted to the higher elevation and rainfall areas, and grass is more adapted to the dryer, lower areas.

Historically, the climax vegetation in the Jackson area is thought to have been conifer forest. As early settlers and miners moved into this "Mother Lode" area, the timber stands were depleted by fire and indiscriminately cut to meet the construction needs for towns, mines, and for fuel.

Once climax timber was gone, natural reforestation was limited. This was due primarily to lack of adequate seed source, continuing abuse from overgrazing and burning, and to climatic conditions only moderately conducive to seedling survival. As a result, less desirable, yet more hardy, species of deciduous trees and brush moved in, thus representing a marked decline in the plant succession.

The Choice -- Trees or Grass?

The transition belt land consists essentially of privately-owned small holdings, limited portions of which have recently been subdivided for weekend cabin sites. Potential land uses for the bulk of the area, however, are range, forestry, wildlife, or just holding the property for speculative purposes. In this report, no attempt will be made to evaluate the latter two purposes, because: Cost and benefit figures for commercial wildlife programs are not readily available; and economic speculation on changes in property sale prices is not within the scope of the Soil Conservation Service.

Production from the area is tied directly to the physical characteristics of the site involved. The average rainfall in the belt is 30 inches or less, and elevations vary between 1,800 and 3,000 feet. Slopes on this land vary from 16% to 50%. The Soil Conservation Service designates these lands in soil capability classes V, VI and VII, all of which are suited

A specific site, class VIe9, within the transition zone, was selected by both forestry and range specialists as one representative of the area in question. The site has light to medium textured soils, averaging three to four feet deep. The present cover consists of fifteen to twenty foot liveoak trees, with an understory of chamise, chaparral and manzanita. The canopy cover varies between 80% and 100% coverage. At present, the land is used primarily for limited range, or left idle.

Evaluation Procedure Used

On the specific site described above, three evaluations are made. The first two analyses assume that the area will be converted to pasture land for use of cattle, and then for use by goats. Budgets were prepared for each enterprise, showing the expected net income for varying yields. The third analysis assumes the brush land to be converted to a managed stand of Ponderosa pine. The budget method was used, which recognizes the importance of interest and annuity tables. To facilitate comparison of the two evaluations, forestry costs and incomes were discounted to present value and then converted to an average annual equivalent rate.

Source of Information

The basic physical data were obtained from range and forestry specialists representing the Soil Conservation Service and the California State Division of Forestry. These men have years of practical experience in the Sierra foothill area. Part of the data is tied directly to actual work which has been accomplished in recent years, and part necessarily had to be assumed. This is especially true in the expected growth rates of the managed second growth stands of timber.

Comparable Management to be Used

Necessary to the validity of a realistic comparison of the two alternatives is the assumption of like levels of management for both enterprises. It is realistic that if an individual expends the necessary funds to clear and establish either grass or timber stands, he will protect that investment with the reasonably good management which is necessary in this area to break even or realize a profit.

Prices Paid and Received

The costs and returns for the budget analysis are based on the present conditions. This assumes that during and until the end of the analysis

period, prices paid and prices received will have the same relationship to each other that exists now. Additionally, it assumes that the expected income relationship between livestock and forestry products will remain constant. These assumptions are not necessarily valid, but are necessary to facilitate a comparison.

Use of Interest

An important factor in arriving at net incomes for either range or woodlands is the use made of interest. It is especially important in forestry, as interest charges on investments in woodlands must be carried at compound interest until the investments are paid by future income. The rate of interest to use for long-term investments of this type would be determined by the rate of interest that could be earned by similar long-term investments with equal risk. The forestry costs and income were computed on both 3% and 4% interest rates. A higher long-term interest rate will decrease net income, and in woodlands it may shorten the financial rotation.

Labor Income and Subsidies Not Considered

The budgets include a charge for labor, whether hired or performed by the individual or his family. As the work may be done primarily by the owner, he will have a labor income, as well as the net income or loss as shown. Additionally, any ACP payments received are not recognized. Even though the farmer may be partly reimbursed, the Government still bears the remaining cost. If a farmer were only concerned with his "out-of-pocket" costs, he could adjust his initial investments by the amount ACP will reimburse, and then follow the same procedure as illustrated in the budget.

Local mores will tend to influence a farmer's decision on alternatives for land use. As we have no way of evaluating this, we have disregarded the many social and economic influences, and have merely presented the picture that if a change were made, these would be the results. If the information is put in this light, then the individual can logically make his own decision, as influenced by individual conditions and experiences.

PASTURE LAND ANALYSIS

Within the transition land use zone between range and forestry located in the area around Jackson, Calif., a specific site classified as VIe9 was chosen for evaluation. In conversion to range, two types of operation are considered -- a complete pasture conversion for cattle production and a semi-brush and grass pasture conversion for goat production. The converted land is considered as only part of a total farm operation. It is assumed to necessitate little additional investment in the livestock enterprise, except possibly for investment in additional animals for utilization of the additional feed. For analysis purposes, a hundred-acre block is used as a basic unit.

There are several ways of clearing the land and developing it that could have been considered. Additionally, different forage mixtures and fertilizer practices could be utilized. As the purpose here was to compare forestry and range under given conditions, a single method had to be chosen. The conversion practices herein included are what are considered normal for the area, and in line with basic Soil Conservation Service recommendations and practices.

