Establishment of Christmas Trees: Risk Reduction in Simple Terms

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INTRODUCTION

New Mexico was not targeted for federally sponsored wind break tree planting projects following the "dust bowl" era. Essentially, the climate and soils of the extreme southern Great Plains region were considered too adverse to expect successful establishment. This meeting of tree growers is evidence enough that technical progress and farmer ingenuity have reduced the risks to acceptable levels. Technical innovations include dryland farming techniques, improved seedling stock types and selective herbicides. For southern New Mexico's coarse- textured, drought-prone soils the introduction of drip irrigation technology and eldarica pine were major advances.

Despite these advances, the risk of crop failure exists for each planting effort until transplant vital signs register a "non-critical" status. In this vein, one should consider the plantation in the "guarded" condition until trees are sold.

The purpose of this paper is to reduce what seem to be malicious and ill-defined "acts-of-nature" to risk factors that can be eliminated, or at least greatly minimized. The key is to address each factor with an appropriate level of management attention. "Appropriate" deserves emphasis because too much or too little attention can adversely affect profitability. Our approach will be to address six topics and to emphasize some key concepts associated with each. Discussions of specific treatments in a detailed manner are available elsewhere (see literature cited) and will be avoided to maintain concept emphasis.

Factor Interactions

There are six issues that greatly influence establishment success (Fig. 1). Also, each factor potentially influences all others. It is therefore important to view both direct and indirect influences of each factor to estimate the overall impact of management decisions. One example will be discussed to emphasize this point: Given a mountain-valley site that has previously grown alfalfa-brome pasture on a clay-loam soil underlain with river-deposited cobble, one will need to: (1) rip soil soil compaction zones, (2) plow out old alfalfa roots, (3) spray resprouted vegetation at least once or twice, and (4) modify the land surface, if necessary, to suit the irrigation method used. Species selection must take into account cold hardiness, water availability and growth rate needed to return financial investments in the time allowed. Crop protection methods and cost will be greatly affected by all the above.

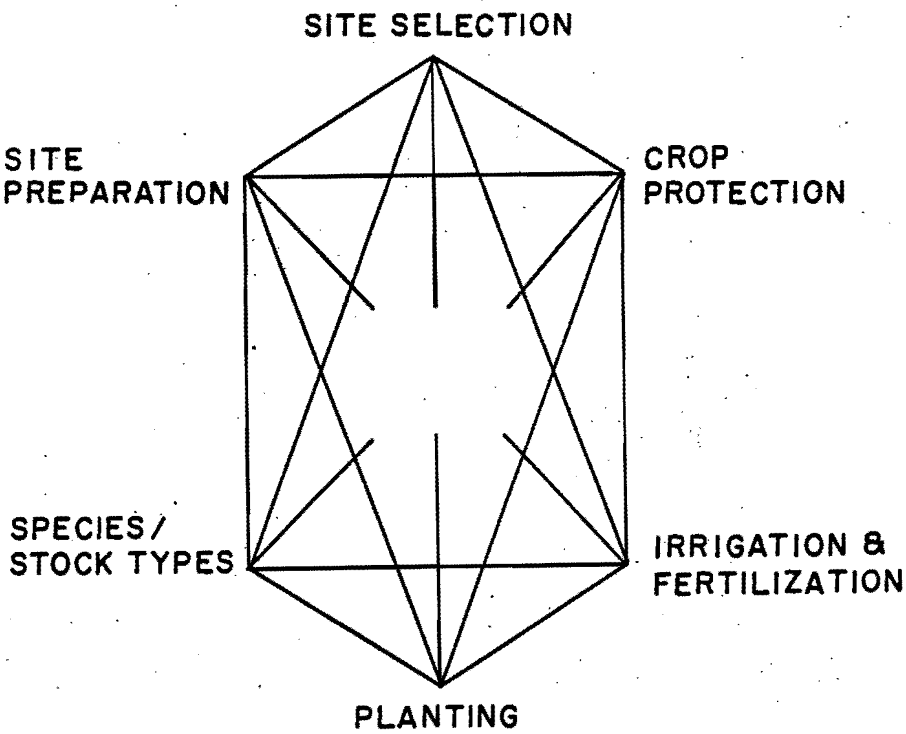


Figure 1. Interactions important in Christmas tree plantation establishment.

