APPENDIX A

SUITABILITY REPORT FOR TREE FRUITS, BERRIES, AND OTHER FRUITS AND VEGETABLES

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Appendix A - Suitability Report for Tree Fruits, Berries, and Other Fruits and Vegetables

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Berries

Raspberries

Raspberry varieties are classified as either floricane (summer) or primocane (fall) bearing and are naturally biennial with a perennial crown. Primocanes grow the first year, become dormant in fall, get chilled in winter, and fruit the following summer (the primocanes are now called floricanes, which die after fruiting). New primocanes are growing as the floricanes fruit. Floricane varieties must be pruned in the spring to thin the fruiting canes and remove dead canes for better disease management and fruit size.

Primocane varieties fruit on the first year's growth in the late summer and fall of the year. The most productive primocane varieties begin ripening in mid-July and will continue production until temperatures of 26 degrees F or lower occur in the fall. Pruning in these varieties is done by mowing canes to the ground before primocanes emerge in early spring (Weber, 2006).

In warmer climates where winter chilling may not be adequate, or fluctuating warm-cold temperatures occur during the winter, primocane varieties have proven to be much more reliable producers than floricane types that are generally grown in more Northern areas

(Walser, Unpublished; Dickerson, 2005b; O'Dell, 2002). Numerous varietal trials have shown that the primocane variety "Caroline" (with "Polana" being a close second) has been the most productive variety. It also has excellent fresh market and processing qualities (Weber, 2006; Walser, unpublished; O'Dell, 2002; Hanson, 2004; Ohio State University, 1999). Therefore, it is recommended that "**Caroline"** be the raspberry variety that is planted on the Fort Apache Indian Reservation (Reservation), along with a small planting of "**Polana**".

Berries require around 100 lbs of nitrogen/year/acre for good production (Dickerson, 2005b; Hanson, 2004; Pritts, 1991; Galletta, 1990). Western soils generally have sufficient phosphorus and potassium for good plant growth, thus the main nutrient required will be nitrogen. With organic production, nitrogen can be applied as winter applications of manure or compost and liquid forms injected into the irrigation water (Sampson 2001; Kuepper, 2003). Foliar applications of minor elements (mainly zinc, iron and boron) would be applied as needed. Raspberries will grow successfully in a wide range of soil ph (from 5 to 7.5), with the optimum being around 6.5 (Kuepper, 2003; Pritts, 1991; Galletta, 1990). However, they are doing very well in locations in New Mexico, Mexico, and Utah in soils with a ph of over 8 (Walser, unpublished). They do best in loamy soils, but will grow fine in heavier (clay) or lighter (sandy) soils. The soils located in the intended growing area of the Reservation (Canyon Day) will be excellent for berry production. These soils are mainly Show Low gravelly clay loam with some Tours silt loam. These soil types indicate good fertility, excellent water holding capacity, and good soil drainage (permeability) through the soil profile, which are all requirements for good berry production (USDA 1981). Irrigation will be by drip method and will require around 24 acre inches of water/year/acre (Pritts, 1991).

Primocane producing raspberries will require trellising. Trellises require at least a 4 inch diameter end post, with 2 inch in-row wood poles or smaller metal posts placed every 20 feet down the row. They also will require three #14-16 galvanized wires, with one placed about 15 inches above the soil surface, on which to hang the drip hose, and two placed higher (one on each side of the plants), that will be raised (to a maximum height of 4 feet) as the plants grow in the summer. It is anticipated that the planting will stay healthy and in place a minimum of 10 years. Weed control will be maintained by mechanical means down the plant row, while areas between the rows will be mowed. A natural cover crop consisting of local native plants will be encouraged to develop between rows.

Due to the isolated area of the proposed planting, and the dry climate, anticipated pests will be minimal, and should be easily controlled using organic methods. The main disease organism that will need to be monitored is grey (Botrytis) fruit rot that could develop during extended wet periods. There are not any approved effective organic fungicides for this disease, but several are in the research stage. However, fruit rot can be avoided or reduced by using cultural methods such as avoiding dense plantings, avoiding overhead irrigation, picking fruit frequently as it ripens and moving the fruit quickly to cold storage. It will also be important to not pick wet fruit. Insects that could become problems include fruit worms, plant bugs, aphids, spider mites and borers. Organic insecticides such as insecticidal soap, spinosad, summer oils, pyrethrum, neem oil etc., along with maintaining beneficial insects in the planting would be used to control these pests if they were to become problems (Walser, unpublished; Kuepper, 2003; WSU, 2005).

Raspberries are generally planted (using bare-root plants or root cuttings) in March or early April. Spacing between rows would be 10 feet, with plants placed every 18 inches down the row, for a plant density of 2,900/acre (Pritts 1991;Galletta 1990). During the first growing

season, root suckers will develop which will fill in the spaces, resulting in a complete hedge of plants down the row.

There will be some production the first year, but commercial harvests will begin in year 2. Yields of primocane varieties vary depending on the location, growing season, and climate. Yields in the Eastern United States are generally reported to be from 4000 to 7000 lbs/acre (2,6), near 15,000 lbs in New Mexico (growing conditions similar to Canyon Day area) and Eastern Washington (Walser, unpublished), and around 20,000 lbs in California (University of California, 2005). The expected yields on the Reservation project will be at least 12,000 lbs/acre, with about 60 percent or more of the hand harvested product going to fresh market sales, and 40 percent to processing (freezing). This would be a hand harvested product that would be collected in one or one half gallon plastic buckets, sorted in a field packing shed, and placed in 6 ounce shipping plastic clam shells. Processing berries would be sorted into puree or juice quality and placed in bulk containers for delivery to a freezing plant. Experience in fresh berry operations in Michoacan, Mexico, and Chile has shown that the 60 percent-40 percent ratio is realistic (Vital Berry-Guimarra). This would produce about 1000-seven lb flats/acre (12-six oz plastic clam shells/flat) for the fresh market, and around 5000 lbs to processing. Once a load of flats is ready in the shed, it will need to be taken immediately to a cold storage facility with the capability of air cooling the fruit to approximately 31 degrees F in about an hour. Using refrigerated trucks, the berries need to be shipped to market within 24 hours (Mitcham, 2002). It will generally require from 5 to10 pickers per acre during the picking season (July-October) to harvest each acre every 2 to 3 days. It is recommended that berries be harvested in the morning hours while temperatures are cooler. Therefore, during the hottest part of the summer, harvest time would be from dawn to around 11am (Walser, unpublished; University of California, 2005; Kuepper, 2003). Processing berries could be machine harvested, but 25 acres or more would be required to justify the expense of leasing or purchasing the harvesting equipment (Ohio State University, 1999). In the event that the hand harvesting crew were not able to keep up with harvesting the ripening fruit, areas of the planting could be machine harvested for freezing (IQF or bulk) then that area could go back to hand harvesting or remain with machine harvesting for the balance of the season.

Blackberries

Commercial blackberries in use today have been domesticated from many wild European and American species. In fact, today's best blackberry cultivars are primarily crosses between blackberries and raspberries. The hybrids are blackberry-like in appearance, but have either reddish or black fruit. Notable examples are the cultivars loganberry, youngberry and boysenberry (Pritts, 1991).

Blackberries can be classified into three types based on their growth habit: *Erect*, which produce self-supporting canes; *Semi-erect*, where canes are partially erect, but require a trellis for support; and *Trailing*, where canes are not erect and require a trellis for support. Each type of blackberry has thorny and thornless cultivars. Trailing and semi-erect types have few root buds, and thus maintain their spacing as planted, while erect types readily produce primocanes from both roots and crowns, thus forming a dense hedge-row. All commercial blackberry cultivars are floricane bearing (produce fruit on last year's canes) and are naturally biennial with a perennial crown (Fernadez, 1999; Dickerson, 2005a).

The most cold tolerant blackberry cultivars will endure winter temperatures of approximately 10 degrees F below zero (Galletta, 1990; Walser, unpublished). An examination of temperature extremes at the White River weather station since 1971 shows the lowest recorded temperature was -11 F, with only three below zero occurrences (NOAA, 2002). Thus, cold winter temperatures will not be a limiting factor for blackberry production in the Canyon Day location. Blackberry yields vary by location and weather conditions. Production in Michigan is reported to be about 12,000 lbs/acre for the Chester variety (Hanson, 2004). At the New Mexico State University Alcalde Science Center (colder temperatures than the Canyon Day location) the yield of Chester and some of the Arkansas thornless erect varieties have also been around 12,000 lbs/acre (Walser, unpublished). However, California boysenberry growers report typical annual yields of 10,000 lbs/acre the second year, 20,000 lbs the third year and 24,000 lbs the fourth year and beyond (Perry et al., 2002). Thus, it is anticipated that the yields of blackberries in the Canyon Day Area (when in full production-third year) will be at least 12,000 lbs/acre, with 80 percent going to the fresh market and 20 percent going to the processing (frozen) market (Vital Berry-Guimarra). This would be approximately 2100 flats to the fresh market and 2400 lbs to the processing market.

The recommended varieties for this planting are the thornless Arkansas erect variety **Quachita** with anticipated harvest period of July 5 to August 5 (Walser, unpublished, University of Arkansas, 2006), and the thornless semi-erect **Chester** with a harvest period of approximately July 15 to August 20 (Walser, unpublished). Berries will be hand harvested directly into six ounce plastic clam shells and hauled to an in-field sorting area where the berries will be visually sorted and containers properly filled. Flats (12 clam shells/flat) will then be transported to a cooler where they will need to be cooled to approximately 31 degrees F within one hour. Processing product (culls) will be placed in bulk containers and frozen. The fresh product should be to the market within 24 to 30 hours, and remain cold during transport and storage (Mitcham, 2002). It will require 4 to 5 pickers to harvest each acre every two days (Pritts, 1991). Harvesting will generally be only about 5 hours per day during the morning while the temperature is cool. Blackberries can be mechanically harvested for the processing market, similar to raspberries.

Erect blackberry plants are generally planted in March or early April using bare-root plants, tissue cultured potted plants or root cuttings. Spacing between rows will be 10 feet, with plants placed every 18 to 24 inches down the row, for a plant density of around 2500

plants/acre. During the first and second growing seasons, root suckers will grow which will fill in the spaces, resulting in a complete hedge of plants down the row. Semi-erect plants are also planted in March or early April using bare-root or tissue cultured potted plants. Spacing between rows will be 10 feet, with plants placed every four feet down the row, for a plant density of 1100 plants/acre (Pritts, 1991; Galletta, 1990; North American Brambles Growers Association, 2006).

Berries require around 100 lbs of nitrogen/year/acre for good production (Pritts, 1991; Fernandez, 1999; Dickerson, 2005a; ,Galletta, 1990). Western soils generally have sufficient phosphorus and potassium for good plant growth, thus the main nutrient required will be nitrogen. In organic production, nitrogen can be applied as manure or compost during winter or liquid forms applied with the irrigation water. Foliar applications of minor elements (mainly zinc, iron, and boron) will be applied as needed (Sampson, 2001; Kuepper, 2003). Blackberries will grow in a wide range of soils, with the optimum being around 6.5 to 7 ph. However, blackberries are doing very well in New Mexico and Mexico in soils with a ph of over 8 (Walser, unpublished). They do best in loamy soils, but will grow fine in heavier (clay) soils or sandy soils, as long as the soils have adequate drainage (permeability). The soils located in the intended Canyon Day growing area will be excellent for berry production. These soils are mainly *Show Low gravelly clay loam with some Tours silt loam.* These soil types indicate good fertility, excellent water holding capacity, and good soil drainage (permeability) through the soil profile, which are all requirements for good berry production (USDA, 1981). Irrigation will be by drip method and will require around 24 inches of water/acre/year (Pritts, 1991).

Semi-erect blackberries require trellising. Trellises require at least a 4 inch diameter end post, with in-row 2 inch wood poles or smaller metal posts placed every 20 feet down the row. They will require one # 14-16 gauge galvanized wire placed about 15 inches above the soil surface on which to hang the drip hose and one #9-11 gauge wire placed about 4.5 feet high which will be used to support the plants and fruit. Erect types of blackberries do not require trellises for support, but some growers install a three wire trellis (similar to raspberries) mainly to keep the drip hose off the ground and out the way of pruning and weeding equipment and to provide some support for the plants the first two or three years. It is anticipated that the planting will stay healthy and in place for at least 12 to 15 years. Weed control will be maintained by mechanical means down the plant row, while areas between the rows will be mowed (Pritts, 1991; Fernandez, 1999; Dickerson, 2005a; Galletta, 1990). A natural cover crop consisting of native plants will be encouraged to develop between rows (Walser, unpublished).

Due to the isolated area of the proposed planting area and the dry climate, anticipated pests will be minimal, and should be easily controlled using approved organic methods. The main disease organism that might be a problem is grey (Botrytis) fruit rot that could develop during extended wet periods. There are no approved effective organic fungicides for this disease, but several are in the research stage. However, fruit rot can be avoided or reduced by using

cultural methods such as avoiding dense plantings, avoiding overhead irrigation, picking fruit frequently as it ripens and moving the fruit quickly to cold storage. It will also be important to not pick wet fruit. It is also important to realize that blackberries are much more resistant to this disease then are raspberries. Insects that could become problems include fruit worms, plant bugs, spider mites, and borers. Organic pesticides, such as insecticidal soaps, spinosad, summer oils, pyrethrum, neem oil etc., along with maintaining beneficial insects in the planting and using proper sanitation procedures will be used to control these pests if they were to become problems (Pritts, 1991; Fernandez, 1999; Galletta, 1990; Walser, unpublished; Kuepper, 2003).

Fruit Trees

Apples

The Canyon Day area of the Reservation appears to be a very favorable location for profitable organic apple production. The excellent micro-climate, good fertile well drained soils, good water quality, past history of fruit production, and isolation are all factors that indicate the tremendous potential the area has for profitable organic fruit production. Apples have been grown for many years successfully in the Willcox area of Arizona. One of the main limiting factors to further expansion of the industry in that area is the occasional losses due to spring frosts. However, based on an examination of temperature records from White River, and the excellent air drainage in the Canyon Day location, it appears that with some frost control measures, spring frosts should not be a limiting factor to consistent apple production in that area (NOAA, 2002; USDA, 1981; Walser).

Nitrogen will most likely be the only major element that will need to be applied to apple trees in the Reservation area. Apple trees require about 100 pounds of nitrogen per acre per year for good consistent fruit production. Five tons per acre per year of manure, compost, or other approved nitrogen source could supply this need the first three years. A perennial cover crop of New Zealand White Clover would be planted the first year (12 pounds of seed/acre) and maintained as a permanent cover crop. All of the nitrogen requirements for the orchard should be able to be obtained from the cover crop from year three and beyond. If deficiencies of the minor elements iron, zinc, boron, or calcium were to occur they would be controlled by foliar applications of these elements (Swezey et al, 2002; Granatstein and Azarenko, 2005).

Red Delicious has been the most widely planted apple variety in the United States, but is fast loosing favor in the marketplace because of poor flavor caused by harvesting the new red sports prior to full maturity, and also because of the excellent flavor and quality of some of the new varieties that have become available. Therefore, it is recommended that the White Mountain Tribe (Tribe) not include Red Delicious in their variety selection. It is

recommended that varieties that currently have excellent market demand and that appear to be well adapted to the growing conditions at the Reservation be selected for this project. Some of these varieties (listed in order of ripening from August 1 to October 15) are Ginger Gold, Gala, Honeycrisp, Golden Supreme, Golden Delicious, Early Fuji, Cameo, Fuji, and Arkansas Black. The varieties will be grafted onto full dwarf rootstock of either B9 or M9 and planted at a spacing of 6 feet between trees and 14 feet between rows for a density of 520 trees per acre. Trees will need to be supported by a 2 wire trellis, with one wire 4 feet above the orchard surface and the other at 6 feet. Sturdy 10 foot metal or wood end posts will be driven 4 feet into the ground and smaller 8 foot posts will be placed every thirty feet down the row and driven two feet into the ground. Trees will be trained to either a slender spindle or vertical axis system. Pruning and training labor will require approximately 25 hours per acre in years one and two, and 60 hours in years five through twenty. Micro-sprinklers will be used for both irrigation and frost control. Approximately 50 gallons of water per acre per minute will be required to provide adequate spring frost control. Water requirements will be approximately 36 acre-inches per year. If additional frost control is needed, one wind machine for every ten acres will be installed (Walser; Swezey et al, 2002; Peterson, 1989; Capril, 2001).

Expected apple yields will be 5 ton per acre in year three, 10 ton in year four, 15 ton in year five, and 20 ton per acre in years six through twenty. Seventy percent of that would go to the fresh market, packed in 40 lb boxes and thirty percent to the juice (cider) market. Pickers pick from the ground or small ladders into picking bags. The bags are dumped into one-half ton plastic bins on a bin trailer. The filled bins are then transported to a cooler. The apples are then removed from the cooler and sorted and packed into cartons, which are then placed back into the cooler to await transport to market. Harvest labor requirements for pickers increases from approximately 50 hours per acre in year three to 160 hours per acre in year six and beyond (Swezey et al, 2002; Capril, 2001; Falk et al. 1994).

The major pest problem that has limited organic apple production in the United States in the past is the codling moth (wormy apples). However, recent advancements in controlling this pest such as the development of pheromone mating disruption, spinosad and other insecticides, and codling moth virus have made it much more economically feasible to produce “worm-free” organic apples that the market demands. The isolation of the Reservation project will make it much easier to control this type of pest compared to areas that are surrounded with fruit orchards, many being abandoned. Other apple insects such as aphids, leaf rollers, spider mites, and plant bugs etc. will be controlled using approved organic methods. The diseases that could be problems in the Reservation area are powdery mildew and fire blight. These can be controlled using products such as copper, sulfur, potassium bicarbonate, lime sulfur, and Streptomycin sulfate. Weeds will be controlled by mowing between the rows and mechanically down the row (Walser; Swezey et al, 2002; WSU, 2006).

Peaches

Intense disease and insect pressure make peaches one of the most difficult tree fruits to produce organically, particularly in the Eastern part of the United States. In parts of the arid West, pest pressure is much less and organic peach production is certainly feasible (Diver and Mumma, 2003).

In the Intermountain West where spring frosts often occur and damage to early developing blossoms can occur, the site or location of the orchard (micro-climate in the area) is critical to successful tree fruit production. Most peach growers in Western Colorado (temperatures generally a few degrees colder than White River) expect a total loss of the crop due to frost about 10 percent of the time and partial losses another 10 to 15 percent of the time (Sharp and Cooley, 2004). The proposed site (Canyon Day) of the Reservation orchard project appears to have excellent air drainage, which would give it a very favorable micro climate (Walser). An examination of temperature records at White River, AZ show that given the excellent location of the Canyon Day site, and with some frost protection, losses due to spring freezes should be less than that in Western Colorado (NOAA, 2002). Also, the soils in the Canyon Day area are excellent for peach production (Walser, USDA, 1981).

It appears that nitrogen is the only major nutrient that would be required for peach production at the Canyon Day location. Peaches require 100 to 150 pounds of nitrogen per year, which could be supplied the first three years by the application of 5 to 7 tons of manure, compost, or other approved organic source of nitrogen. A perennial cover crop of New Zealand White Clover would be planted the first year (12 pounds of seed/acre) which would provide most, if not all, of the nitrogen requirement in year three and beyond. Deficiencies of the minor elements zinc, iron, and boron would be controlled by foliar applications of these elements (Sharp and Cooley, 2004; La Rue and Johnson, 1989).