A necessary and logical assumption is that the range will receive a reasonably good level of management. The rancher who undertakes an expensive conversion normally can be expected to follow through and manage it properly. Management is necessary to maintain stand, composition of desirable forage species, and obtain good production throughout its life.

Brush conversion to perennial grass pasture requires a three to five-year program before the pasture can be considered on an annual basis. During the conversion period, both investments and returns will be realized and properly accounted for to arrive at the true cost of establishment. The cost of establishment, then, is amortized or paid for over the life of the conversion or the analysis period, whichever is the shorter. In this case, it will be the analysis period.

Steps in Brush Conversion

The first conversion step is crushing the existing stand of brush and liveoak. During the fall months, a D-7 with blade is used. This probably will be a custom job and require an hour per acre to knock the cover down. The crushed material is then allowed to dry until

the next fall, when it will be burned in place. This burning of the old cover will also kill many of the new sprouts.

Shortly after the burning, seed is aerially seeded into the ash bed. The following year, legumes are added to the stand. As no grazing is permitted until late the following year, necessary fences and water developments should be built, either before or during this year.

The second, third and fourth years, a brush chemical spray will be required in decreasing amounts. The first spraying should control 60% of the sprouts; the second, an additional 30%; and the third spraying would give 100% control. Actual extent of sprouting, and subsequent chemical controls, will vary greatly by site, timing of applications, and general weather conditions. At intervals of 4 or 5 years, a spot spraying will be necessary to control brush encroachment.

Production from the perennial grass pasture will be realized to a limited extent the second year, and essentially full production from the third year on. Income from the pasture during this period is used to offset some of the establishment costs incurred to date. Starting the fifth year, all costs and returns are computed on an annual basis. Remaining establishment costs will be amortized at 3% interest for the analysis period.

Included in annual costs of pasture production are stand establishment, taxes, fences, water development, fertilizer and fertilizer application. The per acre cost of water developments and fences includes interest on investment, depreciation and maintenance. A breakdown of how many of the costs were computed is included in an appendix section.

Returns from grass pasture utilization are based on pounds of beef per acre. This figure is obtained from pounds of usable forage, estimated to be 2,500, 3,000 and 3,500 pounds annually, divided by 800 pounds which is assumed to be an AUM. The value of an AUM of grazing is considered to equal 50 pounds of beef. The pounds of beef times the price per pound equals the gross return to pasture and to livestock.

Basic to the entire evaluation procedure, it is essential to a realistic pasture analysis that it be recognized that two complete and separate enterprises are encountered. One is a livestock or manufacturing process -- a harvest machine; the other, a pasture or production enterprise. While recognizing that there exists overlapping of the two, it is necessary to allocate to each a portion of the gross income directly realized from pasture utilization. In this manner, then, it becomes possible to obtain a reasonable estimate of the return to land without reflecting either efficiencies or inefficiencies of the livestock enterprise.

The exact proportion of gross production to be reflected to each enterprise is difficult to determine, except on an average area-wide basis. Analysis of 40 years of livestock production records, on range land in the southwest, would indicate that for good range, the division would be 50% to each enterprise; and as the range improves, the return to range would approach 70%. In this evaluation, the 50-50 division will be used as it is generally accepted by the SCS and other Federal agencies. Substantial acreages of range land have been rented in return for half the livestock gain.

In keeping with this premise, the gross return from the sale of beef is equally divided. The one-half that is gross return to pasture, then, will have the annual production costs subtracted, and the remainder will be net income or loss returned to the pasture.

The per acre net farm income or loss, as used in the entire evaluation is that return available to pay: (1) Management decisions, (2) interest on investment of land, (3) net or pure profit. The breakdown to each is almost entirely arbitrary, and up to an individual landowner. As a return to investment in land is usually computed as a per cent of the selling price, and the selling price is not always based on its value for agricultural production, this figure is misleading when included as part of production costs.

A listing of the development costs for brush conversion to perennial grass pasture will follow. Once the conversion is made, an annual budget is itemized and a net farm income graph illustrated.

Per Acre Costs and Returns From Improved Pasture (Cattle) - Transitional Zone, Class VIe9, Jackson, California Based on 1959 Costs and Prices

Cost of Establishment Year 1 - One fall through the next	Total Cost per Acre
1. Crushing . . . D-7 & blade, 1 hour per acre	$ 14.00
2. Burn in place	2.45
3. Aerial seed application	
a. 2 Flagmen	.10
b. Machine	1.00
4. Seed: Hardinggrass, 3# @ $1.00	3.00
5. Taxes: 1¢ 1/4 years	
Total First Year Costs	20.90

Cost of Establishment (Continued) Year 2	Total Cost per Acre
1. Spray sprouts	
a. Machine	$2.40
b. Brush killer @ $8.30 per gal.	8.30
c. Diesel oil @ .20 per gal.	.20
2. Aerial fertilizer application	
a. Machine	1.25
b. Flagman	.20
c. Fertilizer, 200# 16-20	8.70
3. Aerial seed application (machine)	1.10
a. Sub clover 2# @ .60	1.20
b. Rose clover 2# @ .45	.90
4. Taxes	.25
5. Water development	.20
6. Fences	.75
Total second year costs	$25.45

