RESEARCH NEEDS IN SOUTHERN GREAT PLAINS FORESTRY

James T. Fisher
Associate Professor of Forest Ecology
Department of Horticulture
College of Agriculture and Home Economics
Box 3530, New Mexico State University
Las Cruces, New Mexico 88003

Within the Southern Great Plains soil, water, natural gas, and oil are being mined through intensive farming and pumping. Declines in agricultural productivity and economic stability are projected to follow withdrawal of all but the first resources (Hughes and Harman 1969, Guam 1970). The loss of soil productivity is difficult to measure and predict because fertilization and irrigation hide fertility and structural losses to erosion.

The forester has very little control over the broad directions of agriculture and virtually no control over oil and gas depletion. But he can contribute to ecological stability and land value through estalbishment and improvement of shelterbelts, woodlands and game habitats.

Research enables the forester to maximize opportunities for service and the benefits society can derive from trees. Research needs, are, in fact, the information needs of the people served by the forester and his profession: In a particular region such as the Southern Great Plains specific needs are closely linked to the present and potential role of forestry in land use economics and conservation.

In my opinion, the role of forestry in the Southern Plains is to: (1) protect soil and crops from wind and drought, (2) improve the environment of man and domesticated animals, (3) revegetate, protect and improve for man and wildlife the natural woodlands generally scattered and confined

to riparian zones, deep canyon escarpments (e.g. Palo Duro Canyon) and draws, and (4) produce short rotation woody crops for wood products and Christmas trees that can justify supplemental irrigation.

Protection of the soil is critical in the Southern Plains due to the tremendous potential for drought and wind erosion. The need for soil and crop protection has been reduced somewhat due to irrigation, genetically improved crops, and conservation farming (e.g., stubble mulching and strip cropping). However, no crops are produced on dryland farms during extreme drought and "blowouts" can still occur. In addition trees can conserve crop moisture and improve infiltration of precipitation, especially needed in the High Plains.

Farmsteads and livestock retaining areas are highly dependent on protective planting for temperature moderation and energy savings. Home woodlots can also provide fuel and fireplace wood that may otherwise be transplanted from distant forests. The citizens of New Mexico, for example, too frequently spend more energy transporting wood from national forests than is released from the home fireplace (Gray and Bray 1980).

Industrialization and growth of large metropolitan centers (such as Amarillo) have greatly increased the need for water impoundment in man-made lakes. All of the large lakes of New Mexico are man made and provide irrigation and flood control as well as potable water and recreation. Recreational opportunities of these otherwise barren structures are not fully realized without trees.

Population growth has increased pressures on wildlife habitat as well as the potential for development of both hunting and non-consumptive recreation uses. Some species in these regions are seriously close to extinction and their survival in many cases is unquestionably linked to habitat. The lesser prairie chicken, (Tympanuchus pallidicinctus), for example, depends on a balance of Shinnery Oak and tall bluestem for year round cover and feed. The Southern Plains forester therefore plays an active role in wildlife preservation. His part in the growth of a renewable recreational resource, hunting, may include providing more cover for the growth of exotic as well as native wildlife numbers. Exotics such as ibex (Capra sibericus) ad oryx (Oryx gazella) are recent introductions to the Southwest and cover is essential to the management program. Ibex transplanted to the Canadian River canyons of northern New Mexico in 1976 will be harvested this year.

Natural woodlands as well as shelterbelts play major roles in wildlife management. The riparian zone is especially important in the low rainfall areas of the Southern Plains. The Rio Grande corridor in West Texas, for example, is a significant migratory and immigration route for avifauna, and almost forty species nest within the riparian habitat (Patton 1977). Riparian vegetation also enhances aquatic habitats through reduction of the intense solar radiation of the region, reduced erosion, decreased sedimentation and energy inputs in the form of vegetational debris.

In the Southwest riparian may refer to vegetation associated with large rivers such as the Pecos, or small, even intermittent drainages such as arroyos. In New Mexico the term "bosque" implies a stand of riparian vegetation including plants which are growing as phreatophytes. Consequently the term is usually limited to woody plant stands along major rivers or flood plains. Bosques vary from gallery forest-like stands of cottonwood (Populus fremontii) with their associated shrubs to impenetrable thickets which may include combinations of pure stands of such plants as mesquite (Prosopis glandulosa), salt cedar (Tamarix spp.) and willow (Salix spp.). Mountain riparian habitat is immediately accessible to the Southern Plains in such ranges as the Sacramentos and Guadalupes.

Riparian habitats in the Southwest provide classic examples of misuse and are to the forester a sensitive management problem. The riparian zone has been overgrazed, cleared of trees without real benefit in many cases and represents an area of maximum conflict between such resources as grazing, recreation and water.