Peach varieties are available that would ripen during July, August and September in the Reservation area. Thus, it is advisable to plant several varieties with sequential ripening periods for orderly marketing and also to better utilize the labor pool for harvesting and packing. It is also advisable to plant cold and disease tolerant varieties. Some of the recommended varieties listed in order of ripening (starting first part of July and ending in mid-September) are Flamin' Fury PF-5D Big, Harrow Diamond, Brightstar, PF-7A, Risingstar, Redstar, Saturn, Blazingstar, PF-Lucky 13, Coralstar, Contender, Intrepid, PF-23, PF-24-007, PF-24C, Biscoe, PF-27A, Encore, and Autumnstar. Rootstock will be seedlings of Lovell, Halford, Bailey, or Tennessee Natural. Trees will planted at a spacing of 10 feet between trees and 16 feet between rows for a planting density of 272 trees per acre. Trees will be trained (pruned) to a Quad-V (four laterals/tree) system. Labor requirements per acre for pruning and training etc will be approximately 70 hours in year one, 30 hours in year two, 45 hours in year three, 55 hours in year four, and 60 hours in years five to twenty. Labor required per acre for hand thinning peaches will be 10 hours in year three, 50 hours in year

four, 60 hours in year five, and 70 hours in years 6 through 20. Micro-sprinklers will be used for both irrigation and frost control. Approximately 50 gallons of water per acre per minute will be required to provide adequate spring frost control. Water requirements will be approximately 36 acre/inches per year (Sharp and Cooley, 2004; La Rue and Johnson, 1989; Day, DeJong and Johnson, 2005; Day et al, 2004).

Expected yield of marketable peaches is 200 twenty five pound boxes per acre in year three, 500 boxes in year four, and 900 boxes in years 5 through 20. Fruit will be hand harvested into one-half ton plastic bins placed in the orchard. This fruit will then be hauled to the cooler, packed into 25 pound cartons, and then placed back into the cooler until shipped to market. Labor requirements to hand harvest the fruit will be approximately 30 hours per acre in year three, 60 hours in year four, and 95 hours in years 5 through 20 (Sharp and Cooley, 2004, Sharp and Cooley, 2004, Walser; Day et al, 2004)

There are a number of pests that could create problems in organic peach production in the Reservation area, but acceptable controls are certainly available. Potential insect pest are peach twig borer, spider mites, plant bugs, Oriental fruit moth, and aphids. These can be controlled by the use of methods such as biological control, mating disruption, and organic insecticides such as spinosad, Bacillus thuringiensis, Stylet oil, insecticidal soap, neem oil, and pyrethrum. Potential diseases that may need to be controlled are brown rot, powdery mildew, cytospera canker and coryneum blight. Organic fungicides such as lime-sulfur, sulfur, potassium bicarbonate, Serenade (Bacillus subtilis) and stylet oil will control these diseases (La Rue and Johnson, 1989; Diver, 2003; UC, 1999).

It may be necessary to place wind machines in orchards if damaging spring frosts occur more often than anticipated. The Tribe would need one machine per 10 acres of orchard. Cost is about $15,000 to $20,000 per machine.

Other stone fruit that would be profitable to grow in the Canyon Day area would be European plums and apricots. European plums (blue prune type) are later blooming than peaches, thus would have less problems with spring frosts. Apricots are earlier blooming than peaches, thus would have more losses due to spring frosts. Production costs and yields of plums and apricots would be similar to peaches, except production would start one year later than peaches.

Cherries

Organic cherry production in the Canyon Day area of the Reservation could be a very feasible and profitable enterprise. Spring frost problems could occasionally cause losses, but would likely be less than 10% of the year's production, based on the favorable Canyon Day

site and an examination of weather records from White River. The soils in that location are very good for cherry tree growth (NOAA, 2002; USDA, 1981; Walser).

Nitrogen will most likely be the only major element that will need to be applied to cherry trees in the Reservation area. Cherry trees require applications of from 50 to 100 pounds of nitrogen per acre per year. Three to five tons/acre of manure, compost, or other approved organic nitrogen source could supply this nitrogen need the first three years. A perennial cover crop of New Zealand White Cover would be planted the first year (12 pounds of seed/acre) and maintained as a permanent cover crop. All of the nitrogen requirement for the orchard should be able to be obtained from the cover crop from year three and beyond. If deficiencies of the minor elements iron, zinc, and boron were to occur they would be controlled by foliar applications of these elements (Whiting, 2005).

There are currently cherry varieties available that are self-fertile, later blooming, and with extended ripening periods compared to older varieties. The ripening period is anticipated to be during June, which would be close to the end of the California season and the beginning of the Washington crop. This will be a very favorable time-period which should result in excellent demand and prices. The recommended varieties (listed in order of ripening) are White Gold, Benton, Black Gold, Lapins, Skeena, Sweetheart, and Balaton. Trees will be on the semi-dwarf rootstock Gisela 6 and planted at a spacing of 10 feet between trees and 16 feet between rows, which is 272 trees per acre. Trees will be trained (pruned) to either a Spanish Bush system or Vogel Central Leader. Pruning labor requirement per acre will increase from approximately 20 hours per acre in year one to 40 hours per acre in years 6 through 25. Micro-sprinklers will be used for both irrigation and frost control. Approximately 50 gallons of water per acre per minute will be required to provide adequate spring frost control. Water requirements will be approximately 36 acre/inches per year. If additional frost control is required, one wind machine for every ten acres will be installed (Whiting, 2005; Long, Long 2003; New York State Agricultural Experiment Station, 2002).

Expected yield of marketable cherries is 1,500 pounds per acre in year three, 8,000 pounds in year four, and 13,000 pounds per acre in years 5 through 25. Cherries for fresh market are hand harvested and may require up to 200 hours per acre when in full production. Fruit is harvested into padded buckets, transferred to shallow plastic bins, and hauled to a cooler. Fruit is then packed into 20 pound boxes, clamshells, or plastic bags, then placed back into a cooler until it is marketed (Walser; Whiting, 2005).

There are some pests that could be problems in organic cherry production in the Reservation area, but acceptable controls are available. Potential insect pests are Western cherry fruit fly, black cherry aphid, spider mites and leaf rollers. These insects can be successfully controlled using the insecticides spinosad (Entrust or GF-120 NF Bait) Bacillus thurengiensis, Stylet oil, pyrethrum insecticidal soap, and the use of biological controls. Diseases that may need to be controlled are powdery mildew, Coryneum blight, and bacterial gummosis. These diseases can be controlled by using products such as sulfur, potassium bicarbonate, copper, and lime

sulfur. Weeds will be controlled by mowing between rows and mechanically near the trees. If bird damage becomes serious, scare tactics will be used followed by netting if the scare tactics are not effective (Whiting, 2005; WSU, 2006).

Grapes

Grape culture in New Mexico (and later in Western Colorado) dates back to the coming of the early Spanish settlers. There are currently many very productive wine grape vineyards in Northern New Mexico and Western Colorado that are growing in more harsh conditions than the proposed growing areas of the Reservation. The soils and climatic conditions in the Canyon Day area of the Reservation are ideal for excellent grape production (Herrera, 2000; Hamman, 1998; Walser, NOAA, 2002; USDA, 1981).

Grapes have lower requirements for mineral nutrient levels than many other crops. The only major nutrient that would need to be applied at the Reservation area would be nitrogen at a rate of around 50 lbs/acre/year. This amount could be supplied by the application of 5 tons/acre of manure, compost, or other source of organic nitrogen. If minor elements such as iron, zinc, or boron were to become deficient, foliar applications of these elements could be applied. It is recommended that a perennial cover crop of New Zealand White Clover be planted during the establishment year of the vineyard. The rate of planting would be 12 lbs of seed/acre. It is anticipated that following the third year the cover crop could supply all of the nitrogen requirements for the plants, thus eliminating the need to apply additional nitrogen (Herrera, 2000; Hamman, 1998; Walser, Dow and Ahmedullah, 1983; Ingels et al., 1998).

It is recommended that the most cold-tolerant Vinifera (European) type of wine grape be grown in the Reservation project. Some of the varieties that have done very well in Western Colorado and Central Washington are the white varieties Chardonnay, Riesling, Pinot blanc, Gewurztraminer, Muscat blanc, Pinot gris, Sauvignon blanc, Siegerebe, Rkatsiteli, Muller-thurgau, Viognier, and the red varieties, Merlot, Cabernet sauvignon, Pinot noir, Lemberger, Cabernet Franc, Sangiovese, and Syrah (Shiraz). The particular varieties to be grown would need to be determined following consultation with wineries that would be willing to purchase (contract) the grapes. At this time there does not appear to be much of a price premium for organic wine grapes compared to conventionally grown grapes (Hamman, 1998; Nagel and Spayd, 1990; Smith, 2004; Weber, 2005).

Rooted cuttings (non-grafted) will be planted in April, with a spacing of ten feet between rows and six feet between plants, for a plant density of 730 plants/acre. Vines are trained during the first and second years and are expected to begin yielding the third year (2.5 tons/acre) and be in full production the fourth year and beyond (5 tons/acre). The productive life of the vineyard should be at least 20 years. The training system will be a bilateral cordon-trained, spur pruned, vertical shoot positioning system (VSP). The VSP trellis consists of sturdy 10 foot metal or wood end posts driven 4 feet into the ground and 8 foot line posts spaced 30 feet apart and driven 2 feet into the ground. Metal or wood "grape stakes" will be placed near each plant and used for training purposes and support. One fruiting 10 to 12 gauge wire is placed at 40 inches and a first pair of 14 gauge foliage catch wires 12 inches above that and a second pair 12 inches above that. A sixth wire is often attached to the top of the posts to support bird netting if needed. Pruning during the dormant period will require about 40 hours of labor/acre. Canopy management during the growing season will require about 105 hours/acre. Harvesting can be done by hand into one-half ton plastic bins, or mechanically. It is estimated that one picker can hand harvest one ton of grapes during an eight hour day. A contract rate of $50.00 per ton is generally assumed for mechanically harvested grapes (Hamman, 1998; Smith, 2004; Weber, 2005).

Pests are a concern in wine grape production, but are much less severe in dry climates, and can be controlled using organic methods. Powdery mildew is a disease that will occur, but can be controlled with the application of from one to four applications of organic fungicides such as sulfur, potassium bicarbonate, lime-sulfur, and stylet oil. If botrytis or phomopsis infections were to occur (unlikely) then stylet oil or lime-sulfur could be used for control. Grape leafhopper and spider mites are insects that might need to be controlled. Stylet oil or insecticidal soap along with biological controls will give adequate control of both species. If any of the lepidopterous (larvae) species attack the plants, the naturally occurring bacterium Bacillus thuringiensis would be used for control. Weed control will be handled by mowing between rows, and mechanically down the row. Birds will most likely become problems, and would be controlled by applying 17 foot wide netting over each row just before grapes start to ripen. These nets can be applied and removed mechanically (Hamman, 1998; Walser; Smith, 2004; Weber, 2005; Ames, 1999).

Grapes can be successfully irrigated using drip, flood, or sprinkler systems. It is recommended that the Reservation vineyard be irrigated using low profile micro-sprinklers that will apply around 50 gallons of water per minute per acre. With this amount of water applied, the system could also be used effectively as a frost control measure in the spring frost season. This system will also provide full vineyard irrigation coverage, which will allow the clover cover crop to grow successfully. The water requirement will be approximately 24 acre inches per year (Herrera, 2000; Hamman, 1998; Walser).

Cantaloupe

Cantaloupe is a warm-season annual plant that is sensitive to freezing temperatures at any growth stage. Growth is very slow below 60 degrees F and optimal from 85 to 95 degrees F. Cantaloupe can tolerate temperatures in excess of 104 degrees F. Cantaloupe need at least 80 days of suitable growing temperatures to properly mature a crop (Hartz, 1996; Basham and Ells, 1999). The proposed melon planting areas of the Reservation (Canyon Day or Fort Apache area) have approximately 140 frost free days during the growing season (NOAA, 2002), thus, it is clear that temperature extremes will not be a limiting factor for melon production in those areas.

Many soil textures are used successfully for cantaloupe production. Regardless of texture, all cantaloupe soils should be well drained, since the crop is sensitive to root diseases that thrive in poorly aerated soils (Hartz, 1996; OSU, 2004). The soils (Show Low gravelly clay loam with some Tours silt loam) in the proposed Reservation planting areas are excellent for cantaloupe production (USDA, 1981).

Cantaloupe has modest nutrient needs. Typical fertilizer application rates are 80 to 150 pounds of nitrogen and 40 to 80 pounds of phosphorous. Manure and/or compost incorporated into the soil pre-plant could supply most of this requirement, with the balance side-dressed or applied in the irrigation water during the growing season (Hartz, 1996; Basham and Ells, 1999; OSU, 2004; University of California 1999; Gaskell et al, 2000).

There are two distinct types of cantaloupes grown in the United States. The Eastern type (commonly called muskmelon) which are round to oval, usually sutured, and not intended for long shipping, and the Western shipping type muskmelons (often called cantaloupe) which are round to slightly oval, sutureless, very netted, with firm, salmon-colored, sweet flesh that ship well. It is recommended that the Reservation project grow the Western shipping type because of the adaptability to the local growing conditions, and the availability of hybrids that are very productive and can be resistant to powder mildew. Some of the potential varieties are Cruiser, HyMark, Mission, Primo, Durango, Magnum .45, Oro Rico, Yuma Grande, Laredo, Gold Rush, Goldmine, and Gold Express (Hartz, 1996; Basham and Ells,

1999; NOAA, 2002; University of California 1999; Mueller 2004; Mueller 2005). Seed companies would need to be contacted to verify that the variety is indeed powdery mildew resistant and that the seed had not been treated with pesticides.

Cantaloupes are generally planted on beds from 48 to 80 inches wide, and either furrow or drip irrigated. Water requirement is about 24 inches/acre/year. Many growers are beginning to use plastic mulch to increase production. Mike Bartolo at Colorado State University's Arkansas Valley Research Station states that:

> "Melons love plastic mulch. Plastic mulch helps with weed control, conserves water, and improves the quality of a crop that grows prone on the ground like melons. Growers can dramatically improve their yields, anywhere from 50-100 percent by using drip irrigation and plastic mulch (plasticulture)" (Bartolo, 2004).

It is recommended that the Tribe use 60 inch beds with drip irrigation and four foot wide one mil plastic mulch. An application machine that installs the drip tubing and plastic mulch and forms the bed in one pass will need to be purchased. Holes will be punched through the plastic every 18 inches, where either seeds or greenhouse grown transplants (preferred) will be planted. Seeds would be planted in mid-May, and transplants in late-May. Melons require at least one hive of bees per acre for proper flower pollination. Harvest would be from approximately late-July through August. Yields have varied from around 300 forty pound cartons per acre to over 2000 cartons, but most growers report yields of around 500 cartons per acre (Hartz, 1996; OSU, 2004; University of California 1999; Mueller, 2004; Mueller, 2005; Meister 2004). It is anticipated that yields in the Reservation project will be at least 500 cartons per acre. Melons will be hand harvested every two to three days, sized and graded visually, and packed by size (either 9, 12, 15, 18, or 23 pieces per box) into 40 lb boxes in the field. The boxes of melons will then be hauled to a forced air cooler, where the temperature of the melons will be lowered to 36 to 40 degrees F and maintained at that temperature until they are marketed. Melons should have a shelf-life of at least two weeks (Meister, 2004).

There are some pests that will need to be controlled using organic methods, but none that would be anticipated that could not be controlled with the tools currently available. Weeds would be controlled by the use of the plastic mulch. The fungal disease powdery mildew would be controlled by the use of tolerant varieties and organically approved fungicides such as sulfur, potassium bicarbonate, and Neem oil. Potential insects that could be problems would be aphids, white fly, spider mites, and leaf miners. These could be controlled with organic insecticides such as spinosad, Neem oil, pyrethrum, insecticidal soaps, horticultural oils, and the introduction of predacious insects (Hartz, 1996; OSU, 2004; University of California, 1999; Koike, 2000; Fouche, 2000; Matheron, 2004).

Asparagus

Asparagus is a perennial crop that can remain commercially productive for 15 or more years. The plant is grown for its succulent fleshy shoots (spears), which appear after a prolonged winter rest period. The crown of the plant is the critical growth center. As each growing season progresses, the rhizomes (crown) develop buds that generate the spears for the following spring and summer months. If not cut for food, the shoots that give rise to the spears each year eventually become the ferns of the asparagus plant. These ferns produce carbohydrates that are stored in the crown for the next season spear growth, thus healthy fern growth needs to be maintained during the summer growing season (Phillips, 1995).

Major changes in asparagus production have occurred in the past 20 years with most production now confined to California, Washington and Michigan. The advent of new hybrid and all-male asparagus is a major change. Seed of all-male varieties produces only male plants. These all-male hybrid plants are higher yielding and more tolerant to diseases such as fusarium wilt and asparagus rust. They also have greater longevity than female plants or mixed plantings. Although seed and crowns of all-male hybrids cost much more than standard varieties, the extra establishment cost may be compensated for in the first year of full production by the increased yield (2). The varieties recommended for the Reservation agriculture project are the New Jersey all-male hybrids Jersey Giant, Jersey Knight and Jersey Gem, and the California hybrids Apollo and Atlas (Phillips 1995; Oregon State University 2004; Cantaluppi and Precheur, 1993; Mullen, 1998).

Asparagus has been grown successfully in soils varying from sandy loams to clay loams, but good water drainage is required in any type of soil. The ideal pH for asparagus is 6.5 to 7.5. The soils in the Reservation area are ideal for asparagus production. Fertilization practices in asparagus production vary greatly. Requirements depend on the soil type, crop location, crop age, irrigation method, and climatic conditions. When preparing a field for an asparagus planting, a general recommendation would be to apply 100 lbs/acre of nitrogen and 50 lbs/acre of phosphorous. The nitrogen could be applied as manure or green manure (incorporated) and rock phosphate could supply the phosphorous. The following years, only nitrogen would need to be applied at the rate of 100 to 150 lbs/acre/year. If iron or zinc

deficiencies occur, foliar applications of these materials could be used to correct these deficiencies (Phillips, 1995; Oregon State University 2004; Cantaluppi and Precheur, 1993; Mullen, 1998).

Asparagus production will require about 24 inches of water/acre/year. Furrow, sprinkler, or drip irrigation can be successfully used. It appears that in the Canyon Day area of the Reservation that central pivot sprinkler irrigation would be the most economical system to use (Phillips, 1995; Oregon State University 2004; Mullen, 1998).

Asparagus fields are generally established from mid-March to late April. One-year old crowns or 8-10 week old seedlings are planted in 60 inch wide furrows, eight to ten inches deep, with crowns or plants 9 to 12 inches apart. About two inches of soil are then placed on the crowns, and further filling of the furrow would occur during the season as the ferns grow. This spacing will require approximately 13,000 crowns or plants/acre (Phillips, 1995; Oregon State University 2004; Cantaluppi and Precheur, 1993; Mullen, 1998).

Pest problems in asparagus grown at the Reservation project should be minimal. Weeds can be controlled using mechanical methods, and also locating the field in an area that does not have problems with perennial weeds such as field bindweed and nut grass etc. Potential insect problems are the asparagus aphid, asparagus beetle, and cutworms. These insects can be controlled by the use of cultural practices such as the thorough incorporation of field trash and crop residue to reduce populations of eggs, and good weed management around the fields. Chemical controls could be accomplished by the use of organic products such as pyrethrum, insecticidal soap, Bacillus thuringiensis (Bt) or spinosad. Potential disease problems would be asparagus rust and fusarium wilt. Asparagus rust can be controlled by destroying and incorporating old ferns at the end of the season and eliminating all asparagus volunteers within 400 feet of a production field to destroy or reduce inoculum. Sulfur can be used as an organic chemical control. The use of fusarium resistant or tolerant varieties can successfully reduce problems with this disease (Phillips, 1995; Oregon State University 2004; Cantaluppi and Precheur, 1993; Mullen, 1998, Suslow, 2005).