Note: Second year credits: 1,000# usable forage ÷ 800# (assumed AUM) equals 1.25 AUM's or 62# of beef x 20c/# = $12.40
$12.40 - Livestock costs (50%) = $6.20

Total second year costs	$25.45
Total second year income	6.20
Remaining second year costs	$19.25

Year 3	
1. Spray sprouts	
a. Machine	1.20
b. Brush killer	4.15
c. Diesel oil	.10
2. Aerial fertilizer application	
a. Machine	1.25
b. Flagman	.20
c. Fertilizer - 200# 16-20	8.70
3. Taxes	.25

Year 3 (Continued)	Total Cost per Acre
4. Water Development	$ .20
5. Fences	.75
Total third year costs	$16.80

Note: Third year credits: 3,000# usable forage -:- 800# equals 3.7 AUM x 50# = 185# x .20 = $37.00
$37.00 - Livestock costs = $18.50

Total third year costs	$ 16.80
Total third year income	18.50
Remaining third year income	$ 1.70

Year 4

1. Spray sprouts	
a. Machine	$ .60
b. Brush killer	2.10
c. Diesel oil	.10
2. Aerial application of fertilizer	
a. Machine	1.25
b. Flagman	.20
c. Fertilizer - 200# 16-20	8.70
3. Taxes	.25
4. Water development	.20
5. Fences	.75
Total fourth year costs	$14.15

Note: Fourth year credits: 3,000# usable forage -:- 800# equals 3.7 AUM x 50# = 185# beef x .20 = $37.00
$37.00 - Livestock costs = $18.50

Total fourth year costs	$ 14.15
Total fourth year income	18.50
Remaining fourth year income	$ 4.35

Summaries of Establishment Costs	Total Cost per Acre
Year 1 20.90 costs + 5% compound interest - 4 yrs. (1.21550) =	$25.40
Year 2 19.25 costs + 5% compound interest - 3 yrs. (1.15762) =	22.28
Total Costs	$47.68
Year 3 1.70 income + 5% compound interest - 2 yrs. (1.10250) =	1.87
Year 4 4.35 income + 5% compound interest - 1 yr. (1.05000) =	4.56
Total Income	$ 6.43

Costs $47.68 - Income $6.43 = $41.25 remaining establishment costs.

The cost of establishment is amortized over the 35 year evaluation period remaining, at 3% interest:

$41.25 x .04654 = $1.91 annually.

Annual Costs and Returns

Cost of Establishment	$ 1.91
Fertilizer Application	
a. Machine	1.25
b. Flagman	.20
c. Fertilizer -- 200# 16.20 @ 4.35	8.70
Spraying (every fourth year) $5.45 -:- 4 = $1.35	1.35
Taxes	.25
Water Development	.15
Fences	.75
Total Production Costs	$14.56

	Yield in # of Beef per Acre		
	155#	185#	215#
Beef at 20¢/lb.	$31.00	$37.00	$43.00
Return to Livestock (50%)	15.50	18.50	21.50
Gross Return to Pasture	15.50	18.50	21.50
Total Pasture Production Costs	14.55	14.55	14.55
Net per Acre Income to Pasture	$ .95	$ 3.95	$ 6.95

SEMI-BRUSH CONVERSION FOR GOAT RANGE

A second alternative in the utilization of pasture would be angora goat production. The salable product from the range in this case is both kids and pounds of mohair. In the Jackson Area goats are maintained on pasture all year, without supplemental feed. They utilize brush and grass at different seasons, and through good pasture management can remain in a thrifty condition at all times.

Brush conversion for use by goats involves a different procedure from that used in the beef analysis. The liveoak and brush are knocked down and then allowed to sprout so that they may be utilized as part of the goat diet. An annual grass is seeded during the initial year, and then gradually will be replaced by native grasses and forbs. Through proper management, the usable forage is expected to be maintained at 60% grass and forbs, and 40% brush. Goats can survive on a higher percentage of brush, but production falls off and mortality rises.

Pasture establishment is completed in one and one-half years in this analysis, and the establishment is amortized over the evaluation period. Annual costs include establishment, taxes, fences, and water development. Fencing for goats is more expensive than for cattle, as woven wire and shorter post spacings are necessary. A cross fence is also required.

Calculating returns for goat production becomes involved, as two products are sold. Three stocking rates were assumed: 40, 50, and 60 mature goats and their offspring, utilizing the hundred acres the year around. This would be .4, .5 and .6 goats per acre. Kidding percentage is assumed to be 85% or better, and the average fleece weight is six pounds per mature goat. The gross return to range and to the livestock was considered a 50-50 breakdown, just as in the beef analysis.

Per Acre Costs and Returns From Grass-Brush Pasture (Nanny-Kid Operation)
Transitional Zone, Class VIe9, Jackson, California
Based on 1959 Costs and Prices

Cost of Establishment	Total Cost per Acre
Crushing brush -- D-7, 1 hour (Custom)	$ 14.00
Burn brush in place	2.45
Seed grass: a. Machine	1.00
b. Flagman	.10
c. Ryegrass seed: 5# @ 15¢	.75
Taxes (1-1/2 years)	.40

Cost of Establishment (Continued)	Total Cost per Acre
Fences	$ 1.45
Water development	.20
Total Establishment Cost	$20.35

Note: $20.35 Cost of establishment x (.04654) amortized at 3% for 35 years remaining in evaluation period, equals .95 annually.