Site Selection

Site quality is defined as capacity to grow crops. It determines land cost which is a major consideration if capital investment is required. Fig. 2 underscores a simple relationship in terms of economic risk. Land can be so physically poor that risk is high, or in such demand for other high-value crops that unnecessary risk is created by land cost. In either case, economic risk is high. More desirable would be land that is good for tree growth, but unsuited to more site -demanding conventional crops.

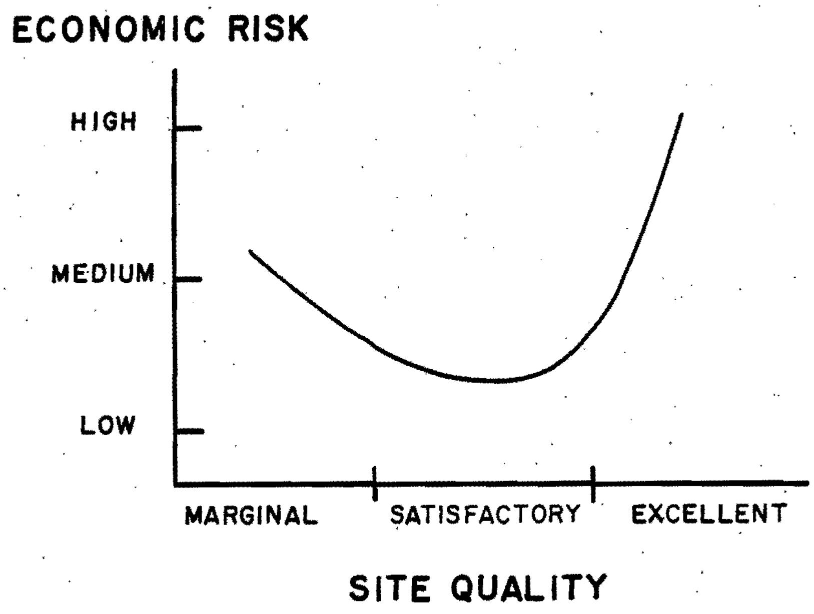


Figure 2. Economic risk of Christmas tree establishment as a function of site quality.

In estimating allowable costs, one must recognize that trees with superior growth potential can require more years to reach marketable size (i.e., 5 to 7 ft.) on sites with problems posed by soil physical condition or environmental stress (Fig. 3). A simple but useful principle is that poor soil nutrition can be overcome rather easily, but poor soil physical condition often is unalterable in practical terms.

A further consideration in selecting a site is product diversity. Within limits, the production of several species as opposed to one can reduce risks associated with commodity supply and demand imbalances. Therefore, the number of tree species that can be grown on a site should be considered.

Site elevation is a major factor in determining potential species diversity because air temperature drops as elevation increases, and species differ in cold tolerance. The number of conifer species that potentially can be grown commercially increases as elevation increases from 4000 ft. to 7500 ft. and then decreases sharply. The relationship shown in Fig. 4 will change somewhat as latitudinal distance from the equator increases. Represented in Fig. 4 are species presently considered among the best for developing plantations in the state. As the Christmans tree industry grows, numerous additional species will prove worthy of culture (see Fisher and Fancher, 1986). Fig. 4 indicates that land from 6000 to 7000 ft. maximizes opportunity for producing diverse crops.

Site Preparation

We have to give the same level of attention to site preparation as corn farmers, and even more if erosion poses a serious threat. Too often site prep receives inadequate planning and attention, resulting in unnecessary cost, poor growth and poor survival.

Effective site preparation positively alters the site for planting. Depending on conditions it can: (1) remove competing vegetation or debris ; (2) level land to improve irrigation efficiency; (3) fracture plow pans; and (4) prepare the soil for planting by breaking soil aggregates (a benefit especially needed for machine planting).

Fundamentally, good site preparation will interact synergistically with efforts made to improve the other factors shown in Figure 1. This means that one dollar invested in site prep combined with one dollar spent for fertilizer can result in an overall positive effect worth three dollars. This synergism has been shown repeatedly in establishment trials and can be observed as improved growth, or survival, or both. For example, when site prep, fertilization and irrigation treatments are applied in all possible combinations, plantation test plots receiving all three treatments generally will show the best survival and growth. In fact, fertilization in the absence of good site prep or adequate water can result in less growth (see Fisher and Mexal, 1984).