Asparagus is not harvested the first year (the year of crown establishment). Second year harvest is usually limited to four to six weeks with 500 to 1000 lbs/acre of product. Full-season harvest is conducted the third year, with 2000-2500 lbs/acre of product, while in the fourth season and beyond, approximately 4000 lbs/acre of product will be harvested. Asparagus spears may be cut below the soil surface with a knife, or they may be hand-snapped above the soil surface. Spears seven to ten inches long would be of marketable length, and would be harvested every 24 to 48 hours, depending on temperature. Approximately two person-hours of labor are needed to hand-pick one acre of asparagus at each harvest over the course of a season. Harvest season in the Reservation would most likely be from late-April through June. Asparagus is generally placed loose in plastic boxes in the field, transported to a packing shed where it is hydrocooled, graded, then packed into one of several types of containers. These shipping containers may be 32 lb crates, loose

pack; or 15 to 17 lb half-pyramid crates; or 24 to 25 lb cartons holding 16 packs each of 1.5 lbs; or 30 lb pyramid wirebound crates holding 15 two lb bunches. It is critical that asparagus be maintained at a temperature of around 32 to 36 degrees F during storage and transport. Storage life is 14 to 21 days with these conditions (Cantaluppi and Precheur, 1993; Mullen, 1998, Suslow, 2005; Mayberry 2002).

If an IQF freezing plant is obtained for the berry operation, it could also be used for asparagus. This would extend the season for the plant. There is a great demand for organic IQF asparagus.

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APPENDIX B

Agronomic Crop Recommendations for White Mountain Apache Tribe

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Appendix B - Agronomic Crop Recommendations For White Mountain Apache Tribe

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Alfalfa

Organic alfalfa would be an excellent crop for the proposed WMA production areas. Demand and prices are high, and should continue to increase due to the demand for feed for organic dairies and organic livestock producers.

Estimated yields of alfalfa hay would be in the 4.5-5 tons per acre range and might be increased slightly if an open fall allows for an additional cutting. Fertilizer applications would depend on soil analysis, but in general, alfalfa needs approximately 20 pounds per acre of nitrogen the first year and 120 pounds of P2O5 and 60 pounds of K2O. Seed should be inoculated with a viable strain of rhizobium specific for alfalfa in order for proper nitrogen fixation to occur. Organic fertilizers that could be applied would be composted manure (or other sources of organic nitrogen), soft rock phosphate (14 percent P2O5) and sulfate of potassium (50 percent K2O and 18 percent sulfur). These materials would need to be incorporated into the soil before planting. Alfalfa responds well to irrigation and is a heavy water using crop. Normally 48 inches of irrigation water per season is sufficient for this area.

Major insect pests that could become problems with alfalfa are weevils, aphids, caterpillars, and blister beetles. Cultural controls for some of these pests are cutting the alfalfa at less than 10 percent bloom, controlling weeds around the fields, spring grazing before head stage, flaming with LP gas burners after harvest, and maintaining beneficial insects. Various organic insecticides such as Neem, Bacillus thuringiensis, Pyrethrum, insecticidal soap, horticultural oil, Sabadilla, and Ryania are available if harmful insect populations increase to economically harmful levels

Field Corn

Production of organic corn for grain would be the most logical purpose unless there is a feedlot or dairy in the area, in which case both grain and silage corn production would be appropriate.

Estimated grain yield for organic corn would be in the 135-140 bushel per acre range. Estimates of silage yields would be 17-22 tons per acre. Fertility requirements for corn are 200 pounds per acre nitrogen, 80 pounds of P205, and 60 pounds of K20. Incorporation of green manure or manure before planting could supply most of the nutrient requirements for corn. However, if manure were not available then nitrogen could be obtained from organic sources such as compost, fish meal, cottonseed meal and blood meal. Some of the nitrogen requirement could be supplied by the previously grown crop in the crop rotation scheme.

This could be determined by timely soil analysis. Soft rock phosphate or manure could supply the phosphorus requirement while sulfate of potash or manure could supply the potassium requirement. Water requirement for corn is 36 inches per year.

Corn insect problems such as corn borer, aphids and corn ear worm can be controlled by using cultural controls such as crop rotations, sanitation (incorporating all residues) and preserving beneficial insects. Organic insecticides such as Bacillus thuringiensis, pyrethrum, horticultural oil, and spinosad will also provide control. Weeds can be controlled by using a good crop rotation and mechanically (cultivation).

Blue Corn

Blue corn is a crop that has a potential for better prices for the grain as it is used for human food and has a unique demand, especially for the organic product. This type of corn will normally yield considerably less than regular field corn because of the unavailability of hybrid varieties, but the better price should offset the difference. Recent breeding programs have resulted in better yielding varieties which approach the field corn yields. A special market appears available for organic blue corn and other flour corn, both yellow and while. Yields of blue corn are estimated to be in the 90-100 bushel per acre range.

Blue corn would not require as much fertility as the field corn or other types of flour corn. Nitrogen requirement would be 150 pounds per acre or less, while P205 requirement would be 45 pounds per acre and K20 at 25-30 pounds per acre. This fertility requirement could be obtained from sources as described under Field Corn. Pest control would also be similar to that described under Field Corn.

Small Grains

Organic wheat, barley and oats would be well adapted to the WMA production areas. Estimated yields of these small grains are: Winter wheat 55-65 bushels per acre, durum wheat 85-90 bushels, barley 120 bushels and spring oats 100 bushels per acre. Fertility needs for wheat are nitrogen 100 pounds per acre, P205 60 pounds, and 25 pounds of K20. Barley needs 120 pounds per acre of nitrogen, 60 pounds of P205 and 40 pounds of K20, while oats need 100 pounds per acre of nitrogen, 40 pounds of P205 and 20 pounds of K20. These nutrient requirements can be met by incorporation of green manure or animal manure pre-plant, by residues from previous crops, or by the application of products such as feather meal, compost, cottonseed meal, soft rock phosphate and sulfate of potash. Water requirement for all small grain is about 18 inches per year.

Potential insect problems such as greenbugs, grasshoppers, and leaf hoppers can generally be economically controlled by the use of proper crop rotations and maintenance of beneficial insects and the application of organic insecticides such as horticultural oils and pyrethrum only when pests reach economically damaging levels.

Soybeans and Dry Beans

Organic edible soybeans and dry beans would be excellent crops for the WMA production area, and would be good crops to fit into the crop rotation scheme. The recommended dry bean is the pinto bean, although other types might be grown as well depending on demand for types such as Navy or yellow beans. The estimated yield for pinto beans is 1,800 to 2,000 pounds per acre, while soybean yield should be about 40-50 bushels per acre. Fertility requirements are about 20 pounds per acre of nitrogen, 45 pounds of P205 and 25 pounds of K20 per acre. These nutrient requirements can be obtained by incorporation of green manures, animal manures, other organic nitrogen fertilizers, soft rock phosphate, and sulfate of potash. Irrigation requirement is about 20 inches of water.

A good crop rotation along with proper fertility management appears to suppress most soybean and dry bean pest problems in organic production. Some mechanical weed control may be needed, while occasional outbreaks of leaf and pod feeding caterpillars are readily controlled by well-timed applications of bacillus thuringiensis.

Chile

Organic chile could be grown for both the fresh green or dry red chile market. Combined yield of green and red chile is estimated to be 5-6 tons per acre. Green chile alone should yield in the 5 ton per acre range. Fertility requirements are 80 pounds per acre of nitrogen, 45 pounds of P205, and 30 pounds per acre of K20. Incorporation of green manures, composted organic products, soft rock phosphate, and sulfate of potash could supply these nutrients. Water requirement for chile is about 24 inches per year.

Potential insect problems with chile are pod worms, leaf hoppers, and aphids. The use of beneficial insects, proper crop rotations and organic insecticides such as pyrethrum, bacillus thuringiensis, horticultural oil, Neem , and spinosad should economically control these pests. Pathogens that could become problems in chile production would be bacterial leaf spot and powdery mildew. Products such as copper, horticultural oil, sulfur, and potassium bicarbonate should provide adequate control of these pests. Root rot should not be a problem, due to the excellent soil water drainage in the recommended planting areas. At present there are no adequate mechanical harvesters for the green chile, however they are in

the development stages, and may be available in the near future. At present green chile would need to be hand harvested.

Potatoes

Potatoes have proven to be good crops in areas similar to the Canyon Day and Cibeque areas. Estimated yields of organic Russet type potatoes are about 350 cwt per acre. Fertility requirements for potatoes are 200 pounds per acre of nitrogen, 180 pounds of P205, and 150 pounds of K20 per acre. Incorporated green manures, composted manures and other organic products, soft rock phosphate and sulfate of potash, along with residues from previous crops can be used to supply these nutrients. Water requirement for potatoes is approximately 24 inches per year.

Potential pests can be adequately controlled using proper cultural practices and approved organic pesticides.

Onions

Onions can be quite profitable from year to year but also come with large risks due to over supply from competing production areas. However, organic onions appear to have a much higher demand and less competition, thus could be much more profitable than the conventionally grown product. Estimated yield of onions is 400-450 cwt per acre. There are onion machine harvesters available, which would reduce considerably the need for hand labor in onion production. Onion fertility requirements are 200 pounds per acre of nitrogen, 1200 pounds of P205, and 60 pounds per acre of K20. Crop rotations and incorporation of green manures, composted manures and other organic plant products, soft phosphate and sulfate of potash can be used to supply the fertility requirement. Water requirement for onions is 24 inches per year.

Potential major insect pests of onions are thrips, onion maggots and wireworms. Maggots and wireworms can generally be controlled by proper sanitation, fall plowing and crop rotations. Thrips can be adequately controlled by use of biological controls (predators) plus application of insecticides such as pyrethrum, insecticidal soap, Neem, and rotenone. Soil pathogens such as pink root and fusarium can generally be adequately controlled by using proper crop rotations.

Crop Rotations

Successful organic annual crop production (field crops and vegetable crops) can only be achieved by using proper crop rotations. Here are potential crop rotations for both animal feed crops and human food crops. In some instances crops can be included in both rotation schemes.

Organic food crops:

Soybeans-blue corn-dry beans-vegetable (onion, chile, potato). Should plant a green manure crop consisting of winter wheat or oats with hairy vetch or winter peas each fall following removal of crop, and incorporate in the spring before the next scheduled crop planting.

Organic feed crops:

Alfalfa (3 years)-corn (1-2 years)-small grain-corn-alfalfa, or Soybeans-corn-small grains-soybeans or alfalfa. Should plant a green manure crop consisting of winter wheat or oats with hairy vetch or winter peas following each crop except alfalfa which would be incorporated before planting the following spring.

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APPENDIX C

Suitability of Christmas Trees

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Appendix C - White Mountain Apache Christmas Tree Enterprise

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Introduction

The aim of this report is to discuss the technical feasibility of developing a Christmas tree enterprise on White Mountain Apache Reservation land. Areas at or near Cibecue, Whiteriver, and Bonito Prairie are understood to be potentially available for developing such an enterprise and comments are directed to their use in particular.

The report will discuss unique features potentially supporting such an enterprise. Likewise, as an overview of enterprise activities is presented, it will discuss difficulties growers face. General and specific recommendations will also surface.

Features capable of prohibiting such an enterprise from the onset are climate, land, and severe market limitations. These will be assessed in Section I. The technical feasibility of the project will emerge as Christmas tree production is discussed in a step by step manner in Section II. Both sections discuss product opportunities and the activities, equipment and facilities involved. Understandably, this report does not provide formal economic or social assessments.

Section I. General Merits of a Christmas Tree Enterprise

WMA Reservation Climate and Land Suitability

Climate and land must be suitable for a Christmas tree enterprise. The climate of Tribal land presently available for production near Cibecue, Canyon Day (near Whiteriver) and "Bonito Prairie" is suited to Christmas tree production. Elevations fall within the 5,000 to 6,000 range thus supporting the culture of numerous Christmas tree species. The climate summaries for Cibecue (5,000 ft.) and Whiteriver (5,250 ft.) are given (Table 1), along with McNary, Arizona (7340 feet elevation). The McNary data combined with data from Cibecue and Whiteriver (at lower elevations) can be used to bracket extreme temperatures at Bonito Prairie (6000 to 6,200 feet), barring unknown topographical influences. Collectively, the data indicate site temperatures favorable for Christmas tree culture. However, precipitation is insufficient at each site to support nursery and Christmas tree culture.

Additional climate inferences can be drawn from the Arizona Plant Climate Zone Map. This map places Cibecue, Canyon Day and Bonito Prairie sites in Zone 2: "Cool Plateau Highlands" (Elevation 4,000-6,000 feet). In Zone 2, winters are mostly cold with drying winds. Zone 2 provides a growing season of 150-200 frost-free days. The last date of killing frost in spring usually is in late April to mid-May, depending on location. Zone 2 is roughly equivalent to USDA Zone 6 (Average Annual Minimum Temperature = -10 to 0 degrees F). Annual precipitation varies from less than 10 inches to more than 20 inches.

Site physical attributes are critically important to success. Soils at Canyon Day and Cibecue sites have depth and textural attributes that will support tree growth, soil working and drainage. The expansive Bonito Prairie area has comparable soil in some areas but in others surface rock and heavy soils are prohibitive. Buchanan Consultants, Ltd. (2006) recently completed a soil survey done to more definitively delineate soils suited to Christmas tree culture and other crops. This survey exceeds the Mitchell (1981) survey of the Bonito Prairie

in both scope and detail and reflects state-of-the art classification and technology. Exhibit D of the Buchanan report shows areas sufficiently large to specifically support Christmas tree production on a scale commensurate with the project proposed. Criteria (Table 2 of the report) used to identify Christmas tree areas take into full account factors that critically influence tree growth and culture. This survey was by no means exhaustive in the sense of identifying all suitable Christmas tree areas within the domain of the Bonito Prairie survey area comprising 41,000 acres. More survey work would be needed to map them, or to determine which moderately limiting areas might be affordably modified.

Land at Bonito Praire, Cibecue, and Canyon Day proposed for project inclusion is level to moderately sloped and will therefore allow equipment to work freely. Each site is generally from deep rooted woody vegetation or heavy debris. All three sites are accessible by road.

Overall, with supplemental irrigation, each of the three proposed sites will support Christmas tree culture. Species acceptable for commercial production can be grown and that the period between planting and harvesting would compare favorably with sites used elsewhere in the U.S. Christmas tree species and cultural methods will be more fully discussed under Section Two of this report.

Table C-1
Climate Data Comparison for Whiteriver, Cibicue, and McNary, AZ

Average Maximum Temperature (F)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Whiteriver	53.2	56.5	61.6	69.3	78.2	88.2	90.2	87.5	83.7	74.5	63.0	54.1	71.7
Cibecue	52.3	56.5	61.8	70.1	78.8	88.5	91.3	88.3	84.5	75.0	62.6	54.0	72.0
McNary	44.5	46.3	51.1	60.0	69.4	79.0	80.9	77.9	74.2	65.3	53.5	46.3	62.4

Average Minimum Temperature (F)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Whiteriver	21.4	25.0	29.3	34.9	41.9	50.0	57.5	56.3	50.3	39.1	28.6	22.3	38.0
Cibecue	21.9	24.5	27.8	32.5	38.2	46.0	56.3	55.0	48.3	37.6	26.9	23.4	36.5
McNary	17.5	19.6	23.3	28.7	35.0	42.4	49.5	48.9	42.9	33.6	24.3	18.9	32.1

Average Total Precipitation (in.)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Whiteriver	1.48	1.39	1.63	0.89	0.49	0.46	2.72	3.26	1.78	1.38	1.27	1.46	18.22
Cibecue	1.83	1.56	1.65	0.89	0.46	0.55	2.39	2.98	1.80	1.67	1.20	1.55	18.54
McNary	2.49	2.25	2.68	1.23	0.72	0.66	3.29	3.94	2.40	2.19	1.86	2.53	26.22

Table Source: Western Regional Climate Center Division of Atmospheric Sciences, Desert Research Institute, Reno, Nevada, Arizona Climate Summaries Web Site.

Market Opportunities

The National Christmas Tree Industry and the Regional Market

Thirty five million trees are harvested each year in the United States. About 7,500 year-round workers plus 100,000 part-timers are needed to plant and tend these. Presently, the vast majority of Christmas trees are produced in the Pacific Northwest, North Carolina, Lake States, and areas in the Northeast. Beyond these areas, one will find more localized operations and markets derived from species found to be acceptable substitutes for those capturing more of the market. Southerners, for example, have developed cut and U-cut operations around Virginia pine, Leyland cypress or Arizona cypress. U-cut operations may also offer pre-cut Fraser fir from North Carolina to round out their offering. Such niche markets are found in Alabama, Texas, and Florida and elsewhere where high quality fir trees commanding the highest prices cannot be grown.

Production on the WMA Reservation would feature a nationally recognized species from each of the major Christmas tree groups (i.e., true firs, spruces and pines) while also benefiting from the niche market approach and some exclusive marketing opportunities.

Another feature capturing attention is the relative absence of Christmas tree plantations in the mountainous Southwest, leading one to believe that regional production may have a competitive advantage. By virtue of its location, the Reservation has potential market opportunities in cities such as Phoenix, Tucson, Las Vegas, El Paso, Albuquerque, and a host of towns with populations of 50,000 or more. With Mexico being near International markets are not out of the question but do present special challenges. Arizona would have an exclusive advantage with U-cut operations. These offer families an experience in addition to a product with both bringing economic rewards to the operator. Indications are that Arizona's national forests are not meeting the demand for the U-cut experience. In 2005 less than 5000 tree cut permits were available through a lottery system. Nationally, more than 20 percent of the trees sold are from U-cut farms. Overall, one questions why Arizona should not compete for its share of the national industry while creating some markets only it can host owing to its location.

Opportunities also exist for related products that are weakly marketed, if at all, within the region. Reference here is to large cut Christmas trees, potted or containerized live Christmas trees of species best serving the region, and Christmas wreaths, garlands and related products. Transportation and shipping do not appear to be obstacles owing to WMA reservation access

to state and interstate highways. The Canyon Day site offers a logical outlet for shipping and direct sales.

Christmas Tree Related Products

Small Christmas trees and planting stock

A Christmas tree enterprise develops facilities and staff technical knowledge that can be directed toward other products. It would be beneficial but not necessary for the operation to include nurseries providing opportunities for growing its own planting stock and marketable small tree products such as table top Christmas trees.

Evergreens

Evergreen industries are often associated with Christmas tree grower sales because the raw material can be derived from their plantations and forests. Floral greens, wreaths, garlands and related products could provide opportunities for seasonal forest and plantation craft labor. Opportunities for utilization and conservation of nontimber forest products appear to merit further exploration in view efforts elsewhere to identify and inventory marketable plant resources on public and tribal lands (Von Hagen et al., 1996).

Commercial Restoration and Landscape Nursery

Reforestation, restoration and ornamental conifers could be grown as well with the skill derived from the Christmas tree enterprise. Short rotation woody plant crops and specialty crops are logical options. The Santa Ana Native Plant and Tree Nursery developed by the Santa Ana Pueblo of northern New Mexico produces low-water use plant materials for the wholesale landscaping market. Clients include licensed landscape professionals, designers, landscape architects and contractors, retail nursery stores and other wholesalers. The nursery produces more than 250 species of plants. These include herbaceous perennials, annuals and biennials; herbs, grasses, trees, shrubs and vines; and vegetable transplants. Similarly, a community goal of Chippewa Cree Tribe members located near Havre, Montana is to establish a seedling nursery business and Christmas tree farm. At present, most of the community members are wage earners. Approximately 662 Indian people reside there.