Annual Costs and Returns	
Cost of Establishment	.95
Taxes	.25
Fences	1.45
Water development	.20
Total Production Costs	$ 2.85

	Production per Acre		
Returns	.4 Goat	.5 Goat	.6 Goat
Mohair at .70/#	$1.70	$2.10	$ 2.50
Kids @ $7.00	2.40	2.95	3.50
Total Gross Returns	4.10	5.05	6.00
Livestock Returns	2.05	2.50	3.00
Pasture Returns	2.05	2.55	3.00
Total Production Costs	2.85	2.85	2.85
Net Loss or Income	- $ .80	- $ .30	+ $ .15

FORESTRY ANALYSIS

Conversion of liveoak-brush lands to commercial forests is a possible alternative land use in the transition zone. Land immediately above the zone in elevation and receiving slightly more rainfall is presently in forestry use. Commercial Ponderosa stands will be evaluated as the logical forest use. It is recognized that some of the land is adapted to and may be used for Christmas tree production. Timber on other lands may be cut as pulpwood or for posts. This analysis is based on what the normal use would be. The stand will be so managed that the first thinning will be saw-logs with a stumpage diameter of nearly twelve inches. This thinning will have a commercial value.

The one hundred acre block of land to be converted is assumed to be only a part of the total farm operation, and the conversion to either range or forestry will not require large additional investments for the farm operation other than for the actual conversion. Also, taking land out of unimproved brush will not require much of a cutback in the farm's total carrying capacity for livestock as, in its present condition, it has only limited forage value.

Probable Markets

In establishing a forestry enterprise, the probable future markets for timber products must be considered. Historically, California has had a saw log economy based on old growth timber. The old growth is being rapidly used up, however, and the logging and sawmill concept as it now exists should change markedly in the years ahead. For the Sierra foothill area, it is expected that small portable mills will develop and gyppo loggers will harvest most of the "woodlot" timber close to where it is grown.

Although stems of less than twelve-inch diameter may have commercial value in the future, we have based our management on the first cutting cycle of the twelve-inch size. We assume that, if more stems were planted per acre and then thinned and sold as posts or pulpwood, the additional costs would offset the additional income.

Another market-management decision is that only those trees which can produce five inches or more of clear wood at harvest will be pruned. The others will not be pruned, although the final choice may be delayed for another ten to twenty years. If the market exists at that time for less clear wood, the pruning should be adjusted accordingly, as long as it is a good investment.

Cutting Cycle and Length of Rotation

The length of the cutting cycle and stand life will affect the total and incremental income. One of the goals of good management of forest stands is to produce the maximum amount of saleable product within a given time period. In our evaluation, a five-year cutting cycle is used, and the thinning rate is based on the maxim of maintaining as fully stocked a stand as possible and

still retain pristine vigor. A shorter cutting cycle would produce a greater volume of wood, but is not considered practical from the average farmer's standpoint. This is because he is selling stumpage, and would have difficulty in selling only a few trees per acre when they are young. If he did his own logging, he might be able to shorten the cycle to his advantage.

The ultimate physical length of rotation is based on the maximum tree diameter size that smaller logging equipment and mills can easily handle. As previously stated, harvest facilities will have been adjusted to the smaller average stem size that will occur when old growth stands are exhausted. Handling logs larger than 30 inches would require special equipment, which would raise costs substantially unless sizable acreages of the large stems are involved. It is logical, then, to discount the stumpage price paid for larger trees to compensate for higher harvest costs. To avoid this situation, we have clear cut at a 30-inch D. B. H. or sooner.

Prices Received

Many final decisions in management of forest stands will be based on price relationships existing in future years. Throughout stand life from pulp to posts, to saw logs and veneer logs, prices for these products may influence the date of initial clear cut. The analysis is based upon present prices and expectations.

The average price for second growth Ponderosa pine stumpage for Amador County (in which the transition belt is located) is $12.50 per thousand board feet as of June 1959. For the entire pine region (14 counties), it averaged $13.96 per thousand board feet. This is for regrowth from unmanaged stands. Veneer stumpage on those stems having five inches or more of clear wood sell for roughly three times the price of knotty stumpage. For 16-26 inch trees, a conservative $30.00 per thousand board feet was used, and $37.50 for 28- and 30-inch stems. These prices, all forty or more years in the future, assume that clear wood will be at no more premium than now. Logically, however, as old growth stands are used up, it should become increasingly more valuable.

The timber is sold as stumpage for two reasons. First, the farmer does not have to invest in costly logging equipment and, secondly, it simplifies the analysis if costs of logging and hauling to a mill need not be computed. Some farmers may want to log their own land and perhaps some for their neighbors. If so, then the farmer is entitled to the labor and net income normally going to the professional logger. This will in no way affect returns from the timber stand itself.