An additional site prep measure is to establish a cover crop before planting and to kill planting strips with herbicides. Areas planted in a carefully selected cover crop will support fewer problem weeds and will require less maintenance than "wild" areas. Cover crops offer obvious

Figure 3. Effect of site quality as years to marketable height of Christmas trees.

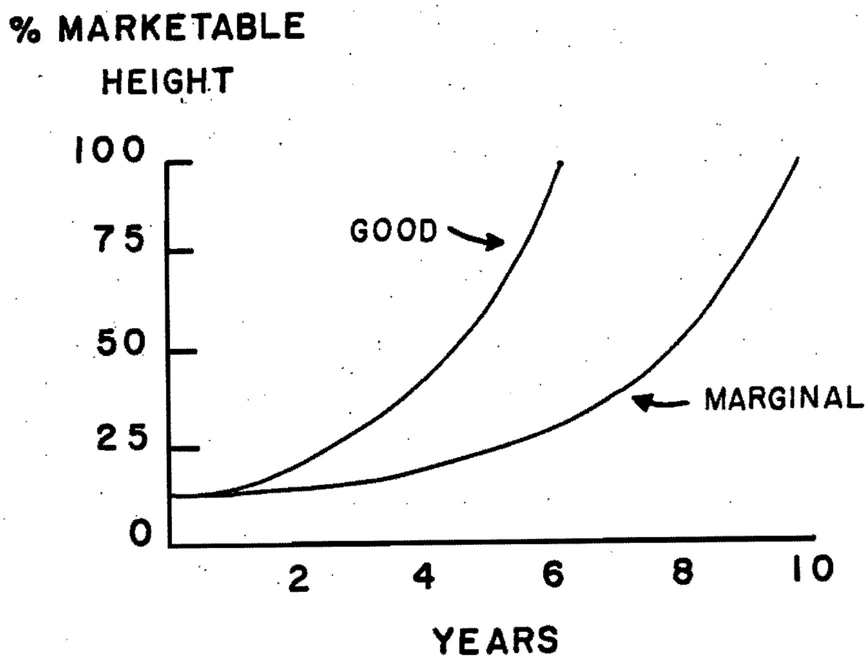
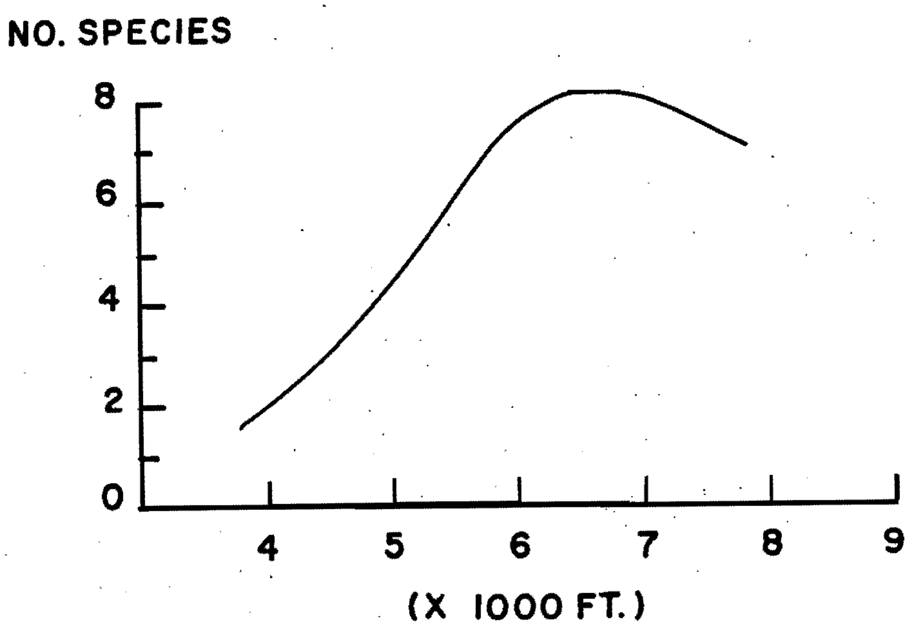


Figure 4. The number of Christmas tree species that can be grown at different elevations in New Mexico.



advantages on sites threatened by soil erosion. They also can retard loss of pesticides and fertilizers to streams, ponds and groundwater. Several criteria are used to select cover crop species (Table 1).