The playa "lakes" of the Southern Plains offer a form of wildlife habitat that would seem unimportant to the newcomer. Playas are shallow saucer-shaped depressions that collect rainfall during times of plenty and are scattered irregularly about the Southern Plains. Foresters have the opportunity in many situations to maximize playas and adjacent woodlands for wildlife habitat.

Large scale and long term forestry is not practiced in the Southern Plains due to: (1) the small area occupied by woodlands and forests and (2) the minimal impact that shelterbelt plantings have had in most of the region. Forest products of the Southern Plains are derived from short rotation crops which can justify supplemental irrigation water. There is some interest in growing Christmas trees on land irrigated with center pivot systems. In New Mexico and West Texas Christmas tree culture is gaining momentum due to the introduction of Afghan pine (Pinus eldarica Medw.), but throughout the Southern Plains production is small compared to areas north and east.

Biomass production is questionable in most of the Southern Plains because 25 inches of yearly precipitation is considered a minimum for silviculture energy farms. Most land potentially available appear to be located in the eastern and central time zones (Henry 1979). There is a growing interest in using mesquite for biomass and animal protein because it can tolerate salinity at levels detrimental to traditional crops and is a nitrogen fixer. Texas Tech is feeding ozone treated mesquite fodder to cattle following mechanical harvest. The idea of using "three dimensional" (i.e., food fuel and fodder) perrenial crops is not new. It was popularized by Douglas and Hart (1976) and is gaining popularity in developing countries such as India and Africa under the name agro-forestry or agri-silviculture.

Coal strip-mining is not substantial in the Southern Plains and is principally confined to the Raton bituminous coal field in northeastern New Mexico. Revegetation of spoils and mined land is extremely difficult, however due to low rainfall, wide temperature extremes, removal of topsoil and animal depredation. On those harsh sites revegetation with native plant species frequently results in better establishment and more rapid growth than can be achieved with introduced species. Foresters are presently challenged with commercial scale production of native tree species such as junipers to be used in revegetation work.

Research Needs in Southern Great Plains Forestry.

Research needs should be identified through close cooperation between university and forest service researchers and state and federal land management agencies. The Forestry Committee of the Great Plains Agriculture Council offers an excellent opportunity for its members to identify, discuss and prioritize specific research needs. Following are research needs perceived by one university researcher and the foresters and researchers who have unselfishly shared their ideas and concerns.

Research needed on tree improvement.

Research needs in tree improvement are largely determined by the severe temperature extremes, low rainfall, and porous and sometimes alkaline-saline soils characterizing the region; and the relatively slow growth rate and undomesticated state of native species. Tree improvement research should therefore concentrate on the introduction of drought and cold hardy exotics and non-native U.S. species

commonly used for protective plantings, and domestication of regional species that have been ignored due to unavailable seed or propagation difficulties. Selections should not sacrifice insect and disease resistance. Secondary attention should be given to the possibility that exotics and natives can provide multiple products and these amenities may encourage planting rather than removal of protective plantings in the Southern Plains.

Drought resistance and water use efficiency are extremely important considerations in selecting and improving trees in the Southern Plains. Drought resistance is often traced to more than one adaptation and may be conferred by such features as rapid root regeneration following transplanting, a deep and extensive root habit, adventitous roots near the soil surface and rapid stomatal response to drought. Considerable differences exist among and within woody species in the capacity for early stomatal closure during drought. Furthermore, stomatal response is to such factors as light intensity, temperature, wind and humidity are quite variable. Because farmers complain about the water shelterbelts take from crops, efforts should be made to select trees with non-spreading root systems. Researchers should also breed for water use efficiency. It may be more important to breed for this trait within than among species. If genotypic variation for water use efficiency is appreciable in a species, advances might be made by simple breeding methods such as mass selection.

It would appear that cold hardiness would not have as much value in the Southern Plains as it does farther north. The fact is that many relatively fast

growing deciduous and conifer species are marginal in the region and could greatly increase forestry potential if adapted. Studies in southern New Mexico for example have shown considerable variation among Mediterranean seed sources of Pinus halepensis in cold tolerance. Selection therefore will greatly reduce the probability of winter mortality. P. eldarica grows quickly in southern New Mexico but suffers mortality and loses rate of growth in northern New Mexico, above 5000 feet. If selections could move the attitudinal limits of the tree up only 300 feet, the tree could serve the largest city in New Mexico, containing almost one half the population of the state. P. eldarica is grown in Albuquerque at present but not without at least moderate risk.

Several fast growing hardwood species could serve New Mexico if cold hardy and could be grown in energy and multiple-use plantations. Examples are members of four genera commonly planted in semi-arid zones: Eucalyptus, Acacia, Albizzia, and Leuceana.