Use of Interest

The economics of timber production differs from that of range or any other agricultural production only in the use of money and its interest which is earned or must be paid out. Forestry is a long-term venture, and its annual physical growth can be harvested only after it has accumulated for varying lengths of time in the future. Costs, however, commence with the initial land clearing and stand establishment, and occur both annually and at intervals throughout the stand life. Interest tables are used to account for what the invested money or earned income would "earn" or must be borrowed for, were it used for other purposes. The annuity tables are necessary to convert all

costs and expenses to a common time basis. The costs and income may be discounted to present worth and then amortized over the life of the timber stand to obtain an average annual equivalent income. The annual income then may be compared directly with range or other crops being harvested annually.

Steps in Brush Conversion to Forestry

Proper site preparation is important to obtain reasonable survival of pine seedlings in the transitional zone. The initial conversion step is crushing the existing stand of brush and liveoak. This is done in the fall with a D-7 and blade, and the debris piled into windrows. The windrows cover as much as 15-20 per cent of the ground area, but less than ten per cent of the canopy area is lost. This is due to the spacing of trees at planting.

The second conversion step is to plant the trees. On slopes up to 25-30 per cent, machine planting is done. For 30 to 50 per cent slopes, the area is hand planted. Survival is stated to be a serious problem in this area. A very conservative 50% survival rate is assumed for the initial and two subsequent replants. During many years, the seedling should have a much higher rate, and possibly only one replant would be required.

The seedlings are planted on a 12-foot spacing so that a fully stocked stand would contain 302 trees per acre. With poorer survival, death loss and the space lost because of windrows, our stand will contain only 237 trees at thirty years of age. No pre-commercial thinning will be necessary.

During the first years after stand establishment, the brush and oak will sprout. The Ponderosa pine, however, will grow faster and by twenty years its canopy will crowd out the brush and oak reproduction. At no time will the brush compete with the trees to the extent of influencing pristine vigor of the timber.

Pruning will be done when the trees are approximately 20 feet high, and again when they are 40 feet high. This is done to produce clear or unknotted wood and to reduce taper in the logs. The first pruning will be up to nine feet high, and the second up to eighteen feet. In neither instance will more than half the crown be removed. Only trees that will produce five or more inches of clear wood before harvest will be pruned. Selection of trees to prune is very important, as they will remain in the stand the longest. We have assumed the strongest, fastest growing trees are the ones selected to prune.

Summary of Establishment Expenditures

1.	Brush clearing - 2 hours with D-7 @ $14.00	$28.00
2.	Plant trees - 12' spacing - 10% area	
	a. Initial planting - 50% survival	
	1/3 hand plant - 90 trees @ .06	5.40
	2/3 machine plant - 182 trees @ .04	7.30
	Trees - 272 trees @ .015	4.10
	b. First replant - 50% survival	
	All hand plant - 136 trees @ .06	8.15
	Trees - 136 @ .015	2.05
	c. Second replant* - 50% survival	
	All hand plant - 69 trees @ .08	5.50
	Trees - 69 @ .015	1.05
3.	Pruning	
	a. Age 10 years - prune to 9 feet	
	135 trees @ .08	10.80
	b. Age 20 years - prune to 18 feet	
	135 trees @ .12	16.20
4.	Selection, Marking - Supervision	
	a. Year 10	$3.00 - Single event
	b. Years 30-45	1.50 per cycle
	c. Years 45-75	.75 per cycle
	d. Years 75-100	.50 per cycle
5.	Administration -- years 30-100 - .40 per cycle	
6.	Land tax -- years 1-100 - .25 per year	
7.	Timber tax -- years 40-100 - .105 per thousand board feet	
8.	Note: No fire prevention or other insurance is carried in this area.	

A regular five-year cutting cycle is established when the trees reach an average diameter of nearly twelve inches. At each thinning only enough stems are removed to make sure the stand does not grow into competition and slow its growth rate. To maintain a high rate of growth, the weaker and less desirable trees are always removed first. "Hi-grading" will not be done, as it would only slow the over-all growth rate, leave weaker trees that are more vulnerable to damage, and destroy an extremely high quality seed source. The last reason is important to the landowner because his forest site probably will be propagated naturally from seed of the last remaining timber.

*25% increase in labor due to inefficient plant spacing.

Table 1 CALCULATED THINNING SCHEDULE AND BOARD-FOOT VOLUME PRODUCTION PER ACRE OF MANAGED STANDS OF PONDEROSA PINE

SITE INDEX 120

100 PERCENT INCREASE IN DIAMETER-GROWTH RATE

Age class (years)	Average Diameter	Trees Removed	Trees remaining	Basal area remaining	No increase in height growth rate		
					Average* height	Volume removed	Volume remaining
30	10.2		237		57		4,740
35	11.9	29	208	160	63	1,450	10,400
40	13.6	39	169	171	70	4,290	18,590
45	15.1	29	140	174	75	4,640	22,400
50	16.6	20	120	180	80	3,600	21,600
55	17.9	16	104	182	85	3,840	24,960
60	19.2	13	91	183	90	4,810	33,670
65	20.6	11	80	185	94	4,070	29,600
70	22.0	9	71	187	98	4,860	3[illegible]340
75	23.3	7	64	189	102	4,620	40
80	24.6	7	57	188	106	5,180	4[illegible],180
85	25.9	5	52	190	110	4,500	46,800
90	27.2	5	47	189	113	5,300	49,820
95	28.5	4	43	190	116	4,680	50,310
100	29.8	3	40	194	120	4,020	53,600
105	31.0	3	37	194	124	4,020	49,580
110	32.2	2	35	198	127	3,260	57,050
115	33.4	3	32	194	130	5,430	57,920
120	34.6	32	0		133	57,920	
	Total board-foot volume produced					134,190	
	Board-foot volume of normal unmanaged stand at 120 years					68,200	

Trees are pruned to a height of 9 feet at age 20 years. They are pruned at age 30 years to 18 feet. Basal area of 210 square feet used as control in calculating thinning schedule and residual stand. Basal area was cut below 210 square feet every 5 years to provide sufficient growing space in residual stand so that it would not exceed 210 square feet by the time of the next thinning.