Table 1. Desirable attributes of cover crops

1. establishes readily
2. outcompetes noxious weeds
3. slow vertical and lateral growth
4. maintains low growth habit
5. tolerant of drought and poor soils
6. requires infrequent fertilization
7. withstands traffic
8. unpalatable to rodents
9. will not limit tree growth

Species and Planting Stock Types

Christmas tree species for New Mexico have been discussed extensively, including site requirements, growth rates and attributes (Fisher and Fancher, 1986). A primary concept is that all species are not created equal in their ability to capture the benefits of intensive culture and long growing season. Similarly, species differ in their abilities to deal with specific stresses.

Generally, the aim of species introduction trials or seed source (provenance) trials is to eliminate genotypes unable to survive stress. Another aim is to select for improved growth resulting from differences among genotypes in shoot growth pattern. Attributes conferring faster growth include: (1) the production of multiple flushes of (recurrent shoots), and (2) the ability to accumulate vegetative primordia in developing buds late in summer or early autumn months. In the latter case, the additional cell divisions will result in greater growth after buds break in the spring. Either case is less conservative than the pattern found in tree species that produce only one segment of terminal branch growth each year. Because shoot extension and bud development are terminated long before winter arrives, this latter case does not maximally utilize the days with favorable temperature. Also of practical importance is that species capable of producing recurrent shoots will be more responsive to optimal fertilization and irrigation treatments sustained throughout the growing season.

The selection of seedling stock types is a rather simple matter at present because of the limited number of types produced in the state. Especially for the beginner, container seedlings have many advantages. Container stock : (1) can be planted during many months of the year in mountain valleys, thus enabling the grower to take advantage of monsoon rains; (2) do not require refrigeration; and (3) are generally more uniform in size than bare root stock.

This is not to discourage future consideration of bare root types. As high-quality stock becomes available, their reduced costs will surely be attractive for the better sites. Good quality bare root types have performed as well as container stock on well-prepared sites with adequate moisture. On marginal sites, containers have a clear advantage.

A variety of large bare root types can be purchased from nurserymen in states such as Michigan. Most promising, perhaps, are heavy transplants of species that are otherwise slow to become established. True firs (*Abies* sp.), for example are typically slow to enter the rapid, juvenile growth phase and their growth can be severely checked by competing vegetation. The use of heavy transplants of balsam fir has greatly reduced the time needed to grow Christmas trees in the Northeast. The actual age of a transplant will be indicated by its hyphenated numbers. For example, a 2-3 balsam fir seedling has spent 2 years in the seedling bed and 3 years in a transplant bed providing each seedling more space. Because seedlings are undercut before being lifted from the seedling bed, new root initiation is encouraged and heavy transplants can arrive with a massive root system. In a semi-arid environment, additional roots should be beneficial. Seedlings with too much shoot should be avoided.

Bare root seedling size clearly influences transplant survival and growth. A general rule here is that the size of choice is the biggest seedling that can be successfully established. Large seedlings confer an advantage under optimal conditions because the juvenile phase can be entered more quicky. However, the same seedling can survive poorly when exposed to moisture stress. Under optimal and suboptimal conditions, seedlings must be large enough to compete with invasive weeds but this problem will be more acute on the better sites.

Planting

Tree planting procedures have been adequately discussed in a previous publication (Fancher et al., 1987). To that we would add that proper site preparation will make any planting job less difficult, and generally must precede machine planting. The good news is that planting is one of those chores that machines actually do better and than humans. Of course, some fundamental guidelines must be followed. Machine planting will also reduce planting cost per seedling if the job is large enough.

The time of planting is an important consideration and should simultaneously optimize three factors: (1) exposure to extreme temperatures, (2) seedling hardiness, and (3) soil temperature and moisture condition. In mountain valleys, one wants to avoid planting too close to the time that ground temperature are not conducive to transplant root elongation. Some root growth is necessary to anchor in the seedling to avoid seedling displacement caused by soil freezing and thawing. In southern lowlands, seedlings can be planted throughout the year, but the "windows of least risk" can provide moderate temperatures and opportunities for root growth to preceed shoot growth before heat becomes a serious factor. For example, we commonly plant eldarica pine in October to exploit conditions that favor root growth and descriminate against warm-season weeds. Why not grow trees when weeds are dormant? One additional suggestion is to irrigate trees soon after planting, even if moiisture seems adequate. This provides intimate soil and plant root contact.