Alkalinity and salinity reduce the potential of desertic soils of the southwest and have been excluded from planting programs 5-59. India has taken a strong lead in planting trees on alkaline soils and is reclaiming soil productivity with many deciduous species. Researchers first need to determine alkalinity and salinity tolerances between species and then make within species selections. In southern New Mexico P. eldarica appears to have greater tolerance to salinity than native conifers and is commonly grown where soil pH exceeds 8.0. The physiological explanation for its success should be determined and P. eldarica

should be recommended over less tolerant conifers where this factor would be critical. According to Epstein (1976) breeding for alkalinity, salinity, and specific ion toxicities and deficiencies offers considerable hope for advances in crop production. I see no reason why respectable gains cannot be achieved with woody plants as well.

Insect and disease resistance are of major importance to the Southern Plains since decades are required to replace slow-growing protective plantings and irrigated tree crops reflect considerable capital investment. Research is needed that will quantify and identify genetic variations in susceptibility. The pine wood nematode (Bursaphelenchus spp.) has recently caused considerable damage to P. halepensis in Arizona and plantations of its close relative, P. eldarica, may be threatened in nearby New Mexico. Selection for resistance against the nematode may soon become a serious challenge.

Selection for growth and form have been discussed by Dawson and Read (1964) and their recommendations point to needs for future work. Cunningham's (1975) provisional seed zone map for the Great Plains points to the need for matching seed zone with planting site, further refinement of seed zone through progeny testing, and the opportunity for producing seedlngs from "out lier" stands west of the Plains that are found in protected areas such as deep canyon escarpments.

Selection on the basis of secondary criteria such as wood product or protein production may advance the utility of native species such as mesquite. Mesquite exists on 75 million acres of land in the U.S. and is so abundant in the Southern Plains that it has been the target of massive eradication programs. University

of California studies suggest that the present view may be improper and may ignore the potential for livestock feed, woody biomass and nitrogen fixation. Two facts encouraged the idea that mesquite can be selected for growing fuel and protein on marginal lands: (1) mesquite has been found growing naturally on alkaline-saline soils, and (2) studies have shown that growth rates and pod productivity are at least 4 to 5 fold lower for mesquite from the southwest as opposed to South American species. Selections should result in non-invasive fast growing trees with the capacity to produce high pod yields under densities ranging from 20 to 80 trees per acre.

Progeny tests, shelterbelts, and natural stands can provide opportunities for selection of primary and secondary traits. Shelterbelts and natural stands growing in alkaline or saline soils provide evidence of genetic suitability, for example.

Too often propagation research is needed when selection has been successful and genetic gain has been achieved. Plains foresters should work more closely with tissue culturists and horticulturists to identify and exploit opportunities for mass propagation and early floral induction (Fechner 1976). Major obstacles have only recently been cleared in tissue culture of many woody plant species, and more applied research is needed to tailor techniques to specific needs. Mass propagation techniques may be particularly important for including in planting programs native trees that produce small quantities of seed in scattered stands or where seed germination is irregular.

Research needed on establishment.

Tree establishment in the Southern Plains is closely related to soil type and weed control because soil moisture stress is linked to water holding capacity and competition. Unfortunately intensive site preparation creates erosion and this contradicts the ultimate goal of tree planting. Research is needed to evaluate straddle cultivation systems involving native or crop plants. The role of fallowing, land beveling and non-woody strips for moisture collection also deserve study.

Herbicides can minimize soil disturbance and can be used to create a mulch layer of dead herbaceous vegetation. This technique is recommended for reforestation in the mountains of the Southwest and may work well on the plains: Application rates deserve more extensive testing to include representative soils, moisture patterns and species of the region. Rates recommended for soils outside the region have too often proved noneffective or lethal to seedlings. Particularly needed is an herbicide that can be applied at time of planting hardwoods.

Drip irrigation greatly increases establishment success and is nicely suited to farmstead windbreaks. Research on application and cost-effectiveness may encourage more planting in a region where landowners have become discouraged by high mortality.

Deer and rodents cause acute problems and there appeared no safe means for controlling losses until plastic mesh tubes became available. These are promising

but cost and effectiveness need further study.

The optimum time for planting varies considerably with latitude and altitude but the general trend is for the "window" to narrow as one travels south to north. In southern New Mexico, for example, fall planting of container seedlings can be highly successful but is unsatisfactory in the mountain valleys of the northern region. Late planting simply does not allow sufficient root growth and seedlings are subject to frost heaving and spring drought. Because moisture is more favorable in northern New Mexico during late summer and early fall, studies should identify the period when sufficient moisture and root growth overlap. Similar studies are needed elsewhere in the region.