* Scribner log rule

Table 2 - Income from Managed Ponderosa Stands Accumulated at Regular Cutting Cycles and Brought Forward at 3% Interest and Clear-cut at Various Intervals

Price Received (Per 1000 B.F)	Age Class (Years)	Volume Merchantable Timber Removed (Board Feet)	Income Per Cutting Cycle (Dollars)	Income Compounded at 3% (Dollars)	Remaining Merchantable Timber (Board Feet)	Value of Remaining Timber (Dollars)	Total Income if Clear-cut (Dollars)	Income Discounted to Present Value (Dollars)	Average Annual Equivalent Income (Dollars)
12.50	35	1,450	18.12		10,400	130.00	148.12	52.63	2.44
12.50	40	4,290	53.62	74.62	18,590	232.37	306.99	94.11	4.07
12.50	45	4,640	58.00	144.50	22,400	280.00	424.50	112.25	4.57
30.00	50	3,600	108.00	275.51	21,600	648.00	923.51	210.66	8.18
30.00	55	3,840	115.20	434.59	24,960	748.80	1,183.39	232.85	8.69
30.00	60	4,810	144.30	648.10	33,670	1,010.10	1,658.20	281.44	10.16
30.00	65	4,070	122.10	873.42	29,600	888.00	1,761.42	257.88	9.06
30.00	70	4,860	145.80	1,158.32	38,340	1,150.00	2,308.32	291.54	10.01
30.00	75	4,620	138.60	1,481.40	42,240	1,267.00	2,748.40	299.43	10.08
30.00	80	5,180	155.40	1,872.74	42,180	1,265.40	3,138.14	294.92	9.76
30.00	85	4,500	135.00	2,306.01	46,800	1,404.00	3,710.01	300.77	9.82
37.50	90	5,300	198.75	2,872.03	49,820	1,868.25	4,740.28	331.48	10.69
37.50	95	4,680	175.50	3,504.95	50,310	1,886.62	5,391.57	325.21	10.38
37.50	100	57,620	2,160.75	6,223.93	--	--	6,223.93	323.83	10.24

Table 3 - Income from Managed Ponderosa Stands Accumulated at Regular Cutting Cycles and Brought Forward at 4% Interest and Clear-cut at Various Intervals

Price Received r 1000 B.F)	Age Class (Years)	Volume Merchantable Timber Removed (Board Feet)	Income Per Cutting Cycle (Dollars)	Income Compounded at 4% (Dollars)	Remaining Merchantable Timber (Board Feet)	Value of Remaining Timber (Dollars)	Total Income if Clear-cut (Dollars)	Income Discounted to Present Value (Dollars)	Average Annual Equivalent Income (Dollars)
12.50	35	1,450	18.12		10,400	130.00	148.12	37.53	2.01
12.50	40	4,290	53.62	75.66	18,590	232.37	308.03	64.15	3.27
12.50	45	4,640	58.00	150.05	22,400	280.00	430.05	73.62	3.55
30.00	50	3,600	108.00	290.55	21,600	648.00	938.55	132.06	6.14
30.00	55	3,840	115.20	468.69	24,960	748.80	1,217.49	140.81	6.36
30.00	60	4,810	144.30	714.53	33,670	1,010.10	1,724.63	163.94	7.24
30.00	65	4,070	122.10	991.43	29,600	888.00	1,879.43	146.83	6.37
30.00	70	4,860	145.80	1,352.02	38,340	1,150.00	2,502.02	160.67	6.86
30.00	75	4,620	138.60	1,783.53	42,240	1,267.00	3,050.53	161.00	6.79
30.00	80	5,180	155.40	2,325.33	42,180	1,265.40	3,590.73	155.76	6.51
30.00	85	4,500	135.00	2,964.11	46,800	1,404.00	4,368.11	155.76	6.46
37.50	90	5,300	198.75	3,805.03	49,820	1,868.25	5,673.28	166.28	6.85
37.50	95	4,680	175.50	4,804.88	50,310	1,886.62	6,691.50	161.19	6.60
37.50	100	57,620	2,160.75	8,006.60	--	--	8,006.60	158.19	6.46

Table 4 - Forest Production Costs Accumulated at 3% Interest by Age of Stand and Type of Investment. Also Shown are Accumulated Costs at Any Given Cutting Cycle. Based on Site 120 for Ponderosa.