Labor, Facilities and Raw Materials

The White Mountain Apache have access to labor needed for seasonal task work (e.g., planting, shearing and harvesting over weeks or months). Facilities to be developed for the enterprise will be scaled to the size of field operations. They may include processing sheds and cold storage that could be used for other Tribal farm and plant craft activities. Finally, with a central market site at Canyon Day, visitors drawn to tree crops would bring greater seasonal traffic that may benefit tourism.

Finally, a neglected resource of the WMA Reservation is the genetic endowment of its native plant species. The Tribe has access to some of the best seed available for growing Christmas trees and landscape plants for xeric landscapes. Numerous published studies have shown that Arizona and New Mexico produce superior seed for Christmas trees and ornamentals grown in Pennsylvania, Ohio, Michigan, Alabama and Georgia, for example. These and other states use seed from the southwest mountains to produce seedlings and trees they market locally and nationally. The WMA Tribe would have the opportunity to derive economic benefits from its own locally and regionally adapted seed, often having superior commercial value nationally.

Section II. Planning and Development of the Christmas Tree Enterprise

Introduction

This section discusses the processes involved in executing a Christmas tree enterprise. Crop opportunities available to a White Mountain Apache enterprise are identified but also can be inferred from the information given. Tasks fundamental to a Christmas tree enterprise are discussed. The background information provided will indicate their relevance to crop success. Equipment and farm facilities needed are indicated with alternatives provided.

Definitive statements regarding project scale must be postponed until the overall size of the farm operation is given. However, many major enterprises existing today began with a few hundred acres or less, but now comprise a thousand or more acres. The lands in question could support several hundred acres collectively, and ultimately could be used to develop an operation of a thousand acres.

Nursery operations are seen in this section as supporting plantation management. However, nursery work could be more fully developed into a major operation with independent products. In any case, the greatest opportunity for enterprise success will exist when the grower has control over seed and seedling quality.

Tree species will be recommended along with the markets best suited. This should aid further refinement of the project scope. For the present it will allow farm budget development. Tasks are discussed and presented in table form along with representative estimates of hours needed to complete them. A market survey will be needed to supply current prices for the products discussed.

Each component of Christmas tree production must be addressed from the standpoint of maximizing both productivity and quality. Intensive cultural work is needed to produce high

quality Christmas trees. Notable activities include selection and evaluation of planting sites, species and seed source selection, proper planting techniques, weed control, fertilization where needed, insect and disease control, shearing and shaping to improve form and density, and harvesting. Failure to deal appropriately with any of these activities can result in management difficulties, pest problems, or production of low-quality trees that are difficult to sell in competitive markets.

Choice of Lands for Christmas Tree Farms

Site Considerations

In the past, Christmas tree operations were often relegated to marginal or so-called "wastelands" that were too steep, infertile, dry or eroded for traditional crop production. This is no longer the case because consumers increasingly demand high quality trees derived from intensive culture including irrigation, fertilization, shearing, mowing, chemical weed control, and spraying for insects and diseases. Consumer interest is also sifting more toward conifer types (e.g., true firs) that are more site demanding.

Intensive culture coupled with increases in size of many Christmas tree operations has led to increased mechanization, greater labor efficiency and to the use of land facilitating both. From an operational view, land with level to gently rolling terrain is the most desirable. Compared to rugged terrain, it allows all operations, from site preparation to harvesting, to be accomplished faster and with less wear and tear on equipment and staff. Also, as slopes become progressively steeper, land becomes more vulnerable to erosion.

Land that is relatively free from obstacles, particularly rocks, large trees, fencerows and to some extent even smaller brush, is preferred. These must be removed or operations will be severely hampered. Removal can be quite costly, particularly if it involves use of heavy equipment.

It is important to match the tree species carefully with the existing soil conditions. Of the species that might be grown for Christmas trees in a given area, some may be much more exacting in their moisture and fertility requirements than others. For example, Scotch pine has relatively low requirements for both moisture and nutrients and, consequently, can be grown successfully on a variety of sites having a wide range of conditions. In contrast, many true firs, spruces and Douglas-fir are more demanding and do well only on sites that are at least relatively moist and fertile.

Soil

For Christmas tree production soil should be sufficiently deep to allow planting to a depth of 12 inches and sufficient root development to support trees grown to Christmas tree size. Species differ in their soil drainage requirements but all will perform well in moist well drained soils. Sites with standing water should be avoided or corrected to improve drainage. Concentrations of wetland plants indicate water accumulation.

Soil cultivation and machine planting will require soil free of rock outcropping and stone fragments or cobble large enough to impede these activities. Coarse-textured soils, sandy loam in nature, are preferable to finer silt and clay soils. Most species will grow on these soils and drainage is seldom a problem. Another advantage of sandy soils is the relative ease and economy of controlling weeds.

Soil should have a pH value suited to species selected. Soil reaction affects nutrient availability which can be adjusted to some practicable extent through irrigation water treatment and soil amendments. Excessively alkaline soils have undesirable physical properties.

Plant nutrients essential to normal growth may be lacking on very infertile soils. Where any of the essential elements are not available in minimal amounts, one or more of the following symptoms may be observed: low initial survival, stunted growth, fewer and shorter needles, and needle discoloration. Drought conditions aggravate the effects of low fertility, so thin topsoil with underlying coarse gravel should be avoided. In general, the more fertile the soil the more vigorous the growth will be, but there might be additional expenses to control competition.

Access and Security

Plantation access and security are also factors that should be considered in selecting an area for Christmas tree production. Many Christmas tree operations, particularly harvesting, may have to be done during inclement weather. Good roads to plantation areas are needed, especially if trees are to be moved by truck. Easy access also affords crop monitoring. Site selection and marketing aims should be considered jointly. Good access encourages wholesale and retail buyers and is critically important if the grower plans to develop a retail operation where consumers choose and/or cut their own trees. U-cut farms typically require all-weather roads.

Choice of Species

Importance of Selection

Not all Christmas tree species grow equally well on all sites. Factors such as wind and air drainage, water availability, soil texture and fertility, and will affect growth rates and tree quality. In general, true firs and Douglas-fir require better quality sites than pines and spruces. Species that are planted "off-site" will be stressed more frequently with survival and growth reflecting prevailing conditions. Stressed trees are more likely to be attacked by insect or disease pests, and will be less likely to tolerate or recover from pest damage, than healthier trees.

Most conifers planted for Christmas tree production require 4 to 10 years to reach maturity, depending on the species, the size of trees produced, and the intensity of management. Pines generally can be produced faster than spruce or fir trees, although size of planting stock, soil fertility and water availability can significantly affect rotation length. Through better seed selection and more intense culture, firs and spruces are grown in shorter rotations than decades ago.

Relevant Christmas Tree Genera and Species

In selecting species, it is helpful to recognize a simple principle: Species within a genus are more similar in their site requirements than are species of different genera. A given genus will occur naturally in environmentally similar habitats throughout the world. The second principle of importance is that some genera are more genetically diverse, evidenced by their comparatively large numbers of wide-spread species. This explains why the genus *Pinus* can be planted over a wider range of site conditions than less genetically diverse genera (e.g., *Picea* and *Abies*). Descriptions of Christmas genera are important for understanding characteristics and needs that generally apply to a given genus. The individual species discussed are relevant to the Reservation Christmas tree enterprise.

Abies (True Firs)

Several species have excellent Christmas tree properties, including compact crown, soft fragrant foliage, and favorable shearing response. Shipping qualities and needle retention are very good to excellent.

The true firs are widely scattered through the forests of North and Central America, Europe, Asia and North Africa. They grow in cool temperate regions and mountains. It follows that fir

Christmas trees prefer moist, cool climates and moist, well drained soils with moderate to high fertility.

Needles of the true firs are borne singly along the twigs and are usually fairly short and rounded at the tips. Needle retention on cut trees is excellent. The basic conical form of trees is good, but irregular growth rates and limbs of uneven length usually require some shearing in order to produce high quality trees. Firs are subject to late spring frost injury. Low lying sites or "frost pockets" should be avoided when possible.

Abies concolor

White fir (*A. concolor)* occurs naturally from northern Oregon, southward through the mountains of California, New Mexico, southern Colorado, and Arizona into northern Mexico. It is one of the most popular Christmas tree species in the western states. Its needles are longer than most fir species, 1½" to 2½" long. Needles are flattened, glaucous on both sides, curve upwards along the twigs and smell like tangerines when crushed. It is popular where sold as a cut tree, is an excellent U-cut candidate and can be dug and sold as a landscape tree.

Trees grown from Arizona and New Mexico seed tend to grow faster than trees from other regions and are less susceptible to winter injury than trees from more southerly sources. Trees from more northern sources have not grown as rapidly when planted in the eastern United States. Transplants (2-2 or 2-3) grown from white fir seed from central Arizona sources have been shown to develop into quality Christmas trees.

White fir usually will produce a premium Christmas tree in about seven years. Improper culture or seed source will slow growth considerably. White fir is susceptible to late spring frost and, therefore, should be planted on sites with good air drainage. Branch buds are sensitive to winter desiccating wind, common to open exposures at high elevations.

West Coast sources are not winter hardy in Arizona and New Mexico. Rocky Mountain white fir is generally bluer than west coast sources. Although some southern New Mexico white firs are much greener than southern Colorado sources, extremely glaucous specimens can be found in north central New Mexico.

Site Requirements: White fir is adapted to a wide variety of sites and soils. White fir will tolerate drier conditions and heat better than most other firs, especially after it is well-established. It also grows well under varying soil pH conditions.

Coldbark fir (A. lasiocarpa)

Corkbark fir is native to the southern Rocky Mountains and trees are sometimes harvested from native stands. It is not recommended for plantation production because its form and growth are much inferior to white fir.

Abies procera (Nobel fir)

Abies procera (Noble fir), a popular tree grown in the Pacific Northwest and exported nationally, is not suited to the climate of Arizona.

A few species of ***Abies*** deserve further attention but at present are not recommended for Arizona:

- California red fir (***A. magnifica****.)* occurs naturally in the mountains of California and Oregon. Its needles are shorter than white fir. Red fir is not currently grown in Arizona but deserves attention because of its attractive blue green foliage. Its elevational limits may be lower than white fir in Arizona. Seed sources of the eastern Sierras should be better adapted to cold and aridity.

- Nordmann fir (***A. nordmanniana),*** also known as Caucasian silver fir, is native to the mountain regions of the West Caucasus. Juvenile trees have straight stems and narrow pyramidal crowns and dark green foliage. Nordmann fir is a widely used Christmas tree species in northern Europe and tree breeding research is being directed to its market value (Nielsen and Chastagner, 2005). In recent years there has also been increasing interest in using Nordmann fir as a Christmas tree in North America. This species is not grown widely in the U.S. because viable seed has been difficult to obtain. It deserves attention because, among true firs, it is above average in tolerance to heat and soil calcium.

Major Pests of True Firs

Major Pests in Pacific Northwest plantations (Rinehold, 1999, p. 6) are Balsam twig aphid (*Mindarus abietinus*), Spruce spider mites (*Oligonychus ununguis*), Balsam gall midge (*Paradiplosis tumifex*), and Lirula needlecast (*Lirula sp.*)

Pseudotsuga (Douglas-Firs)

Douglas-fir (Pseudotsuga menzesii)

Douglas-fir is not a true fir and is similar in growth form and appearance to the spruces. It is native to a wide geographic area in the West and Canada and consequently shows considerable genetic variation. Douglas-fir possesses many attributes of the ideal Christmas tree. Its branches are spreading and drooping and the needles are soft, dark green or blue green in color and usually 1 to 1 ½ inches long. They have a sweet fragrance. Its natural conical form and shearing response result in a high quality product.

Seedlings grown from seed collected on the West Coast are generally not winter-hardy in Arizona. On the other hand, seed from the Coconino, Lincoln, Santa Fe, San Juan, San Isabel and Kaibab National Forests produce superior Christmas trees in northeastern states. These sources produce trees having good growth rates and relatively long needles borne singly along the twigs and usually have bluish or blue-green foliage. Arizona and New Mexico seed sources of Douglas-fir are the bluest available to growers. They also break bud somewhat later in the spring; thus, they are less subject to late spring frost damage.

Douglas-fir has well established markets although competition from true firs has shifted it from its once dominant position. Noble fir (a true fir) and Douglas-fir are among the species most favored by Pacific Northwest growers. Excellent needle retention and shipping quality make it well suited for national markets. About seven years are needed to produce 6 to 7-foot trees on good sites. Gall aphids and *Rhabdocline* needle cast are the major pests affecting Douglas-fir.

Major pests of Douglas-fir in Pacific Northwest plantations are Rhabdocline needlecast , *Rhabdocline pseudotsugae*, Swiss needlecast, *Phaeocryptopus gaumanni*, and Cooley's spruce gall adelgid, *Adelges cooleyi* (Rinehold, 1999, p. 6).

Spruces (Picea spp.)

Spruces are native to cool parts of the northern hemisphere. The species are much less distinct than in the pines (Wright 1976). Characteristically, spruces are more site demanding and slower growing than most pines. Although most species of spruce prefer moist, well drained soils with moderate to good fertility, they will grow on rather sandy soils if there is a favorable water table throughout the growing season. Spruces often undergo a slow-growing establishment period following planting, after which growth is usually relatively rapid. As a group, the spruces are subject to spring frost injury if they leaf out early. Low lying sites or "frost pockets" should be avoided when possible.

Although juvenile spruce trees are more symmetrical than pines, some shearing is needed to produce high quality Christmas trees. Spruce needles are short, rarely exceeding more than one inch in length. Several species have particularly attractive foliage and aroma. Needle retention varies among species but generally is not as good as for pines. Consequently, spruces should be marketed close to production areas so they can be sold fresh.

Colorado Spruce (*Picea pungens)*: Blue spruce, or Colorado blue spruce, is native only to the central Rocky Mountain States. It occurs naturally in higher elevations of western Wyoming and eastern Idaho southward through into Arizona and New Mexico. In the southern Rocky Mountains, blue spruce grows singly or in small groups along the banks of streams, or on moist loamy soils of canyons and mountain valleys. Although a western native, it is planted extensively throughout much of the United States. as an ornamental and Christmas tree. It is adaptable to a wide variety of sites and soils, including heavier clays, but does best on well-drained sandy soils.

Blue spruce is finding increasing popularity as a Christmas tree as a result of its symmetrical form and attractive blue foliage. The species has a natural Christmas tree shape and requires little shearing. Needles are generally longer than those of Norway and white spruces and are sharp-pointed. Although foliage on some trees is a bright bluish color, most nursery run seedlings are green to blue-green. This characteristic is somewhat related to seed source. Generally, trees produced from seed originating in the southern Rocky Mountains of southern Colorado, Arizona and New Mexico are preferred for Christmas trees. Seed from the Coconino, Kaibab Lincoln, Santa Fe, San Juan, San Isabel National Forests produce the best trees. These sources produce trees having good growth rates with bluish or blue-green foliage. They also break bud somewhat later in the spring; thus, they are less subject to late spring frost damage.

Blue spruce is more popular in choose-and-cut operations than in large wholesale plantations. Owing to its stout branches it does not compress as well and does not ship as easily as some species. Fewer trees can be shipped per load and compressibility and needle retention should be considered in developing long distance markets. Its popularity as an ornamental leads many consumers to use blue spruce as a living Christmas tree, to be planted after the holiday season. Spruces have commanded and continue to command an important portion of the Christmas tree market. Historically, white spruce and Norway spruce were the major species. Today Colorado spruce is more important owing to its superior needle retention and other attributes.

Engelmann spruce (*P. engelmannii)* is wide spread throughout the mountains of the western states, including Arizona. It is sometimes is harvested from the wild for Christmas trees but is not recommended for plantation production because its form is inferior to blue spruce. Jones and Bernard (1977) reviewed the genetic and ecological distinctness of Southwestern spruces. They explained how to distinguish Engelmann and blue spruces by crown shape, branch angle, bark and foliage. This information is useful to growers collecting their seed.

White spruce (*Picea glauca*)

White spruce is found in the northern latitudes of North America. It will grow on sandy soil, but does best on well-drained loam. It has good form and color and requires minimal shearing. Dwarf Albert spruce (***Picea glauca 'Conica')*** can make an excellent table top Christmas tree.

Norway spruce *(P. abies.)* was imported from Europe and is best suited to a cool, moist climate. An overall coarse appearance of the tree makes this species less desirable than either blue or white spruce. Norway spruce is not generally recommended for commercial Christmas tree plantations.

Major *Picea* pests (Rinehold , 1999, p.7): White pine weevil (*Pissodes strobi*), Cooleys spruce gall adelgid (*Adelges cooleyi*), Pine needle scale (*Chionaspis pinifoliae*), *Rhizosphaera* needlecast (*Rhizosphaera kalkhoffii*), *Cytospora* canker (*Cytospora kunzei*).

Sawflies, gall aphids, spider mites, white pine weevil, ***Cytospora*** canker and ***Rhizosphaera*** needlecast are the major pests affecting Colorado spruce.

Pinus

Native pine species are widely distributed in the northern hemisphere. Pines are the fastest growing Christmas trees, but were rarely grown as Christmas trees more than 40 years ago. Their juvenile crowns are less dense than spruces or true firs, but shearing generally improves their appearance.

Scotch Pine (Pinus sylvestris)

Although native to Europe, Scotch pine is a widely planted Christmas tree species in the United States. It is hardy and grows well over a wide range of soil and moisture conditions. It prefers moist, well-drained soils but is also well suited to sandy soils. Although not as popular as it once was, Scotch pine still occupies a niche in the industry because it has good form, holds its needles well, and can be shipped to cold and warm environments.

Considerable variation exists among geographic seed sources (provenances) in foliage color, needle length, growth rate and stem straightness. The needles of Scotch pine are mostly blue-green, 1 1/2 inches to 3 inches long, and slightly twisted. Many varieties differ in length, color, and needle stiffness. Often a colorant is used to improve fall color, especially of trees grown from seed sources more prone to winter yellowing. Many commercial nurseries have developed varieties with distinctive characteristics and sell seedlings specifically as

Christmas tree stock. Sources from northern Spain and southern France are widely used. Scotch pine usually requires about 7 years to produce a 6-foot Christmas tree. The tree is subject to crooked stems and fast growth, and it requires heavy pruning. Scotch pine also has inherent problems with needle cast, gall-cankers, tip moths, and sawflies.

Afghan pine (*P. brutia subsp. eldarica =P. eldarica* Medw.). Naturally occurs only in the Caucasus Mountains of southern Russia. It is among the few pine species able to grow well on calcareous soils with pH values above 7.8. Afghan pine, or Eldarica pine, is the fastest growing Christmas tree in North America. Marketable trees can be grown in 3-4 years, depending upon planting time, site and culture. Its fast growth is attributed to the production of numerous, evenly spaced whorls of growth during each growing season. Multiple flushes are particularly evident after establishment (Fisher, et al., 1986). At present, it is popular as a live Christmas tree in semi-arid to arid areas with well drained soils such as southern Arizona, New Mexico and West Texas. It has become popular as a U-cut tree west of San Antonio, Texas. Its shearing requirements are much like Virginia pine, another fast grower.

This pine is not adapted to high clay content soils with poor drainage. Growers who ignored early warnings about this potential hazard met failure. It also suffers from *Diplodia* when subjected to a highly humid environment. In Arizona and New Mexico, nearness to forests with Commandra blister rust could create problems and this demands attention. Tip moth can threaten tree quality and will require a control program if encountered (Phillips, et al., 1988).

Overall, much is known about producing this tree under irrigated conditions similar to those found on the Reservation. Its rapid growth could provide and early return on investment while enabling staff an opportunity to develop growing expertise over a brief time. Because this species can be grown for shelterbelt trees, its use can be extended beyond plantations and urban settings.