Irrigation and Fertilization

The role of nutrition in tree establishment has been examined in recent years (Fisher and Mexal, 1984). As a rule, one should optimize nutrient and irrigation levels to avoid antagonisms and unnecesary costs. Also it is important to recognize that tree response to nutrient or moisture stress varies in a seasonal manner and is species dependent.

Understandably, growers are frustrated when they are unable to find fertilization recommendations that meet their specific needs. We suggest they begin by consulting their local orchard growers. Treatments routinely applied to broadleaf fruit or nut crops are tailored to perenniating plants whose roots explore large volumes of soil over time. Christmas trees are similar to fruit trees in that they have similar opportunities. Also, both deciduous and conifer trees have mechanisms for accumulating and storing nutrients over time and for reallocating them to tree parts where they are most needed. Fertilization treatments applied to most agronomic crops reflect the need to provide nutrients in large amounts to rapidly growing plants that are closely spaced.

Another relationship of potential value is that trees will be most responsive to nitrogen (N) fertilization.

Fertilizer selections should recognize this relationship. There is no need to purchase and bear the expense of applying elements that are adequately available in the soil.

Plants are highly responsive to N for two rather simple reasons: (1) N is a primary constituent of plant cells and principal metabolic compounds , and (2) N is highly soluable in soil systems and therefore disappears rapidly after fertilization. Generally, other macro-nutrients such as phosphorus (P) and potassium (K) elict comparatively smaller postivite growth responses. However, there are exceptions to any generality. For example, P can be present in the soil but unavailable to the plant. In such cases, fertilization will be needed to restore a more favorable N:P balanace. Without available P, additional N can further depress growth.

Beyond these statements, we strongly suggest that growers seek assistance from government and university personnel that are trained to assist the development of long range fertilization programs. Many New Mexico growers have markedly improved tree quality by combining this approach with their good judgement.

Irrigation and fertilization practices should be designed to capture synergistic effects and, conversely, to avoid antagonisms. It has been shown repeatedly that fertilization in the absence of sufficient moisture can add stress that kills plants. A more positive approach is to manage these factors jointly to gain maximum benefits. In this vein, several growers in southern New Mexico have developed irrigation systems that deliver fertilizers precisely and routinely. This approach assures that nutrient levels do not fall too low, and directs the water and dissolved nutrients to crop plants rather than weeds. Another step toward improving farm irrigation practice is to laser level the land. This will improve the distribution of both water and nutrients. When performing a cost-and-benefit analysis, one should carefully consider the labor and land quality preserved by these treatments.

Crop Protection

The absence of effective crop protection is probably the most common cause of planting failure when viable planting stock (i.e. seedling quality) clearly is not an issue. In simple terms, animal depredation and weed problems are more acute in semi-arid and arid zones than in wetter regions. Because water is scarce, the impact of competition is noticeably more severe inthe Southwest than in the Northeast, for example. Animal pressure can be severe in semi-arid regions because of the lack of plentiful vegetation.

To understand weed competition, one must recognize two principles: (1) plants are resource limited, and therefore (2) the capacity of a unit of land to produce crops is determined by its inherit resources, barring man's drastic intervention. Because plants are immoble, they must have growing space to receive adequate sunlight. With sufficient sunlight, moisture and nutrients, plants can maintain the foliage needed to trap carbon dioxode (CO_2) and to produce adequate amounts of plant sugars to survive and grow.

Competition essentially reduces the growth that species A will attain in the absence of species B and vice versa. Again, the amount of growing space is fixed and the total amount of vegetation that can be supported is finitely limited. Of course, other factors can become limiting before all space is occupied and this is the situation one finds in the arid Southwest.

It follows that survival and growth of conifer seedlings depends on the availability of resources, and more specifically the availabilty of soil moisture. Taking this point further, any moisture used by competing vegetation is that much less available for conifer seedling survival and growth. In irrigated plantations, space and nutrients can be limiting factors. Competition among trees grown too close together can result in poor tree quality.

Removal of competition will allow plant A the room it needs but will also reduce other risks. The area becomes less inviting to animals and plant A is not exposed to toxic substances produced by plant B (i.e. allelopathy).