	Costs of Production (3% interest)							Summary of
Age Class	Land Clearing	Stand Planting	Pruning	Selection Supervision	Administration	Land Tax	Timber Tax	All Costs Accumulated to Date
5	32.46	38.11				1.33		71.90
10	37.63	44.18	10.80	3.00		2.86		98.47
15	43.62	51.22	12.52	3.48		4.65		115.49
20	50.57	59.37	30.71	4.03		6.72		151.40
25	58.62	68.83	35.60	4.67		9.11		176.83
30	67.96	79.79	41.27	6.91	.40	11.89		208.22
35	78.79	92.50	47.84	9.51	2.12	15.12		245.88
40	91.34	107.24	55.46	12.52	4.58	18.85		289.99
45	105.28	124.32	64.30	16.01	7.44	23.18	12.74	353.27
50	122.75	144.12	74.54	19.31	10.75	28.20	48.59	448.26
55	142.30	167.07	86.41	23.13	14.58	34.02	72.36	539.87
60	164.96	193.68	100.18	27.56	19.03	40.76	105.31	651.48
65	191.24	224.53	116.13	32.70	24.18	48.58	140.83	778.19
70	221.70	260.29	134.63	38.66	30.16	57.65	187.31	930.40
75	257.01	301.75	156.07	45.56	37.09	68.16	243.24	1108.88
80	297.94	349.79	180.92	53.31	45.11	80.34	307.19	1314.60
85	345.39	405.50	209.73	62.30	54.42	94.46	384.86	1556.66
90	400.40	470.08	243.13	72.72	65.22	110.83	476.85	1839.23
95	464.17	544.94	281.85	84.80	77.73	129.81	583.41	2166.71
100	538.09	631.73	326.74	98.80	92.23	151.82	708.41	2547.82

Table 5 - Forest Production Costs Accumulated at 4% Interest by Age of Stand and Type of Investment. Also Shown are Accumulated Costs at Any Given Cutting Cycle. Based on Site 120 for Ponderosa.

	Costs of Production							Summary of
Age Class	Land Clearing	Stand Planting	Pruning	Selection Supervision	Administration	Land Tax	Timber Tax	All Costs Accumulated to Date
5	34.06	39.72				1.35	--	75.13
10	41.44	48.32	10.80	3.00	--	3.00	--	106.56
15	50.42	58.79	13.13	3.64	--	5.00	--	130.98
20	61.35	71.53	32.18	4.44	--	7.44	--	176.94
25	74.64	87.03	39.15	5.40	--	10.41	--	216.63
30	90.81	105.88	47.63	8.09	.40	14.02	--	266.43
35	110.49	128.82	57.95	11.34	2.16	18.41	--	329.17
40	134.42	156.73	70.51	15.29	4.80	23.75	--	405.50
45	163.55	190.69	85.78	20.10	8.00	30.25	13.02	511.39
50	198.98	232.01	104.37	25.20	11.91	38.16	31.22	641.85
55	242.09	282.27	126.98	31.40	16.65	47.78	52.31	799.48
60	294.54	343.43	154.49	38.95	22.43	68.49	80.02	1,002.35
65	358.36	417.83	187.96	48.13	29.46	73.74	119.24	1,234.72
70	436.00	508.36	228.69	59.30	38.01	91.07	164.22	1,525.65
75	530.46	618.50	278.24	72.89	48.41	112.15	224.37	1,885.02
80	645.38	752.48	338.50	89.18	61.06	137.81	299.63	2,324.04
85	785.20	915.50	411.83	109.00	76.46	169.02	391.48	2,858.49
90	955.31	1,113.38	501.05	133.11	95.19	206.99	505.47	3.510.50
95	1,162.77	1,354.59	609.60	162.44	117.98	253.19	646.34	4,306.91
100	1,414.68	1,648.06	741.66	198.13	145.71	309.40	817.64	5,276.28

All income and expenses which occur at intervals over the years are carried at compound interest. By carrying periodic income at interest, as well as costs, we are essentially saying that as it occurs, the income is used to pay some costs incurred to date, yet it is not necessary to say which ones, how much or when.

Conversion to Average Annual Net Income

Tables 1 through 5 show most of the basic calculations, and illustrate the evaluation methods used. Using the data thus developed, a forestry budget was prepared on an average annual equivalent basis, using a long-term interest rate of 3%.

Table 1 represents the physical production that is expected from a managed site of this type. It is a one hundred per cent increase over growth of an unmanaged stand. This appears somewhat conservative in the light of discussions with some foresters in the foothill area and a review of literature on responses to thinning by other species in Denmark. Thinning was done using maximum allowable basal areas in accordance with the findings of Krauter and Baker in SCS TP-132.

The second and third tables list the expected income from the volumes of merchantable timber established in table 1. Calculations were done on a rotation basis and also were completed as if the rotation ended at each cutting cycle. This was done to determine at what point it is most beneficial to clear-cut and start over.

Tables 4 and 5 show the accumulation of costs at interest to any given point in the rotation. Some costs started immediately; others accumulated at various amounts throughout the rotation, and some are an annuity of one throughout. The sum of all the costs, by cutting cycle, was brought back to present value and then amortized to show the difference in average annual equivalent costs of production by rotation lengths.