Austrian pine (***P. nigra**.)* is native to Europe. It grows well on loamy to heavy soils and appears to be more tolerant to alkaline soil conditions than most pines. Its dark green needles are objectionably long and rather stiff. However, needles are strongly attached and are retained well under warm, dry conditions. Shipping quality is not good because branches tend to be stiff and brittle. Austrian pine is especially suited to flocking due to its strong branching habit. Austrian pine Christmas trees are grown on a relatively small scale and its use should be limited to landscaping. It occupies a low priority for the project considered.

Southwestern White Pine (Pinus strobiformis)

Southwestern white pine (*Pinus strobiformis*), is also called border pine because it is native to the mountainous areas of southern Arizona and New Mexico, west Texas and northern Mexico. It is related to limber pine (*Pinus flexilis*) and Mexico's white pine (*Pinus ayacahuite*) and is now considered a species in its own right.

P. strobiformis is recommended over *P. flexilis* for plantation production because it grows faster. *Pinus ayacahuite* serves as a plantation tree in Mexico but more information is needed for consideration.

P. strobiformis is one of the bluest of the white pines. Its soft, densely arranged needles on all branches are retained three years. It is a five-needle pine very similar to eastern white pine used for producing Christmas trees. However, its needles are usually shorter, darker and bluer and its branches stouter. Southwestern white pine can be found in some choose-and-cut plantations, but is not a major species in the wholesale industry. It is hardy in the northeast U.S. and has found its place in landscapes.

Southwestern white pine is resistant to *Dothistroma*, *Diplodia* and Pine Wilt. One would assume border pine is susceptible to the diseases that attack other white pines. *Cronartium ribicola* is a recently established pathogen of southwestern white pine (*Pinus strobiformis*) in New Mexico. Therefore, white pine blister rust poses a special threat in the Southwest where white pines are generally isolated into small populations subject to local extinction.

Pinon pine (*Pinus edulis*) occurs naturally from southern Wyoming, western Texas and northern Mexico but is most conspicuous in the Four Corner states: New Mexico, Arizona, Colorado and Utah. Pinon Christmas trees generally are harvested from natural stands. Under plantation conditions trees will be harvestable in 10 to 12 years. Pinon is one of the most popular trees marketed in the Santa Fe, New Mexico area. Live Christmas trees or potted products appear most attractive and are highly desired for landscaping.

Swiss stone pine (*P. cembra.)* occurs naturally in the high mountains of southern Europe, from the Alps to the Carpathians. Its conical crown is unusually dense because needles are retained about five years. Its growth rate is similar to pinon but its appearance is superior. It is not presently planted in the Southwest but should be more cold-hardy than pinon in mountain valleys at high elevations. This species deserves greater attention, particularly as a live Christmas tree, because its proportions and growth are ideally suited to garden plantings.

Cupressus

Arizona cypress (*C. arizonica.)* occurs naturally in Arizona and western New Mexico and grows on relatively dry, infertile soils. It tends to be more upright when young and more spreading with age and has aromatic bluegreen, evergreen foliage.

Arizona cypress is an excellent Christmas tree when young. Its natural form is too columnar, but this can be corrected easily by shearing. Its best characteristics include fast growth, a beautiful blue color and an excellent aroma. The “scale like” leaves are minute, about 1/16 inch long. It is relatively easy to grow in most soils that drain well. Under optimal conditions, Christmas trees can be grown in 4 years.

Arizona cypress can be easily grown from seed or propagated with cuttings. “Carolina Sapphire” and other cultivars have been developed for Christmas tree and nursery industries. It is increasingly planted in the South for Christmas trees where soils are well drained. Arizona has a good opportunity to market this tree because of its immediate access to superior native seed native stands. Arizona seed is the basis for production of this tree in the South and elsewhere with Arizona locations such as Clifton being preferred.

Leyland Cypress (x Cupressocyparis leylandii)

Leyland cypress (**X Cupressocyparis leylandii**) is an intergeneric (of two separate genera) cross between Monterey cypress (***Cupressus macrocarpa***) and Alaska Cedar (***Chamaecyparis nootkatensis***) that originated in England in 1888. Since that time, many cultivars have been selected that differ in coloration and growth habit for use in shelterbelts, hedges, landscape plantings, and Christmas tree production.

Recently, “Leyland cypress” has shown promise for Christmas tree production because of its fast growth, natural form and attractive foliage. The foliage is scale-like without the sharp needles common to Arizona cypress. Foliage color varies by cultivar from bright green to grayish green. Based on trials in the southern United States, 'Leighton Green' cultivar is the most desirable for Christmas trees. Shaping is required if quality Christmas trees are to be produced (McKinley, 1995) but is less demanding than more widely used species.

Christmas trees are usually harvested at ages 3 to 6 (McKinley, 1997). Many growers produce saleable trees in four years on quality sites. Propagation is by rooted cuttings as the cross does not produce seed. Leyland cypress may develop into acceptable Christmas trees with very little pruning. However, some pruning is necessary to produce consistently uniform trees. Early removal of double leaders reduces field pruning work.

Unlike most Christmas tree species, Leylands have no noticeable aroma. Because of its tendency to dry quickly after being cut, Leyland cypress is generally recommended for production only on choose and cut farms (McKinley, 1997). It is well suited to containerization for Christmas tree and nursery purposes.

Leyland cypress will tolerate a wide range of soil types from clay to sand, acid to alkaline. Growth is best when moisture is adequate, but it is also drought tolerant and is suitable for dry sites. It is classified hardy to USDA Hardiness Zone 7 (average minimum winter temperature 0° to 10°F. There are few major diseases or insect pests that limit growth. Major pests include bagworms and several species of canker diseases.

Overall, species listed in Table C-2 are recommended for possible inclusion in Christmas tree and ornamental plantings on White Mountain Apache land. Further attention is needed to arrive at which sites presently available are best suited to each species.

Table C-2
Summary of Tree Production and Marketing Possibilities for Species to be Considered for Immediate Inclusion in the Reservation Project Planning

Species	Years to 5-7'	Demand/ Marketing options	Recommended Use			
			Christmas Tree			
			Std. cut WS,R[1]	U-Cut, R[2]	Live, WS.R[3]	Landscape[4]
Colorado blue spruce*	6-8	Cut tree demand in increasing. Best suited to U-cut and shorter shipping distances. Excellent possibilities for live Christmas trees and ornamental**	X	X	X	X
Concolor fir*	6-8	Cut tree demand is moderately high and is increasing. Good possibilities for live Christmas tree and ornamental	X	X	X	X
Douglas-fir*	5-7	Cut tree demand is moderate and stable	X	X		
Eldarica pine	4	Cut tree is increasing, especially for U-cut. Good live Christmas tree.	X	X	X	X
Scotch pine	5-7	Overall demand has declined from peak years but will remain marketable.	X	X		
Border pine*	5-7	Demand is unknown but with shearing has produced marketable tree. Has live Christmas tree and nursery possibilities.		X	X	X
Pinon pine	10-12	Demand for live Christmas trees and ornamentals is good			X	X
Swiss stone pine	10-12	Form and better cold tolerance make this a good choice for a live Christmas tree and ornamental 3			X	X
Arizona cypress*	4	Has become a traditional U-cut tree of the South. Suitability to SW landscapes makes this a good choice for live Christmas tree and ornamental. 23		X	X	X
Leyland cypress	4	Increasingly used for U-cut. Wide tolerance of soils makes suitable for live Christmas trees.		X	X	X

* Arizona native
**Trees to be used as live Christmas trees and ornamental nursery crops should be directed to and labeled for compatible climatic zones with landscape uses specified.
[1]Std. cut means trees can be cut and sold as 5-7 feet trees, wholesale (WS) or retail (R)
[2]U-Cut refers to trees that are to be selected by consumers in the field and sold retail (R)
[3]Live refers to trees to be sold as live Christmas trees wholesale (WS) or retail (R)
[4]Landscape refers to trees that are suited to specified landscapes.

Plantation Establishment and Management

Pre-Planting Land Preparation

Modern Christmas tree operations often spend much effort in site preparation activities including tillage, use of cover crops and soil fertility enhancement. These efforts pay off in more efficient planting, more rapid early growth, higher seedling survival, fewer pest problems on young trees, and an overall increase in tree quality.

Bulldozing

Large stone, thick stemmed shrubs, trees, or large forest debris can impede efficiency of operations in Christmas tree plantations and should be cleared. Bulldozing and large woody plant removal with mechanical and chemical means will not be needed on the sites proposed for Christmas trees and will not be discussed.

Pre-Planting Tillage

Some type of tillage (plowing, disking, rototilling, etc.) may be desirable before trees are planted; either before the first crop of trees is established on a site or after removal of a stand and before the new rotation is begun. This can help to eliminate or reduce woody and herbaceous vegetation and roots of cut trees. It can also provide a loosened soil layer that may permit easier planting and better seedling root development. Tillage is particularly important on finer textured soils having high clay content. In such soils, roots of seedlings may be restricted by compacted soil around the planting slit made during hand or machine planting. Compaction impedes root growth and causes root abnormalities. Tillage helps to break down the compact structure of the soil, providing granular soil particles more favorable to root development and planting slit closure. Tillage can also be used to incorporate fertilizers into the soil (Brown et al, 1991, see section “Pre-planting Land Preparation”

Control of Herbaceous Weeds at Planting Time

Tillage and weed control prior to planting should be jointly considered. Depending on soil condition, tillage may not be needed. In this case growers may spray herbicide on herbaceous weeds in 2- to 3-foot wide strips or spots in which trees will be planted the following spring. When tillage is needed to arrive at acceptable soil condition or to aid in weed control, foliar herbicide may be applied a week or two before tilling. This would apply to areas that have been under recent vegetation control. The most aggressive approach would be applied to long abandoned crop land, or land otherwise supporting a rank stand of well established

perennial weeds. This calls for steps to clean up the site in spring and summer with herbicides, preparing the soil in the late summer, and planting the following spring. Combinations of foliar and soil herbicides may be needed.

Sometimes weed control in plantations cannot begin until the spring of the planting year. If it is begun early, before weeds have begun substantial growth, an application of a soil applied herbicide about two weeks before planting or after one or two rains following planting normally controls all but the most deep rooted perennials

Some growers involve cover crops in the replant phase only, or continue them for the duration of the crop. After tilling, a cover crop may be sown the summer or fall before spring planting so that the site does not remain barren. The cover crop is then sprayed in 2 feet strips that will become the planting rows. This process helps exclude more competitive weed species, provides a balance between covered and bare ground, and reduces the need to work in muddy fields

For the proposed project, the course recommended is to use tillage and herbicides to plant seedlings in soil free of weeds that otherwise will be pose problems throughout the rotation and, most notably, during early seedling establishment. Growers failing to control weeds around trees in the early phases of the plantation forfeit the opportunity to set the course for efficient management and a short rotation. Because land will be planted in a staggered manner, some areas might lay idle before trees are planted. Cover crops could be grown in these areas to begin the vegetation control process.

Pre-Planting Fertilization

Before site preparation a soil analysis should be done to determine soil pH, and elemental deficiencies that may be critically important to the culture of conifers on the site. Fertilizer guides and crop advisers can help determine which elements should be soil incorporated before planting.

Fertilizers that are relatively immobile in soil can be plowed down and mixed into the soil before planting. Alternatively it may be possible to provide all elements through fertigation. A crop consultant can aid this decision. Material such as phosphorus may take two or more years to become distributed throughout the rooting zone after surface application in the absence of fertigation. Additionally, when large amounts of soluble fertilizers such as potassium are needed, the grower may choose to incorporate them into the soil well in advance of planting. Incorporation of material for the sole purpose of acidifying soils generally is not recommended.

High concentrations of soluble fertilizer salts can kill or injure seedlings if they are in close proximity to roots of recently planted trees. Nitrogen fertilizers should probably not be used

before planting because they are usually leached from the soil before they can provide benefits to seedlings. Pre-plant fertilization should be based on laboratory analyses of soil samples.

Choice of Planting Stock: Seedling Quality and Age

Success or failure of Christmas tree plantings depends to a great extent on the quality of planting stock used and seedlings should be purchased from reputable growers. Orders for nursery stock should be placed well in advance of the planting season, particularly if a specific seed source or size is desired.

Special attention should be given to seed source which will be a major factor in determining the time and work needed to produce a quality Christmas trees or nursery product.

There has been considerable improvement in planting stock quality over recent decades owing to research. Seedlings are usually raised from seed in nurseries or greenhouses involving markedly different approaches and requiring different time intervals between seed sowing and the final product. The grower must understand the basic methodology and terminology used in seedling production to select the planting stock chosen.

Nursery Seedlings

Nursery grown seedlings may be sown and harvested from the same bed or transplanted to other beds to allow more room for both shoot and root development. Seedling age is designated by two numbers connected with a hyphen. The first number designates the number of years the tree was raised in the original seedbed; the second figure indicates the additional years in a transplant bed. Thus, a 2-0 Scotch pine seedling would be one grown for two years in the original seedbed and not transplanted. A 2-2 Concolor fir transplant would be one grown for two years in the original seedbed and an additional two years in a transplant bed. In recent decades root pruning instead of transplanting has been used as a means of improving seedling quality based on root morphology, stem caliper and other factors.

Because the development of planting stock varies greatly among species, among nurseries and from one season to another in the same nursery, age alone may not be a reliable indicator of planting stock quality. Quality should be judged mainly on the basis of size and balance. Stem caliper and length and weight of shoots compared to length and weight of roots are probably the best criteria for judging seedling quality. Seedlings should be a minimum of 6 inches and preferably 9 inches in height. Maximum height varies but should not exceed that which provides a well balanced seedling still convenient for machine or hand planting. In most instances this is no more than 12 inches.

For pines 2-0 or sometimes 3-0 seedlings are commonly used. Transplants are usually not needed. For spruces, firs and Douglas-fir, three or more years are usually needed to produce high quality planting stock capable of meeting shorter rotation goals. Because of their larger root systems and stem diameters, transplants of these species can move more quickly through the establishment phase. The use of heavy or “beefy” 3-2 fir planting stock has markedly shortened the cycle from transplanting to cut tree harvest.

Container Planting Stock

In recent years, there has been increasing interest in use of "containerized" seedlings in Christmas tree plantings. Seedlings are greenhouse grown from seed in containers. The volume of the container and container spacing will determine seedling size and overall morphology (Brissette, et al., 1991, pp. 117-141). Seedling crop uniformity is much easier to control with containerization and consequently planting stock is more uniform.

The key advantage of containerization is that the root system remains intact and maintains contact with its medium before and after planting, thus greatly reducing transplant shock. Bud release is also easier to control and is less critical when containerization and irrigation are combined for plantation establishment. The planting window imposed on bare root stock is greatly reduced. Because of faster, more uniform growth, it may also be possible to grow containerized trees to a merchantable size sooner and to harvest all trees in a plantation in fewer years.

Age criteria discussed previously do not apply because hardy containerized seedlings can often be grown in a year or less. However, criteria should be used to ensure quality. Tops and roots should be in balance and stems should have the diameter desired. Bud condition and other factors should be used to determine whether planting stock has been properly hardened for field planting. For short rotation pines, 9 to 12 inch container stock have performed reliably under irrigation

Container grown trees may cost more than bare root seedlings but be comparable or less than heavy transplants. In any case, planting stock type suitability and quality are especially important for spruces, true firs and Douglas-fir. This should be measured carefully against cost considerations. Inspected and certified stock purchased from reputable dealers will help prevent new pest problems.

Care of Trees before Planting

Bare root seedlings become available for shipment in late winter or early spring as they are lifted in the dormant state and shipped with refrigeration provided. Seedlings must be planted

before bud elongation and therefore require careful management to achieve successful field results.

Improper care of bare root nursery seedlings before planting can result in poor initial survival. Drying and heating are the major causes of injury during transport. Seedling bundles or cartons should be delivered as quickly as possible.

Bare root seedlings should be planted soon after arrival. If they are to be planted within a week, seedlings may be kept in the bundles, bales or crates in a cool, moist location. Stock should be moistened, but not soaked, daily. Cold storage is needed for holding seedlings longer. Temperatures must be maintained above freezing, preferably about 35 to 38 degrees F.

Containerized seedlings provide greater flexibility and with irrigation the planting season can be extended. Containerized seedlings can be cared for more easily but should be protected from extreme temperatures (Brissette, et al., 1991, p. 136, sec. 7.11.2). Although tops may be cold hardy roots can be damaged by cold. Excessive drying can also injure stock. In areas where ground freezes, planting too late leads to frost heaving and planting failure.

For the proposed project, it is recommended that containerized seedlings be relied on most heavily, at least until staff become more experienced. Containerized seedlings can be grown by in Tribal greenhouses in the region. Bareroot transplants can be used to develop heavier fir transplants and potted Christmas trees by employing appropriate nursery culture.

Season of Planting

Spring planting will allow bare root seedlings to be planted while dormant and to maximize plant growth over the frost free season. Container seedlings can be planted later but should be allowed enough time for root establishment before ground freezes. Seedlings planted beyond mid July may be subjected to frost heaving. The presence of irrigation water provides much more flexibility for planting operations. Planting should not be attempted in frozen or snow-covered ground or when soils are wet and sticky.

Plantation Subdivision into Planting Blocks

On most Christmas tree farms, some subdivision of the major planting units into smaller blocks is needed. These blocks are used to provide additional access and, in some cases, to further subdivide areas into sites having similar characteristics and/or management requirements.

In general, the length of planting blocks should be as long as possible (considering limitations mentioned previously) in order to minimize lost space and turnaround time needed at ends of rows. Another concern is how blocking will influence the occurrence of insect and disease pests. For example, Douglas fir and blue spruce should not be planted together because Cooley spruce gall adelgid needs both to complete its life cycle (Rinehold, 1999, p. 9).

The width of individual planting blocks, or the number of rows of trees within each, often depends on factors specific to the individual farm. The distance from the center of any block to the alley between blocks represents the maximum distance any tree should have to be moved by hand during harvesting. If only cut trees are to be sold, block width may be relatively large, 15 to 20 rows or more (Fig.1). However, if trees are to be balled-and-burlapped, it may be more efficient to reduce block width, and subsequently, the distance heavy balled trees must be moved. The number of rows included in each block should be based partly on necessary cultural treatments and methods of application. Thought should be given to width of coverage provided by spray equipment used in insect and disease control, chemical weed control application and fertilization so that materials can be applied evenly throughout the blocks

Spacing Within and Between Rows

Spacing within Rows

Obviously, spacing should be kept to the minimum possible so that the greatest number of trees can be grown per acre. However, the total number of trees planted per acre and the size of the operation dictates the equipment needed for mowing, spraying, and other activities.

Spacing within rows is usually determined by species characteristics and the size to which they will be grown. Pines generally have relatively broad crowns. A spacing of 5 to 6 feet between trees within rows is therefore needed if trees are to be grown to a height of 6 to 8 feet. Spruces, true firs and Douglas- fir usually have narrower crowns and, thus, may require slightly less minimum space (Brown, et al. 1991).

Spacing Between Rows of Trees

Spacing between rows of trees is governed by species characteristics and equipment to be used in operations. Row widths should be at least 2 and preferably 3 feet wider than the widest piece of equipment that must travel between the rows. If mechanical diggers will be used in the future, extra space is needed to maneuver the tractor and digger. Once trees are planted, spacing is set.