A key issue is: How much bare ground does a young pine seedling need to maintain maximum growth? The answer to this question should affect our efforts to eradicate weeds, as well as the manner in which we manage cover crops. A simple rule is to provide as much bare ground as possible within a 3 to 4 ft. radius of the tree (McDonald, 1986), without inviting soil erosion. This can be a difficult decision that may require consultation with soil conservationists. In any case, the site should be thoroughly prepared initially to give young trees a "fighting" chance. Competition can slow the growth of established trees but this risk is less threatening.

Too often weed control is begun too late or is not sustained as a planned activity. Consequently, it too often requires additional costs and reduces profitability. Furthermore, treatments often are applied after irreversible damage has occurred. Clearly, weed control should be planned before the first seedling is planted. This put into place a weed prevention program and reduces the need for "fire-fighting" approaches.

Weed control actually begins, of course, with site preparation and can include cover crop establishment, as discussed. Herbicides should be combined with mechanical weed clearing treatments to thoroughly remove rank vegetation. Herbicides can be used to "brown up" weeds before plowing and disking, and again to remove resprouts. This can be an expensive process that can require a few months to complete. However, our view is that it generally is better to postpone planting than to attempt weed control shortcuts. As the adage goes, "plan the work and work the plan". The reason forcing a compromise on to destroy vegetative resprouts.

Animals can decimate a new plantation of seedlings within a week, or be a source of continual aggravation by killing 20 to 30 percent of the seedlings each year. The risks posed by animals varies over time various groups over time (Fig. 5). indicates the level of risk posed by each of the major animal groups as trees grow over time. A simple relationship is that trees either outgrow the risk of predation as their growing points (stem apices) escape vertically, or become increasing able to tolerate predation as more biomass accumulates.

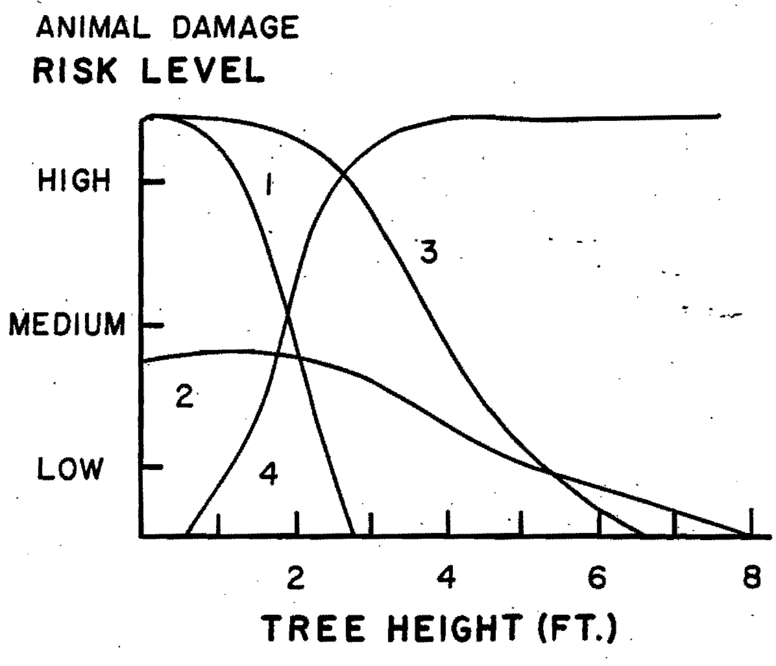


Figure 5. The effect of Christmas tree height on the relative susceptibility to damage from rabbits (1), pocket gophers (2), large mammals (3), and foliage insects (4).

The risk posed by rabbits is initially high but diminishes sharply as apices escape their reach. Large animals and rabbits pose similar risks initially, but cattle and deer can and will frequently damage trees less than 4 ft. Larger trees are damaged less frequently but snow can force livestock and deer to feed on exposed branches. Pocket gophers damage rapidly and therefore pose less total risk initially. However, they can kill most trees in a plantation over a period of years and will remain a low to modest threat until harvest. Various insects can attack Christmas trees and the risk varies among groups. Tip moth risk is initially low because small trees are less visible, but rises precipitiously as trees reach a critical target size.

SUMMARY

Christmas trees can be successfully established in New Mexico if steps are planned and taken to eliminate or minimize avoidable risks. We firmly believe that faithful adoption of some rather simple crop management principles will greatly improve the odds in favor of the grower, as many growers have demonstrated.

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