Maximizing Income by Rotation Length

Average Annual Equivalent Incomes and Expenses

	3%			4%		
Age	Production Costs	Income	Net	Production Costs	Income	Net
40	$3.84	$4.07	$ .23	$4.26	$3.27	-$ .99
50	3.97	8.18	4.21	4.20	6.14	1.94
60	3.99	10.16	6.17	4.20	7.24	3.04
70	4.03	10.01	5.98	4.18	6.86	2.68
80	4.09	9.76	5.67	4.21	6.51	2.30
90	4.12	10.69	6.57	4.24	6.85	2.61
100	4.19	10.38	6.19	4.26	6.46	2.20

Note: At 50 years, the price received is more, and again at 90 years; otherwise the tail end of both groups would continue to drop.

Rotation length is determined by many things other than the above data. The farmer should cut at the times needed to go into a sustained yield rotation of all age development if that best helps him meet his own needs.

The annual equivalent costs and returns were compared to determine at what length of life the annual net income would be maximized. For the 3% analysis the best paying rotation was 90 years; for the 4% evaluation a 60 year rotation gave the best annual income.

Per Acre Cost and Returns From Ponderosa Pine
Site Index 120, Transitional Zone, Jackson, California
Based on 1959 Costs and Prices

Average Annual Equivalent Costs	Total Cost per Acre
Land clearing	$ .90
Planting	1.06
Pruning	.54
Selection, Marking, Supervision	.16
Administration	.14
Land tax	.25
Timber tax	1.07
Total costs	$4.12

Per Acre Cost and Returns . . . (Continued)

	Total Cost per Acre
Average Annual Equivalent Gross Income (This income is based on a 90 year rotation)	$10.69
Average Annual Equivalent Net Income	$ 6.57

If a long-term interest rate of 4% was used, the rotation would be reduced to 60 years and the average annual equivalent gross income was $7.24 and the costs $4.20. The net income per year was $3.04, or less than half that realized with the 3% interest rate.

The forest budget was prepared to include all items that go into the production of timber except, of course, the return to the investment in land. This return was not computed in the range budget, either. Both range and forestry have hidden incomes to an individual farmer, however, in the form of labor income, tax write-offs and ACP payments. To illustrate the value of these in forestry, assume ACP pays for 80% of land clearing and tree planting, and that pruning, selection, marking, supervision and administration are all the farmer's own time. His cash expenses might be closer to .18 + .21 + .25 + 1.07, or $1.71. His net income (disregarding value of his labor) would be $10.69 - $1.71, or $8.98.

SUMMARY - FOREST OR RANGE?

Within California, many areas exist where land is physically suited to several land uses, but none in particular. Such an area is the transitional zone in Amador County, located in the Sierra foothills. Immediately above and below the zone, forestry and pasture respectively have an ecological advantage. Within the zone, neither has an apparent physical superiority as to growing conditions, and both do relatively well. Farm and ranch planners face a difficult decision as to which land use they should recommend in this and like areas.

This paper is written to establish, in a very general way, the economic impact of forestry or pasture under as nearly similar conditions as possible. The results should be considered as only part of what must always be considered in a long-range plan of any type. With this type of analysis as one more of a "kit of conservation tools," the farm planner and farmer can better plan to put each acre to its best use -- physically and economically.

A specific site, Class IVe9, was chosen as representative of the problem area. It is covered with liveoak and brush, has 16-50% slopes and fairly deep soils. The elevation ranges from 1800 to 3000 feet and the average rainfall is less than 30 inches.

To convert the area to pasture, it must be cleared, burned, seeded, fertilized and brush invasion periodically checked. If converted for cattle pasture, an estimated average annual yield of 3000 pounds of usable forage per acre is expected. This yield is limited somewhat by the steeper slopes and in some areas proper use will be a problem. If the land is converted for goat use, the average annual carrying capacity will vary from .5 to .6 goats per acre. One major problem here will be to maintain a proper balance of brush and grass over a long period of time.

Forestry is an alternative use for the transitional area. Its conversion entails crushing and windrowing existing cover, planting and replanting trees, pruning and thinning on 5-year cutting cycles. Total production is based on a 100% increase in growth over unmanaged stands, and thinning periodically to stay below the basal area density where growth is impeded. The length of rotation determines the total board feet of merchantable timber produced. Where the long-term interest rate is 3%, a 90-year rotation is the one maximizing annual equivalent net income and approximately 101,000 board feet were produced.

Based on the above estimated levels of production and a given price framework, the average annual net incomes were computed to be as follows:

Pasture: for cattle	$3.95 per year
for goats (.6 per acre)	.15 per year
Forestry (90 yr. rotation, 3% interest)	6.57 per year

Based on the framework of this evaluation, over the long pull, forestry will give a substantially higher per acre return in the transitional zone than pasture. This advantage would be further accentuated in later rotations where natural restocking of stands should take place.

The final answer to forestry versus pasture in this area is not simple, however. Even though forestry will make more money in the long run, pasture will produce income almost at once. This is extremely important to a man depending on this particular piece of land to supply his basic needs. Also, forestry takes a substantial investment today while the first initial return may be beyond his lifetime. Local mores must be considered, as well as existing assistance programs, and so forth.

In summary, physically the transitional zone will produce both pasture and forests; economically, both are justified, with forests having a substantial advantage in the long run. Socially, the choice must still be governed by conditions best fitting the farmer's needs and wants.

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November 2, 1959