Spacings are often set at 5 to 6 feet between rows to accommodate mowers. A tree 6 to 7 feet tall needs a minimum field spacing of 5 to 5.5 feet (Landgren, et al., 2003, p. 9). If large tractors and trail-behind mowers are used, spacings of 7 to 9 feet between rows are required, with a corresponding decrease in the number of trees grown per acre. This problem has been greatly alleviated by the introduction of tractors having not only narrow axle widths (for which 5 to 7 foot spacing may be suitable) but also sufficient power to operate mowers, sprayers, diggers, etc. Growers often leave more room between rows than within rows (e.g., 6 feet between rows, 5 feet between trees). Planting too closely often lowers profits by increasing pest problems and by making tree management more difficult (Landgren, et al., 2003, p. 9).

Trees Per Acre for Different Spacings

As noted previously, spacing should be minimized to that needed to accommodate species-equipment combinations being used. Wider spacings reduce the number of trees that can be grown on each acre and increase operational costs per tree for many cultural practices such as mowing, chemical weed control, etc. The number of trees that can be planted per acre using different combinations of spacing, independent of access roads, harvest lanes, buffer strips, etc. is presented in Table 3.

For the proposed project, a 6 X 6 spacing providing 1210 trees per acre is recommended.

Tree Planting Operations

Planting of trees can be done by hand or machine. The choice between the two depends on a number of factors, including the number of trees to be planted, terrain, intensity of site preparation and labor access.

Efforts should be made during planting to ensure that trees within rows are lined up and spacing between rows is fairly uniform. This facilitates movement of equipment between rows without damaging trees and promotes uniform applications of herbicides, pesticides, and fertilizers. Fertigation would eliminate the need for soil applications of fertilizers.

Table 3
Number of Trees Per Acre for Different Spacings in Christmas Tree Plantings

Spacing (feet)	Number of Seedlings	Spacing (feet)	Number of Seedlings
4 x 4	2722	5 x 8	1089
4 x 5	2178	6 x 6	1210
4 x 6	1815	6 x 7	1037
4 x 7	1556	6 x 8	908
4 x 8	1361	7 x 7	889
5 x 5	1742	7 x 8	778
5 x 6	1452	8 x 8	681
5 x 7	1245	8 x 9	605

Hand planting can be accomplished in numerous ways. Power augers with 3-in. bits are often used in addition to shovels or other tools. A well prepared soil with proper moisture can be dibble planted, depending on soil texture This involves a tool that leaves a hole slightly larger than the root plug of a containerized seedling. Hand planting provides easy control over spacing within rows.

The majority of commercial tree operations establish new plantations using machine planters. Hand planting is mostly confined to small operations and to replacing trees which have died in established plantings, or for plantings in rough or inaccessible areas. The rate of planting with a machine is substantially faster. A well organized planting crew can plant 1000 or more trees per hour. In contrast, an experienced hand planter can only plant up to 800, or at most 1000, trees per day. Overall, machine planting gives the lowest cost and quickest planting but is limited to times when soil physical properties are suitable (Landgren, et al., 2003). Wet soils must be avoided.

The planting machine is either attached to a tractor by a standard three-point hitch or is pulled behind a tractor on wheels attached to the planting machine. Although designs vary considerably, several components are common to all mechanical planters: a rolling coulter or cutting blade that cuts through the ground surface, a trenching plate or plow that opens a furrow, a pair of packing wheels that firm the soil after planting, some type of carrier (usually a tray) for planting stock, and a seat for the person doing the planting.

Fig. 1: Two types of tree planting machines. Upper photo, planter where seedlings and placed by hand in the planting slit. Lower photo, planter mechanically places seedlings in the planting slit by use of mechanical "fingers" attached to a rotating chain. Parts of the machines include seedling carrier, seat, packing wheels, coulter, trencher or plow, spacing wheel and contour adjustment. (From Brown et al., 1991, see “Tree Planting Operations”).

On sloping ground, trees are usually planted along the contour. Machine planting may be difficult on stony and fine textured soils because it is difficult for the machine to open a suitable trench and pack the soil firmly around the roots. Regardless of the planting method, care must be taken to keep seedlings moist while planting.

Survival can be excellent using either hand or machine planting methods. Likewise, low survival rates can result from either method. With both methods it is essential that the planting hole or slit be deep enough to allow the roots to be spread naturally and not become jammed or twisted. Failure to have good root distribution is one of the most common reasons for poor survival and growth in plantations. Furthermore it is necessary that the soil be firmly packed around the seedling or transplant, to prevent drying and to ensure that adequate moisture relations be established and maintained.

For the proposed project machine planting would be the method generally preferred for areas well tilled. Otherwise auger planting provides a reliable means of opening a hole sufficiently large for seedlings. Dibble planting may be an option on well prepared light textured soil that will not be compressed by the tool and make root growth difficult.

Fertilization at Planting Time

Fertilization of seedlings at planting time must be done with care. Seedlings can be injured or killed if soluble fertilizers such as nitrogen and potassium come too close to roots. Banding fertilizers without adequate prior weed control also stimulates excessive competition from herbaceous vegetation, thereby reducing tree survival and growth.

With fertigation it will not be necessary to fertilize at planting time. Nutrient needs of the more demanding species such as spruces, true firs and Douglas-fir can be more reliably provided with fertigation.

Initial Survival and Replanting

First year survival in plantings depends on a number of factors: vigor of planting stock; proper matching of species requirements and site characteristics; care of seedlings before and during planting; time of planting; protection from animal damage and vegetative competition. Weather conditions before and after planting can affect success. Planting should be postponed on days that are warm, windy and dry to avoid excessive plant stress. The availability of irrigation water will greatly reduce the risk of planting failure otherwise imposed on newly planted seedlings by drought during the months of May and June.

Regardless of effort, some seedlings will be lost and the grower must decide whether to replant voids and maintain the greatest potential harvest, or to move on. Some growers do not replant in plantations designed for harvest in four years or less. On the other hand, with a rotation of seven years or more, as one would expect with firs, the same grower would fill voids. Over the longer run, replants can catch up somewhat and crop uniformity will remain acceptable.

Weed Control Methods

Grasses and weeds compete with newly planted and established trees for moisture and nutrients. Failure to control competitive plants will likely result in poor survival as well as reduced growth rates. Seedlings are especially vulnerable to competition because roots are less extensive and they are easily overtopped. However, weeds also reduce the growth and quality of established Christmas trees. Effective weed control benefits are most pronounced on sites having heavy weed cover and those used to grow the more demanding spruces, firs and Douglas-fir. Nevertheless, all species on any site benefit from good weed control. Also, rodent, insect and disease problems may be less serious in a plantation where effective grass and weed control is practiced.

After trees are established, weed management practices are directed away from cultivation which is not well adapted to Christmas tree plantations. Besides being impractical for large areas, it may injure tree roots and contribute to compaction and increased soil erosion.

Weed Control with Herbicides and Mowing

In most Christmas tree plantings, use of chemical herbicides provides the most effective and economical way of reducing or eliminating weeds around the base of Christmas trees during the critical early years of establishment and growth. Often a combination of herbicides and mowing provides an effective means of simultaneously maintaining a weed free zone near transplants and avoiding excessive bare soil. One approach is to combine the careful use of herbicides within rows with growth of a controlled cover crop between the rows. Herbicides are used to maintain a weed-free strip 24-30 inches wide under the trees and the cover crop between rows is managed by mowing once it is established. A cover crop of perennial rye, hard fescue, or a mixture thereof will usually crowd out noxious weeds and keep the need for mowing to a minimum.

The number of mowings needed in a plantation in any year depends on weather, soil fertility and the type of weeds. Mowing is generally done using small tractors or specially designed mowing units. The kind of mowing equipment used depends on the type and size of the Christmas tree operation and the capital resources of the grower.

Types of Herbicides

The success of many herbicide treatments relies on assessing the stage of growth of both weeds and trees and clearly understanding the herbicides' mode of action. Herbicides can best be classified based on whether the chemical is soil- or foliar-applied.

Soil-Applied Herbicides . As the name implies, soil applied herbicides are applied to the soil, although some require incorporation into the soil. They are carried into the soil by water and absorbed by the roots of weeds. These herbicides effectively control weeds for a few weeks to several months, with the exact time depending on the particular herbicide, rate and time of application, weather and type of soil. Because of this long-term residual effectiveness, soil-applied herbicides are sometimes referred to as residual herbicides. Examples of soil-applied herbicides that have been used by Christmas tree growers include simazine (Princep), atrazine (Aatrex), pronamide (Kerb) and hexazinone (Velpar).

Soil-applied herbicides are the "backbone" of chemical weed control in Christmas tree plantation management and are the chemicals used year-in and year out for maintenance of relatively weed-free areas around the base of young trees. Depending on the particular herbicide and management system, these herbicides are applied either in late fall or early spring. Normally, applications are most effective when rainfall incorporates and activates the herbicide in the soil.

Many of the residual herbicides such as simazine can normally be applied directly over trees at any time with no expected damage to the foliage. With some, such as atrazine, care must

be taken to be sure the trees are not actively growing or some damage will occur. Labels must be read carefully.

Foliar-Applied Herbicides Foliar-applied herbicides are applied directly to the weeds and kill them primarily by being absorbed into the foliage. For this reason, they are often referred to as contact herbicides. In addition, some of the contact herbicides have a relatively short-lived soil activity. Glyphosate (Roundup) is an example of a contact herbicide used widely.

Soil-applied herbicides, used at recommended rates, usually do not "knock down" tall, well-established weeds. A foliar herbicide is needed to weaken or kill such weeds and allow the soil- applied herbicide to gain control. Generally, a soil-applied herbicide is applied with or after the contact herbicide.

When foliar-applied herbicides are sprayed in established plantations, trees should usually be protected (read the label). This can be done by rigging shields on the sprayer so that the spray does not contact the trees.

Some foliar herbicides can be applied over Christmas trees in the fall while the weeds are active but after trees have hardened off sufficiently. Such applications are useful for controlling deep- rooted perennial weeds not easily controlled with residual herbicides.

Certain weeds resist repeated use of the same control practice. Many perennial weeds, for example, tolerate cultivation, and low-growing prostrate weeds resist mowing. Some species resist a specific herbicide. Rotating control practices, including individual herbicides, and spot treating with herbicide eliminates resistant survivors and reduces severe infestations of tolerant weeds. Several approved and labeled chemicals are available. Depending on the type of weed-grass problem present, herbicides may be used singly or in combination with one or more products.

On sites prone to soil erosion, managers often use vegetative ground cover that requires minimal management. Examples include "living mulches" that respond to drought, low fertility, or sublethal rates of postemergence herbicides. These practices can save resources, minimize production costs, and improve long-term productivity while maintaining tree vigor and quality.

Herbicide application

Herbicides are formulated as soluble powders, wettable powders, flowables, dispersible granules, miscible liquids, or emulsifiable concentrates (William and Al-Khatib, 1995, p.8). Rates are adjusted to soil type and organic matter content as product labels routinely explain.

Herbicides must be applied accurately and with proper equipment as described on the product label. Persistent soil-applied herbicides can be either broadcast or applied in bands within the tree row. Foliar applications to upscale plantations require tractor mounted sprayers. Adjustable spray booms can be designed for multi-row, directed, or topical applications (William and Al-Khatib, 1995, p.6). Often, a small tractor is used with a spray tank, boom, and nozzles spaced over the row or directed toward the tree base to form an 18- to 24-inch band along the tree row. Backpack sprayers are suited to small acreages and spot spraying on larger areas.

Comments made earlier regarding selection of mowing equipment apply equally to selection of spraying equipment. Similar factors must be considered in determining what spray equipment is best and most economical for a particular operation.

Figure 2. Where sites are prone to soil erosion, some managers have adapted technologies used in orchards to manage a vegetative cover between tree rows. They use herbicides to control vegetation within tree rows. Dwarf or intermediate sods require less maintenance than taller grasses if drought or low fertility occurs, or if growers apply sublethal rates of postemergence herbicides (referred to as "chemical mowing").

Other Approaches

Mulch. Mulches can effectively control weeds around the bases of trees and reduce evaporation of moisture from the soil. Sawdust is one of the most commonly used mulches. It should be applied only to the soil surface. If mixed into the soil, it can cause nitrogen deficiencies unless about two percent (by weight) nitrogen fertilizer is added to the sawdust. The adoption of mulch would utilize a resource available from the Tribal sawmill operation. However, considerable time and labor would be needed for its prescribed use. On balance its attractions seem outweighed by less costly approaches. The issue remaining open is whether sawdust mulching would greatly eliminate the need to apply herbicides in tree rows.

Biological Control. Various efforts have been made to mix Christmas tree production with farm animal control of vegetation. Often these efforts have resulted in dead or deformed trees and trampled landscapes. From the onset, it must be recognized that livestock and game animals must be excluded from the operation.

Culturing

During the first couple of years, focus will be on replacing dead or sick trees, removing multiple leaders, and keeping fields free of weeds and pests. Basic culturing techniques for the rest of the tree cycle include basal pruning, leader length regulation, and side shearing (Landgren and B.S. Douglass, 1993, pp. 11-18**)**. The objective is to get the tree up to a height where you can begin shaping it into a Christmas tree.

Basal pruning

The objective of basal pruning, or "handling" as some call it, is to create a clear length of stem that can be inserted into a Christmas tree stand. Ideally, this length should be 10 to 12 inches for a tree that's 6 feet or taller. On shorter trees, growers remove about 2 inches per foot of height.

Basal pruning makes it easier to apply mow and to apply herbicides. Regardless of method or timing, basal-pruned branches should be cut near the main stem to prevent resprouting and recutting.

Basal pruning is commonly done when tree leader length reaches about 10 to 12 inches. Some growers basal prune trees in two stages in different years to avoid removing too many branches. Excessive pruning during this stage will stunt tree growth.

Leader length regulation

Regulating leader length is essential on most Christmas tree sites, especially with optimal moisture and nutrients provided. Once leader control begins, many growers retain about 10 to 14 inches of leader each year. The cut length depends on desired final tree height, number of buds on the leader, tree quality and vigor, density desired, and grower experience. Trees that grow slowly at first and then bolt during the last couple of years tend to have dense lower sections and open tops, which is not desirable in the marketplace.

Leader length is controlled by clipping the leader once annual growth stops. Timing can be important. Leaders on fir and spruce respond best to cutting during the late succulent stage, once buds have been set and the leader stands up straight (late July and August). Pine trees

are shaped earlier in the year when the leaders (called candles) have elongated and the new needles are about half the length of last year's needles (June to early July).

Side shaping/ shearing

The purposes of shearing are: 1) to control tree height and width and develop desired taper and shape; 2) to stimulate increased numbers of buds and bud development, thus increasing the number of branches and foliage density (pines) and 3) to correct branch deformities and insect and disease damage and to remove competing multiple leaders.

Shearing permits the development of trees with a uniform shape and taper. Foliage density is increased by promoting the formation of more buds, and therefore the development of more twigs and branches. The regulation of leader length and the length of lateral branches creates the desired taper. Taper is width divided by height, so a 5-foot-tall tree with a 60-percent taper would be 3 feet wide. Pines are currently grown with a taper in the range of 60 to 90 percent, while for the spruces and firs, it is usually from 40 to 70 percent. Table C-4 gives terms and dimensions traditionally associated with taper. The role of shaping and shearing in determining Christmas tree quality can be seen in U.S. standard grades for market (Table C-5). As a grower gains experience, the market determines the amount of taper targeted for adoption.

Table C-4
Terms and Dimensions used to Describe Christmas Tree Taper

	Pines	Spruces, firs, Douglas-fir
Normal	40 to 90%	40 to 70%
Flaring	more than 90%	more than 70%
Candlestick	less than 40%	less than 40%

Shearing usually begins when the trees are between two and three feet in height. For species such as Scotch pine, this normally occurs in the second or third growing season. For firs, Douglas fir and spruce, shearing usually begins in the third or fourth year following planting. Shearing must continue for each year of the rotation including the year of harvest.

Long bladed knives or power tools are used conventionally for shearing. Timing can be very important. Pines need to be shaped when new needles are about half as long as the previous year's needles. True firs, Douglas fir and spruces generally are sheared in summer to early fall. The strategy for shaping Christmas trees varies widely by species and among growers. Some knife shear all species yearly, or hand-clip the firs in only the harvest year. Hand clippers are used to preserve a natural appearance, but are labor intensive. Power shearing equipment can substantially increase shearing productivity, although some hand work will still be necessary on most trees.

Table C-5
Summary of United States Standards for Grades for Christmas Trees

	U.S. Premium	U.S. Choice or U.S. No. 1	U.S. Standard or U.S. No. 2
Foliage	Fresh, clean, healthy, well trimmed	Fresh, fairly clean, healthy, well trimmed	Fresh, fairly clean, healthy, well trimmed
Density**	Heavy	Medium	Light
Taper	Normal	Normal	Candlestick, normal or flaring.
Faces	4 free from damage	3 free from damage	2 adjacent free from damage

*Healthy: foliage has thrifty, fresh, natural appearance.

**Density amount of foliage present, determined by number and size of branches, distance between whorls number and arrangement of branchlets, extent of internodal branching, needle arrangement, needle length, etc. Species differ in these characteristics, and density is judged on the basis of "species characteristics."

***Taper: relationship of tree width to height, expressed as %

Table Source: USDA, Agric. Marketing Service (1989).

Fertilization and Tree Nutrition of Established Trees

Tree growing operations use fertilizers to increase growth, and to improve the trees' vigor, color and needle density. General principles of plantation conifer fertilization are discussed by Fisher, J.T. and J.G. Mexal (1984). Two critical times to check tree nutrition are before site preparation (discussed above) and after trees are established.

The first year following planting begins the establishment phase. Growers gain little benefit from applying nutrients as seedlings make the transition from the nutrient-rich nursery condition to the dryland situation. Nutrients are stored in seedlings, and newly planted trees have a nutrient concentration approaching double that needed for adequate field growth. For example, nursery stock commonly has 3 to 4 percent N in the needles, while older field-grown trees have 1.5 to 2 percent N. The high level of tissue N in seedlings supplies growth needs during establishment. Excessive fertilization, improperly calibrated rates, and poor fertilizer placement easily damage first-year seedlings

After the trees have been established, foliar nutrients should be monitored carefully and nutrients added as needed. Macronutrient fertilizer recommendations for the Pacific Northwest (Table C-6) show how guides can aid interpretation of test results and be used to determine fertilizer additions. Foliar samples commonly are collected in September and October. Soil samples can be collected anytime.

Table C-6
Macronutrient Fertilizer Recommendations for Douglas-Fir Based on Foliar Analysis

Nutrient	Foliar analysis	Fertilizer
Nitrogen (N)	**(%)**	**(lb P_2O_5/acre)**
	Below 1.20	150
	1.20-0.60	100
	Above 1.60	0
Phosphorus (P)	**(%)**	**(lb P_2O_5/acre)**
	Below 0.08	180
	0.08-0.15	90
	Above 0.15	0
Potassium (K)	**(%)**	**(lb K_2O/acre)**
	Below 0.4	100
	0.4-0.8	50
	Above 0.8	0

Begin foliar analysis in September the third growing season after planting.

Reanalyze every other year to determine whether deficiencies have been corrected.

Table Source: Adapted from Hart et al, 2004

Hart et al.(2004) provide a list of fertilizer materials and sources, recommended tissue nutrient levels and field sampling methods to determine fertilzation rates. The reader must note that their recommendations on some topics are directed to acid soils.

Irrigation

Drought stress occurs when trees need more moisture than is available in the soil. This condition may be caused by one growing season of severe drought or several seasons of below-normal rainfall. Seedlings are especially vulnerable owing to their limited root depth and spread. Transplanted Seedlings that survive drought can grow poorly and become more susceptible to environmental and pest injury.

Christmas trees are generally a dryland crop in humid climates. As climate becomes drier overall, or shows pronounced swings from wet to dry seasons, irrigation may be required. In the arid Southwest, irrigation is necessary to supplement natural precipitation and, depending on site, may provide the majority of the moisture needed. In addition to its obvious crop benefits, timely access to water supply is also important to operational scheduling (e.g., time of planting).