Desertic soils are a formidible challenge to forestation (Stoeckeler 1970) due to soil porosity, alkalinity, salinity, ion and zinc deficiences and poor capacity for sustained release of fertilizer nitrogen: Research is needed to (1) determine which soils will support tree growth, and (2) provide fertilization regimes that will compensate for low organic matter and high pH resulting nitrogen, iron and zinc defiencies.

Plantations and protective plantings may be irrigated where water is available and information on scheduling and consumptive irrigation requirements is almost non-existent. This information would provide more efficient watering and may be necessary for the ajudication of water rights.

Research needed on silvicultural management.

Once successfully established, tree plantings can become crowded, decadent

thickets, prone to insect attacks and disease. Proper silvicultural management can maintain tree vigor. Thinning, properly prescribed, will maintain the structural integrity and aesthetics of plantings, and biologic activity of both plant and animal life. Operations might also include management for fuel wood and other products.

Silvicultural techniques may be similar for all uses early in the life of a planting. But as the stands age, they may be managed differently to meet various objectives. Many planting types such as recreational and shelterbelt plantings may never receive identical treatment.

Silvicultural practices need to be sufficiently tested so that desired benefits and products can be reliably produced. Reliable information will enable the forest manager to carefully weigh the outcome of his efforts against the investments required.

Research is needed to develop best methods for maintaining optimum density for the intended purposes and uses of the planting. The effects of silvicultural practices on susceptibility of trees to insect and disease attack particularly deserves more study. Lastly, management practices are needed that optimize product mix. If, for example, fuel wood production is a goal then thinning should provide the kinds and amounts of product that will sustain vigor while earning income.

Research needed on insects and disease.

Insects and disease reduce the quality and quantity of tree seedlings produced in nurseries and greenhouses and frequently cause heavy mortality in plantings. Epidemics such as Dutch elm disease visibly cause massive losses while problems created in nurseries, seed production areas, and seed orchards create a perennial drain on manpower and finances. In the Southwest, seed and cone insects present a major challenge to natural regeneration, commercial nurserymen and foresters. More than one hundred insect species are associated with ponderosa pine, and at least five species cause economic loss. Collectively, they annually destroy an average of 82 percent of the potential seed (Kinzer and Reeves 1976).

Insect and disease research efforts should not ignore any segment in the chain of events necessary to establish and maintain vigorous plantings. Moreover, efforts should include more work on broadlened species. Previous work has concentrated on the nursery diseases of conifers.

Researchers should specifically: (1) determine the role and economic impact of insects and disease on seedling production and plantings, (2) develop effective control methods, (3) develop early warning systems for impending epidemics, (4) identify resistant stock, and (5) evaluate the potential of native isolates of mycorrhizae-forming fungi for increasing outplanting survival.

Research needed on natural woodlands.

The natural woodlands scattered throughout the Southern Plains provide recreation, wildlife habitat and infrequently wood products. The riparian

habitat is particularly important for deer and avifauna. Escarpments and riparian zones may provide mostly non-commercial quantities of wood products due to the absence of high-value hardwoods.

Preservation of the small area of natural woodlands found in the region will require competent management and research is needed to prevent further loss and deterioration of a dwindling resource. Specific needs that should be addressed are (1) maximization of area occupied by natural woodlands (2) development of genetically improved trees for wood and wildlife; (3) minimization of losses due to insects, disease and overgrazing, (4) development of guidelines for maintaining adequate stocking and vigor and (5) development of management practices that will optimize product mix (e.g., wood value and upland game bird habitat).

Maximization of the natural woodland area can be achieved through reforesting areas mapped suitable for woodlands through characterization of soils and topography. Tree improvement and insect and disease research can follow conventional pathways established for introduced plantings. However, forest gene conservation may deserve greater emphasis in native tree improvement work. Management guidelines for tree stocking, livestock grazing and product harvest will be difficult to develop but are much needed for preservation and maximum benefits.

Research needed on shelterbelt influences.

Researchers understand the major influences of shelterbelts on crop mecioclimate and with some additional information on such factors as optimum density (or porosity) could construct a model for the simulation of shelterbelt influences.

A model would make it possible to tailor a shelterbelt design to intended purposes such as improved snow distribution, reduction in soil erosion, and noise abatement.

The aerodynamic effects of shelterbelts on environmental modification could be simulated if sufficient information were available. Modeled effects might include: (1) downwind soil-plant-atmosphere interactions, (2) noise abatement, (3) snow distribution and (4) livestock feed conversion. This would provide quantification of benefit and where return on investment was favorable, protective plantings could be economically justified.

CONCLUSION.

In conclusion, the Southern Great Plains region is pressed for its mineable and renewable resources. Research can enhance somewhat the ecological and economic stability by providing answers to some very serious problems. The degree to which research successfully meets the objectives discussed will impinge on the survival of wildlife, the recreational opportunities of the region and the conservation of land and livelihood.