Overhead and trickle systems are both common to Christmas tree plantations. To reduce capital costs, Pacific Northwest growers sometimes move overhead sprinkler equipment from

one field to another as needed. This may not be feasible where irrigation is needed more frequently. A more expansive system or more labor will be required. Trickle systems may provide a better solution in terms of capital and labor. It clearly has the advantage of not presenting as many pest and weed problems. Trickle irrigation concentrates the water on the trees rather than encouraging weeds. It also does not encourage foliar diseases more common to foliage allowed to remain moist for extended periods. With trickle irrigation, the water supplied would be increased as the plantation grows from seedling size to harvest size. Overall, each grower must understand the capital and labor costs required by irrigation options to make the best selection for a given area.

Fertigation

Drip or trickle irrigation and fertilization can be applied through the same system thus offering another advantage to some growers. Fertigation can offer precise control over the application of nutrients so that nutrient levels are present when needed most and the addition of micronutrients is less difficult.

Care must be given to avoid excessive nitrogen fertigation of fast growth pines that may respond by producing too much leader growth**.** Also, irrigation done late in the summer may predispose trees to damage from early frost and should be discontinued as necessary to create the response desired.

Best Management Practices

Irrigation and fertilization as well as other crop management practices should be applied with a view toward best management. The aim of best management practices (BMPs) is responsible environmental stewardship. Numerous BMP guidelines are available for nursery and Christmas tree industries and would serve the interests of a Christmas tree enterprise in its planning phase. Some steps recommended for protecting water are available from Oklahoma State Cooperative Extension (von Broembsen and Schnelle, E-951, Water Quality Handbook for Nurseries*).*

Rotation

Rotation, the time from planting to harvest, is a key feature to Christmas tree economics and financial planning. Generally, years to reach maturity will depend on the species, the size of trees produced, and the intensity of management. Choice of planting stock, seed source, soil fertility, and water availability can significantly affect rotation length.

The timber industry has significantly reduced the time necessary to grow merchantable trees by exploiting genetic differences within a given species. The Christmas tree industry has

progressed similarly with research being supported with public and, to a lesser extent, private funds. Research often has involved cooperatives supported by both private and public participation. Through genetic selection and improved crop management, rotation length has been reduced. This, along with other factors, explains reported differences in time required to grow a given species to marketable size.

Arizona and New Mexico both have access to geographic seed sources (provenances) capable of producing quality Christmas trees (Fisher and Davault, 1978). Seed from both states produce trees with similar traits more desirable than those derived from more northern groupings (Kung and Wright, 1972). Early rapid growth, noted for southwestern provenances, allows transplants to move more quickly into the juvenile, or accelerated, growth phase. As transplants gain height and root extension, the adverse influences of weed competition, frosts and many pests become less threatening. Overall, faster establishment and early growth results in shorter rotations.

Fast growth pines such as Eldarica pine require 4 years to produce a well shaped tree, 6 feet or larger. Firs, Douglas fir and Blue spruce will require about 7 years but prices will be higher, up to twice as high or more. Also to be considered are the sizes that would be the most marketable in a given area. Larger trees, beyond the traditional 5-7 foot tree, will require a few more years with greater investment, but with reliable clients can provide another market opportunity. Some growers are specializing in larger trees (10 to 15 feet) commanding a high price for a well defined market. Fewer trees or sold and fewer make a semi-truck load but the prices can be considerably higher, 300 dollars or more retail.

Little has been said of using field grown trees for either ball and burlap operations or containerization. Live Christmas trees and ornamental trees are dug and roots wrapped with burlap or placed in a container. This step requires additional cost but product prices are considerably higher.

Protecting the Christmas Tree Planting

Insect, Disease and Animal Issues

Most Christmas tree growers will need to address insect or disease problems, if not both. If neglected, these pests can have major effects on tree growth, appearance and value. McCullough et al. (1996) provide brief categorical descriptions of damage caused by insects and disease.

Managing these pests, along with weeds, rodents and larger wildlife is critical to producing quality trees in acceptable time. Specific problems may be more or less intense across regions

and growing conditions. Foliage diseases are more common in humid areas, and plantations growing near forests may be exposed to insect pests they harbor. Additionally, stressed trees grown from ill adapted seed are more easily attacked by pests. Site adapted seed, from known superior sources or breeding programs, will offer greater overall vigor and resistance to specific diseases. A brief discussion of some of the insect and diseases that may threaten plantations follows:

Insects

Above ground insects. Aphids probably are the most damaging of the insects that attack Christmas trees, particularly firs. Many mite species attack Christmas trees, and no tree species seems immune. The balsam wooly adelgid damages noble and other true firs. Cooley spruce gall adelgid can damage both spruce and Douglas-fir. Finally, a number of moths, borers, weevils and other pests can attack trees. Pine tip moth is particularly troublesome for Eldarica pine that is relatively free of insects otherwise. Bag worms have been observed on Leyland cypress.

The damage caused by mites, aphids and many other insects is cosmetic and effective control is within easy reach of beginning growers. Pine tip moth must be dealt with aggressively because the apical bud is often damaged and crown symmetry will require correction.

Below-ground insects. These may stunt the growth of trees and may become noticeable as foliage yellows. The potential for weevils, root aphids and other below ground pests should be gathered from a professional.

Diseases

Disease can reduce growth, produce unsightly foliage, increase susceptibility to insects and other diseases, and even kill trees. Several species of fungi attack Christmas tree needles, causing yellowing and needle loss. Rhabdocline needle cast is a needle disease on Douglas-fir, causing needle loss in some regions. Two rust fungi may threaten western pine forests and may threaten pine Christmas trees. The white pine blister rust fungus is associated with eastern and western white pines and other five-needle pines, including ***Pinus strobiformis***.

Pinus eldarica is susceptible to Comandra blister rust, *Cronartium comandrae*. The alternate host for the rust is *Comandra pallida,* commonly called bastard toadflax, a small herbaceous perennial plant found in close association with oak and occurs throughout Arizona at elevations of 4,000-8,000 ft. *P. eldarica* should not be planted within a mile of *Comandra* populations since the spores that infect pine must come from *Comandra*. Disease has been severe on Eldarica pine in areas of oak habitat near Prescott and Sedona where Comandra is

common, but has not been observed in Christmas tree plantations in the Sulfur Springs Valley.

The level of threat presented by insects and disease in a given case, planned or actual, can be measured by consulting histories and surveys reported by professionals, growers, and grower organizations. Information regarding selection of site, species and crop culture is especially useful in obtaining grower assistance so that risk can be avoided or minimized.

Monitoring

Prompt identification and management of potentially damaging insect and/or disease problems is a must for high quality Christmas trees. Frequent and regular scouting will enable growers to detect pests before economic damage occurs. Plantations should be monitored for pests and diseases beginning in April and continuing through September.

Signs and symptoms are highly useful to detection of problems. Signs include the physical evidence of pest presence such as insect frass or cast-off skins, or the fruiting structures of disease organisms. Symptoms refer to evidence that the tree has been affected by insect or disease attack. For example, mites are invisible to the naked eye, and their presence is indicated by the browning of foliage needles. Growers are especially encouraged to use scouting to determine when the stage of the pest most vulnerable to control treatment is present.

Signs and symptoms aside, many insect s can be observed directly and identified with professional help if needed. The presence of aphids and other insects can be obvious and regular monitoring can be highly useful in determining population levels. Insect traps are often used in the sampling process.

Pests, particularly diseases, may be transported on infested nursery stock. Careful attention must be given to the use of only pest free planting stock. Guides are available to help train the grower's recognition of pests (e.g., Dept. Entomology, MSU: 1998). Purchasing stock from reputable dealers or buying inspected and certified stock can help prevent establishment of new pest problems. In any case plants received and shipped should be monitored for the presence of pest problems.

Treatment

Despite management efforts to keep insect and disease problems at low levels, chemical pesticide treatments likely will be necessary at some time in the course of the rotation. Numerous approved insecticides and fungicides are commonly used in plantations and nurseries and are available. The selection of appropriate insecticides or fungicides is less

difficult than otherwise because insect and disease pests are usually fairly specific in their symptoms. Also, in contrast to tree fruit orchards, there generally is no need to follow a specific spray schedule involving several treatments each year.

The use of application technology varies widely among growers, depending on the size of the operation. Many growers use air blast sprayers but backpack sprayers, boom sprayers and airplane or helicopter applications are not uncommon.

Timing of pesticide application can have major effects on efficacy. Using degree days, rather than calendar days, can improve the timing of pesticide applications. Degree days accumulate rapidly during warm weather and more slowly when temperatures are cool.

Effectiveness of insecticide or fungicide applications may be poor if sprays do not penetrate the dense outer canopy. Dense foliage, particularly on sheared trees, often makes it difficult to get good coverage. The use of pruning and shearing to remove damaged and infected crown parts can improve spray applications. Tip moth incidence can be improved in this manner.

Minimizing pesticide applications makes sense for both economic and environmental reasons, and makes it easier to integrate pesticides with other management strategies. Natural enemies often play an important role in reducing potentially damaging insect populations and can be encouraged with appropriate chemical treatment. Fields managed on multiple year rotations are more likely to provide stable habitat for beneficial arthropods than fields cropped annually.

Pesticide safety requirements. Christmas tree growers frequently have the option to use pesticides to control weeds, diseases, and insects in their plantations. State agriculture departments classify pesticides as either general use or restricted use. To buy restricted-use products, a person must have a pesticide applicator license or other appropriate license. Each state ,and even some counties, have specific interpretations governing pesticide use.

Integrated Pest Management (IPM) is increasingly used to provide a more environmentally sensitive approach to pest management. In IPM, the Economic Injury Level (EIL) and Action (or Economic) Threshold (AT) are used to determine if and when pest control measures are needed. Unfortunately, few thresholds have been developed for Christmas tree pests. The difficulty of establishing an EIL or AT for any given pest arises from several factors. These factors include the difficulty of 1) quantifying aesthetic injury, 2) determining the economic costs of that injury and 3) relating pest density to levels of aesthetic injury. However, the concept of an Action Threshold remains valid and is incorporated into pest management recommendations wherever possible. One factor that affects pest management decision-making is the type of damage caused by the pest. Another important factor is how soon the trees will be harvested. A third factor affecting an AT is how long it will take the tree to recover from pest damage. Owing to the fact that the Christmas tree industry is in an

early phase of development in the Southwest, the same knowledge limitations constraining full adoption in states with well established operations are even more forceful in the Southwest. For this reason IPM remains a future consideration that will emerge naturally as the industry develops.

Animals

Deer and rabbits can cause considerable damage to a plantation. They can be particularly destructive in young plantings because they nip off the leaders. This can seriously impair the future shape and form of the trees or even cause mortality. Some growers have installed high tensile fencing to control deer browsing.

Normally Christmas trees and livestock are not compatible. Cattle, sheep, or horses grazing in a Christmas tree plantation can cause considerable damage by browsing, rubbing against the trees, and soil compaction (Brown et al., 1991).

Mice can cause damage by chewing on seedlings at the ground line. This activity can girdle the trees and cause mortality. The problem is probably most severe in weedy plantations that provide nesting habitat and cover. Poison bait can be used for control, but it should be used only in epidemic situations and then with considerable care.

Pocket gophers feed on tree roots and cause both mortality and tree toppling. Trapping can be effective in controlling a pocket gopher population although a certain degree of skill is involved. Wildlife control professionals can provide advice concerning the most effective measure available.

Harvesting the Christmas Tree Crop

As the trees attain marketable size, the owner should make a detailed inventory of the trees that will be for sold that particular season. A good time to take this inventory is immediately after completion of the final shearing. Potential buyers inquire about trees as early as July and August.

Before the harvest begins, most growers tag individual trees that will be sold. Colored plastic flagging or paper tags tied to each tree are often used to denote different grades or sizes. These are useful for sorting and pricing purposes. If the trees selected for harvesting are marked in advance, considerable time can be saved during the actual cutting operation for both wholesale and retail approaches.

Many growers spray trees with a water-soluble green latex pigment in August or September. The green paint is applied to mask the characteristic yellowing of foliage which commonly occurs in some varieties of Scotch pine, white pine and Douglas-fir. A power sprayer capable of throwing a mist spray is best for tinting trees in the field.

The actual harvest operation is a well organized process. A successful harvest uses a minimum amount of time to cut, sort, bale, and get the trees to market while at the same time avoiding soil damage. Trees to be shipped to out-of-state markets may be harvested in late October or early November. Cutting for sales to local markets can often be delayed. It is particularly important to delay harvest of the spruces as late as possible, because, as noted in the section on species selection, needle retention on cut trees of those species is poor.

Cutting generally is with a lightweight chain saw or with circular saws mounted on rotary brush cutters. Time is very limited during harvest and equipment must be sound to avoid delay.

Once trees are cut, they usually are yarded to a central location for baling and loading. This can be done by hand for shorter distances but might involve tractors or trucks for greater distances. More than any other harvest activity, yarding has the greatest potential for damaging tree quality. Caution must be given to avoiding branch damage by abrasion and foliage damage caused by excessive exposure to cold and wind. . Species with rigid branching such as the sharp-needled blue spruce and those with large bulky crowns need special attention. Firs are especially sensitive to prolonged exposure.

In the baling process, individual trees are bound with string or plastic mesh netting. This should be done as soon as possible after cutting to maintain tree quality before and after shipping. Baled trees are less prone to breakage, are easier to handle and load, will stay fresher than unbundled trees, and suffer less damage during shipping. Because trees are compressed and easily organized, at least twice as many baled as opposed to unbaled trees can be loaded in the same space. Attempting to move and store any quantity of trees without some type of tying or baling greatly increases handling costs and may also increase possibilities of damage to trees. Baling contractors would not be available in Arizona making this operation a farm supervised operation involving its own equipment. A number of different types of balers are available commercially. Trees are usually compressed by mechanical arms or as they pass through a cone- shaped device. For some buyers and/or export destinations it is necessary to shake trees to remove pests, dead needles, and other materials before baling. Mechanical shakers are commercially available.

Trees should be stored properly until they are shipped or sold. Low temperature, high humidity and protection from sun and wind are desirable for keeping trees fresh after cutting. A farm building or shed is ideal for this purpose. Occasional spraying helps retain tree freshness.

Shipping

Transport to markets is most commonly done by truck. Some type of conveyor or elevator can be very helpful, particularly if larger vehicles are to be loaded. When a truck arrives, enough help is needed to load it promptly and to make sure that the correct quantities and sizes of trees are on board. Refrigerated vans may be required, depending on distance and destination. Trees for local or regional markets can be covered with tarps and shipped in open trucks. The benefits of keeping thorough records of loading operations should be obvious.

Tree freshness is an important factor affecting marketability. The time between harvest and final sale should be as short as possible. Harvest for shipping to out-of-state markets must begin earlier in order to get trees to their destinations for retail sales, which commonly begin in late November or early December.

Harvesting of live trees may begin after trees have finished annual growth and received enough chilling for tight bud set. Trees are dug by hand or machine with part of their roots intact. After digging, balls are wrapped in burlap or containerized with care to avoid damage to the root ball. The full integration of cut trees with live tree operations cannot be fully discussed with present information.

Time Required for Christmas tree field tasks

For the sake of decisions and planning, it is important to understand the approximate time needed to complete the tasks outlined in the above sections. Table C-7 provides estimates gathered from intensively manage plantations grown in the Pacific Northwest. Table C-8 indicates approximately when various grower activities would be needed over the course of a year.

Table C-7
Estimated Time Need for Christmas Tree Field Production Tasks

Activity	Method	Time required
Weed and grass control	Backpack	5 acres/day
	Tractor	20+ acres/day
	Helicopter	100 acres/hr
Disease and insect control	Backpack	2-3 acres/day
	Tractor	10+ acres/day
	Helicopter	50 + acres/day
Shearing	Knife	Young trees: 500+/day
		Mature trees: 300+/day
Tree Planting	Shovel	300 + trees/day
	Auger	400 trees/day
	Machine	6000 + trees/day
Harvesting	Tagging	1,000 trees/day/person
	Cutting	800 trees/day/person
	Hauling	200 trees/day/person
	Baling	600 trees/day/person
	Loading	3 hrs./semi-truck -4 people

Table C-8
Grower Activities over the Course of a Plantation Year

Jan.	**April**	**July**	**Oct.**
Remove cull trees Repair equipment	Tree planting* Monitor for pests Weed control (before budbreak)	Shear concolor fir, Douglas-fir Monitor pests	Continue harvest preparation Recheck labor and shipping arrangements
Feb.	**May**	**Aug.**	Nov.
Repair equipment	Control grass (postemergence) Monitor and control Pests (e.g.aphids, adelgids, rusts)	Continue shearing Finish top cutting Prepare fields for next year's planting Begin showing trees to prospective buyers	Harvest
March	**June**	**Sept.**	**Dec.**
Tree planting Grass and weed control Fertilize (if needed)	Monitor and control pests Shear pine Early season culturing on true firs	Take foliage samples for nutrient analysis Prepare for harvest: tag, grade, check equipment	Harvest U-cut sales

*Tree planting can be with the containerized seedlings.

Table Source: Adapted from Landgren et al., 2003).

Gorman, et al., 1989 provide an economic assessment of growing Scots pine and white fir in New Mexico. Their assessment includes activities and labor costs estimated for the conditions given.

Marketing

The marketing and sale of the Christmas trees is of vital importance to the profitability of the enterprise. This should be investigated and potential markets identified with a considerable degree of certainty before deciding to plant.

Growers can choose from various Christmas tree marketing options. Off-farm distribution can take many forms: direct retailing, selling to tree brokers, contract sales through established growers or wholesalers, and mail order. The traditional method is selling trees to wholesalers.

On-farm U-cut sales are growing in popularity and provide another option. Growers situated near population centers are able to market trees on a choose-and-cut basis. U-cut operations

provide consumers the opportunity to personally select a fresh tree from an acceptable mixture of tree species and sizes. Consumers find this and other grower hosted activities to have high recreational value. Customers may buy products and services beyond a single tree and often return when farm produce such as berries and apples are sold.

The type of marketing chosen will dictate basic planning and layout decisions. Off-farm sales will require establishing staging areas for baling and loading trees and roads facilitating semi-truck traffic. It is essential to arrange labor and contractor availability before harvest begins. Also, buyers often need large quantities of trees, often a truckload or more. U-cut farms typically require closer proximity to customers, all-weather roads to the farm site, and restroom facilities. Growers will require tolerance to vehicles, signs, long open-for-business hours, and all the issues of serving customers on farm.

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APPENDIX D

Hybrid Poplar Suitability for Bonito Prairie

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FEBRUARY 2007

Appendix D - Hybrid Poplar Suitability for Bonito Prairie

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Introduction

The Bonito Prairie of the White Mountain Apache Reservation consists of over 41,000 ac used for livestock and wildlife habitat. However, with the addition of irrigation, it is feasible to consider growing woody crops for production. These crops could consist of Christmas trees (presented by J.T. Fisher, and not discussed further), piñon, and trees, such as sycamore and hybrid poplar, for lumber, fuel, and other wood products.

Piñon (*Pinus edulis*) is a potentially high value crop indigenous to the region. A number of species not only produce a harvestable pinenut, but also are harvested commercially including; *Pinus koreaensis* from Asia, *Pinus pinea* from Europe, *Pinus cembroides* from Mexico, and *Pinus monophylla* from Utah and Nevada. However, only *Pinus edulis* can legally be sold as 'piñon' in the State of New Mexico, giving this species an economic advantage. During years when piñon are readily available (e.g. 2005), the wholesale price is $5/lb. However, during years when nuts are scarce, the wholesale price can be $10/lb. One attraction is piñon has many of the same human health benefits as almonds, pecans, and walnuts, plus the *cache* of an indigenous foodstuff.

While there have been no attempts to produce piñon under orchard conditions similar to pecans or almonds, it is not inconceivable. Throughout the South and Northwest (Idaho, Oregon, Washington), pines are grown in orchards to produce seed for reforestation efforts. Virtually all southern pine forestry (*Pinus taeda, P. elliotii, P. palustris,* and *P. echinata*) uses seed produced from orchards. An orchard could be established by transplanting 'wildlings' (trees growing in native woodlands). The advantage of this approach would be that nut production would likely commence within 3-5 years of transplanting. The disadvantage is this method of establishment is the transplanting costs are much higher than establishing an orchard with seedlings. An orchard from seedlings would require about 10-15 years before seed production would commence, assuming the trees at attained a height of at least 8 ft. The market for piñon could be traditional foodstuffs for tribal members, or the piñon could be marketed directly to wholesalers (e.g. Buffett Candies in Albuquerque, NM).

Trees could be established on 20 ft X 20 ft (100 trees/ac) or 15 ft X 20 ft (150 trees/ac) spacing. Yield could be 70-240 lb/ac[1] at 1,900 seed/lb. Fertilization and irrigation would increase seed size to about 1,200 seed/lb, thereby increasing yield to 120-375 lb/ac[2]. Furthermore, fertilization and irrigation would decrease year-to-year variation in seed production. Seeds could be harvested either traditionally (manually) or with a pistachio nut harvester (with apron to catch seed). The recommendation to consider piñon has a higher risk than other recommendations below, because this enterprise has never been pursued. Furthermore, the soils at the Cibecue, AZ site may be better suited to piñon growth. Regardless, a piñon orchard should start small (5-15 ac) to evaluate the feasibility. Nevertheless, if successful, the gross income could be $365-$1,185/ac/yr at $5/lb and 1,900 seeds/lb, or $585-$1,875/ac/yr at the larger seed size. Furthermore, the demand for piñon likely exceeds 24,000 lb/yr or about 100 ac.

Arizona sycamore (*Platanus wrightii*) is another potential species for Bonito Prairie. This species would be used for lumber, fuelwood, and other wood products. In fact, at least until proven successful, Arizona sycamore should be considered as an alternative to hybrid poplars. The advantages of Arizona sycamore is it is native to the regions and has superior wood properties (density, strength) compared to poplar. Another advantage is growth may be comparable to poplar. In trials in South Carolina, American sycamore (*Populus occidentalis*) had growth comparable to hybrid poplar (Coleman et al. 2004). One disadvantage is Arizona sycamore is an 'unimproved' species which will have variable growth rate and habit (straightness, branch size). Seedlings would have to be grown from seed collected in the region. If the tribe does not have a nursery production, assistance could be pursued with the Mescalero Apache or Navajo tribal reforestation programs. A breeding program to select for superior trees would have to be initiated in relatively short order.

Hybrid poplar (*Populus* crosses) has been used for reforestation for over 70 years (USDA 1949). Plantations of hybrid poplar selections have been planted in the northwest, north central, and southeast US. Furthermore, improved planting stock are readily available if ordered in advance. For this reason, the remainder of the report will focus on hybrid poplar.

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1 Assumptions = 7-10 seeds/cone, 200-300 cones/trees planted at 100 or 150 trees/acre.

2 Assumptions = same as note 1.

Hybrid Poplar

Planting material (cuttings) is produced in stooling beds, and the cuttings are typically supplied in 8" to 20" lengths. For sites that receive supplemental irrigation, 8" lengths result in excellent survival (Vallotton et al. 2000). Cuttings can be planted either manually or by machine.

Plant material

Previous work in the southwest US has identified at least one superior hybrid poplar clone (Lombard et al. 2005, Vallotton et al. 2000). This clone (OP-367) is adapted to many parts of the western US from Oregon (Shock et al. 2002) to south Texas (Vallotton et al. 2000), with growth being remarkably similar across all sites. This clone grows rapidly (6 ft to 12 ft/yr) and seems tolerant of highly alkaline soils where iron chlorosis could be problematic. The uniform growth across latitudes is likely because growth of the OP-367 clone appears to be photoperiod determined; breaking bud in mid-April, and losing its leaves in late-September regardless of latitude. This could be considered a potential drawback where the growing season is longer (e.g. Texas), but the cultivar seems well adapted to northern New Mexico, where the growing season would be similar to Bonito Prairie.

Since hybrid poplar cuttings are vegetatively propagated, all cuttings of a particular clone will be genetically identical. This may pose future problems in disease or insect susceptibility. Consequently, clonal forestry operations require a variety of clones (8 to 10) to ensure genetic diversity. While the clones would be planted in blocks, individual blocks of one clone should be no larger than 50 ac. The OP-367 clone provides an excellent starting point, but better clones may be available in the future. Certainly, additional clones will need to be identified before Bonito Prairie can be fully reforested. Early results from New Mexico State University's Farmington Agriculture Science Center indicate the additional clones may be useful (Dr. Michael O'Neill, pers. comm.) (Table 1).

Table 1.
Clones exhibiting good height growth in trials at the NMSU Farmington Agriculture Science Center

Clone designation	Female parent	Male Parent
OP-367	*Populus deltoides*	*Populus nigra*
DN-34	*Populus deltoides*	*Populus nigra*
311-93	*Populus deltoides*	*Populus nigra*
015-29	*Populus trichocarpa*	*Populus deltoides*
059-289	*Populus trichocarpa*	*Populus deltoides*
049-177	*Populus trichocarpa*	*Populus deltoides*

Table Source: Dr. Michael O'Neill, personal communication

Soils

Poplars are adapted to a wide range of soils, but growth under rain-fed conditions is generally better on loam soils. However, the use of drip or sprinkler irrigation has increased the range of soils suitable for poplar growth. Recently, a detailed soil survey of the 41,000 ac in the Bonito Prairie tract was used to identify over 12,000 ac that would have either slight limitations (1,041 ac) or moderate limitations (11,098 ac) for poplar planting (Buchanan Consultants, Ltd. 2006). The soil suitability criteria were developed in consultation with Drs. James T. Fisher and John G. Mexal. The determining characteristics were depth to clay, surface rock content, or rock content in the upper 12 in of soil (Table 1). It is likely there is additional acreage that could be identified, or brought into a better suitability class is the surface rock content were physically removed during site preparation (see below). Soils with 'slight' or 'moderate' limitations should be suitable for poplar production under supplemental irrigation. The soils are excessively to moderately well drained, and should be amenable to productive use under drip or sprinkler irrigation where the quantity of irrigation water applied can be controlled.

These soils determined as suitable for poplar are montmorillonitic in origin, indicating they can shrink when dry and swell when wet. This could be problematic during the rooting of poplar cuttings, if moisture availability is not maintained. If the soils are allowed to dry during rooting, the tender, new roots could be stripped from the cutting, resulting in high mortality. However, managing soil moisture through drip irrigation should minimize any potential for soil shrinkage, especially during the establishment phase.

Table 2
Soil suitability criteria for hybrid poplar trees, Bonito Prairie, White Mountain Apache Indian Reservation

Limitation	Slight	Moderate	Severe
Slope	<3% (not ponded)	3-8%	>8% (or ponded)
Depth to bedrock	>40”	24-40”	<24”
Drainage	Somewhat excessively, well	Moderately well	Very poorly, poorly, somewhat poorly
Surface			
Gravel & Cobble (%)	<15%	15-35%	>35%
Stone (%)	<15%	15-35%	>35%
Texture (0-4”)	Loam, sandy loam, silt loam, <27% clay	Clay loam, sandy clay loam, silty clay loam, 27-40% clay	Clay, silty clay, sandy clay, >40% clay
0-12”			
Gravel & Cobble (%)	<15%	15-35%	>35%
Stone (%)	<15%	15-35%	>35%
Depth to Clay Texture	>8”	4-8”	<4”

Table Source: Buchanan Consultants, Ltd. 2006.

Identify Silvicultural Requirements for Poplar Production

Given the soil characteristics were unknown when the report for Task Order No. 1 was prepared, it is unlikely that ripping will be required for much of the site as previously suggested. However, shallow ripping (18” to 24”) may improve plantability on sites with moderate limitations because of rock content in the surface 12” of soil. Additionally, any site preparation should create a furrow which is free of surface rock. Rock-raking the planting line (~12” to 18”) would improve plantability as well as provide a rock mulch which would decrease weed growth and moisture evaporation from the soil surface. Any site preparation prescription should be performed on the contour, and occur during the dry season, prior to the onset of monsoonal rains to allow precipitation to ‘melt’ ripping trench to increase effective soil depth and facilitate planting.

Drip lines should be located down the planting trench at least one month before planting to check proper function of the irrigation system, moisten planting site, and facilitate ‘siltation’ of soil into the planting line. The plantation can be irrigated either with drip irrigation or a sprinkler system. A sprinkler system would have higher installation costs, but lower maintenance costs (repairing rodent damage, clogged lines). However, the sprinkler systems

will necessitate greater weed control as soil surface across the plantation will be moistened. The sprinkler system also will use more water at least until canopy closure, as some water is lost to volatilization and weed growth. Drip irrigation is used successfully in both Farmington, NM and Oregon. During the establishment year, only one drip tube (down the planting line) would be needed. However, within the first three years, a second and possibly a third line would be needed to irrigate a row of trees, once canopy closure occurred.

Plantation establishment should commence in the early Spring (no later than mid-April), as soon as the irrigation system is in place. Hybrid poplar cuttings (OP-367 for the Year-1 operational trials will have to be ordered at least one year before planting. Order cuttings with an 8" (20 cm) length (1/4" to 3/8" diameter) and at least three (3) viable buds. Maintain cuttings in cooler at 34ºF (±2ºF), and in an insulated cooler while on the site.

Planting crews should receive several days of training just prior to every planting season. The training should include explanation of what this activity means to the future of the WM Apache tribe, employment opportunities for the sawmill, as well as address any environmental concerns, such as 'clonal forestry'. The training should include practice planting over 2-3 days with about 800 cuttings/person. This is crucial for two reasons:

1. proper handling and planting of cuttings ensures high survival. Anything less than 90% survival is considered poor success.

2. tree planters are paid by the tree. GreenWood Resources budgets $0.075/tree for planting costs. Thus, in order to earn minimum wage ($41.20/day), a tree planter must plant at least 550 trees/day or 1.8 ac. On level ground, with easy planting, an efficient worker can plant 1,500 to 1,800 cuttings/day ($112 to $135/day).

While the ground will be pre-moistened, there may be rocks present below the surface that could damage the cutting. Consequently, planting holes should be made with a flat planting bar or K-B bar. Place the cutting (buds facing up) in the planting hole with the cut surface level with the ground, or slightly above the ground. This will help ensure that only the uppermost bud sprouts, thereby minimizing the risk of multiple shoots.

Typical spacing for poplar plantations are 10 ft X 10 ft (435 trees/ac), 10 ft X 12 ft (363 trees/ac), or 12 ft X 12 ft (300 trees/ac). Trees need space to grow, but that space need not be perfectly square (e.g. 10 ft X 10 ft (100 ft^2) or 12 ft X 12 ft (144 ft^2)). Comparable growth can be expected is comparable space is provided with rectangular spacing (e.g. 8 ft X 12 ft (94 ft^2) or 10 ft X 14 ft (140 ft^2)). This can be useful if there are restrictions caused by site preparation practices (e.g. ripper shanks).

Final spacing will be dependent on targeted end use. Trees grown at higher stocking rates (e.g. 435 tpa) will produce more wood volume per unit time, but smaller individual logs. Trees grown at lower stocking rates (300 tpa) will produce less volume, but larger, and consequently more valuable logs.

A tentative scenario for establishing 10,000 ac of hybrid poplar plantations is outlined in Table 2. The operations should start small to develop a 'tree planting' culture; planting no more than 100 ac the first year. The best planters should be used as future crew leaders. The planting window is by necessity narrow. Planting can begin once the ground has thawed, but should conclude in early Spring. A two week delay in planting can reduce wood yield by over 1%/tree in a 10-year rotation.

Table 3
Example of planting schedule for a 10-yr rotation of 9,000 ac hybrid poplar plantations.

Year	Planted Acreage	Planting Rate (cuttings/m·d)	Crew number & size (no.)	Planting window (wks)
1	75-100	300-700	2 of 5-6	3
2	200-300[1]	500-1,000	4 of 4-6	2
3	600-725[1]	1,000-1,500	6 of 4-6	2
4-10	1,000[2]	1,000-1,500	6 of 4-6	2-3
11	1,000	1,000-1,500	6 of 4-6	2-3

1 Also replant large blocks (>100 blanks) from Year-1.

2 There should be no replanting in Year-4. Interplanting, or the replacement of mortality, is never successful. The replacement trees are one year younger, and grow in the shade of the older trees, essentially losing the last two years of volume growth.

Water and fertilization requirements will have to be estimated from nearby research and operational trials. The closest site with planted hybrid poplars is the NMSU Farmington Agriculture Science Center and on the Navajo Agriculture Products Industries land in northwest New Mexico. Estimated cumulative water use (evapotranspiration) was about 17" (43 cm) in year-1 and 28" (70 cm) in year-2 (Figure 1A) in a region that receives about 4" (10 cm) annual rainfall, but can receive as much as 10" (25 cm) (Figure 1B). At full canopy closure in year-3, the estimated water use of hybrid poplar will be about 64"/ yr (160 cm/yr). This estimate compares with measured water use by this same poplar clone in Bend, OR (Shock et al. 2002) and estimated water use in Ojinaga, Mexico (Figure 2) (Lombard, unpubl.).

The seasonal water use of hybrid poplar most likely is similar to pecan which has a similar period of budbreak (mid- April) and leaf fall (late-September). In Las Cruces, NM, pecan used 56" (142 cm) of water during the growing season (Figure 3) (Sammis et al. 2004), and relies of rainfall or storage for winter water requirements. Thus, the pecan scheduling scheme could be used for hybrid poplar until better information is available online (www.weather.nmsu.edu).

Figure 1a and 1b
Cumulative Evapotranspiration (mm) and Applied Water (mm) for Hybrid Poplar Clones Grown under Drip Irrigation for 2002-2003; Monthly Precipation for the year 2004 at NMSU Agricultural Science Center at Farmington, NM

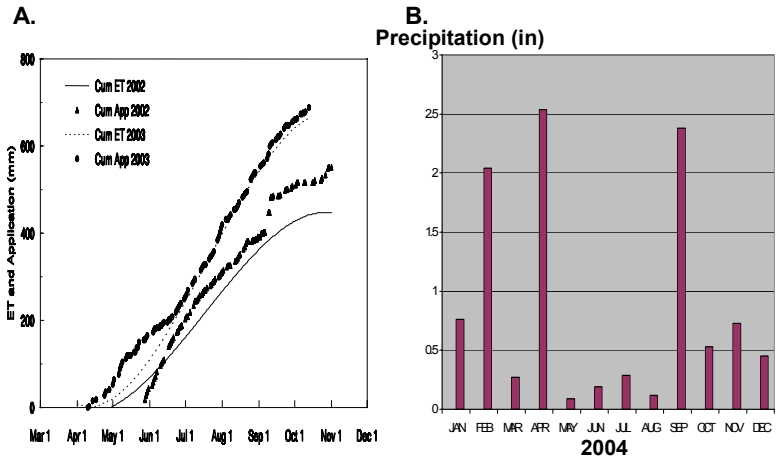


Figure Source: Lombard, et al. 2005.

Figure 2
Estimated Potential Evapotranspiration (PET) for Hybrid Poplar Plantations (OP-367) at Three Locations

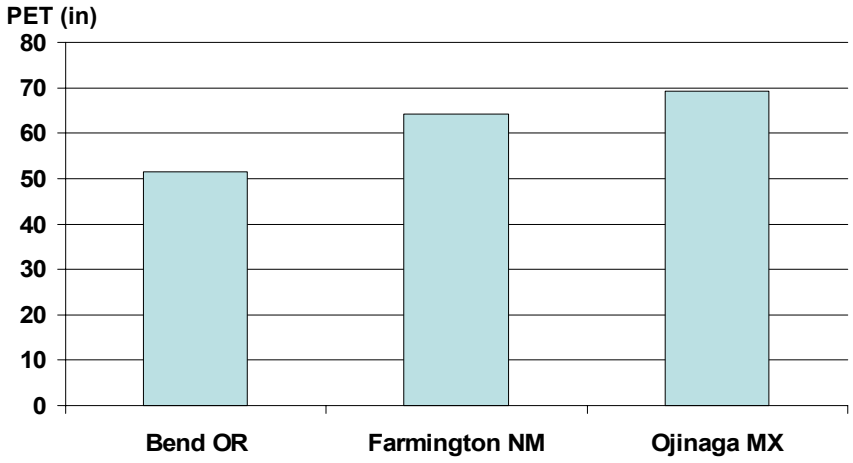


Figure Source: Lombard, et al. unpublished.

Figure 3
Potential Evapotranspiration (Eto) and Pecan Crop Water Use (Et1, Et2) in the Mesilla Valley, New Mexico

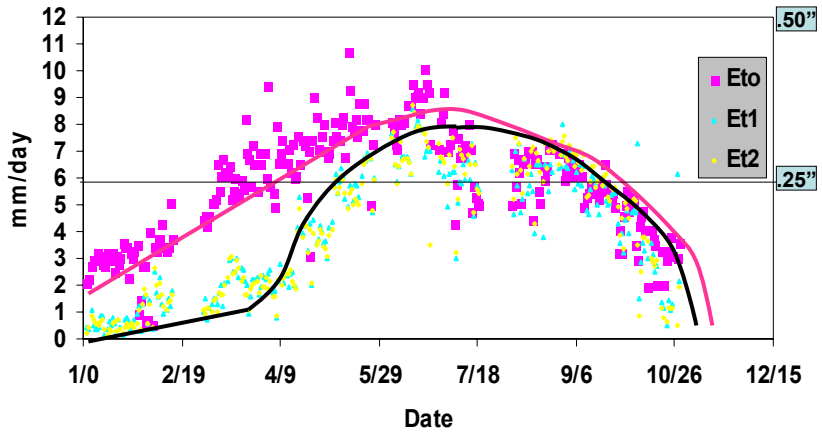


Figure Source: Sammis et al. 2004.

The Bonito Prairie has been used as unimproved pasture for livestock and wildlife. The incipient nitrogen content is low (Buchanan Consultants, Ltd. 2006). Nitrate-nitrogen averages less than 1 mg N/kg soil (1 ppm), while organic matter ranges from 1% to 3% depending on soil type and depth. Because of low soil fertility, fertilization will likely be required during the establishment year (Year-1). Nitrogen should be applied through drip system at 40-50 mg N/L beginning in late May-early June (at 45 days after planting). During the first year, 30-50 units of nitrogen should be applied, but applications should cease by mid-September, when defoliation is eminent. Year-2 nitrogen applications should commence in the Spring and total 50 to 100 units of nitrogen, depending on soil and foliage tests. Year-3 through the end of rotation 80 to 200 units of nitrogen depending on soil test results. In addition to nitrogen, phosphorus will be a needed fertilizer, both pre-plant and post-establishment. Iron (chelate) may need to be applied depending on the clone. If needed, iron should be applied to the foliage, beginning early in the season, and possibly several times during the growing season. Lombard (pers. comm.) is developing a color key for iron chlorosis in hybrid poplar, based on his work at the NMSU Farmington Agriculture Science Center.

Pest Management

To control weeds through first 3 years use RoundUp® or herbicides registered for poplar trees (Stanturf et al. 2002). Crown closure after year-3 should obviate need for further herbicide use.

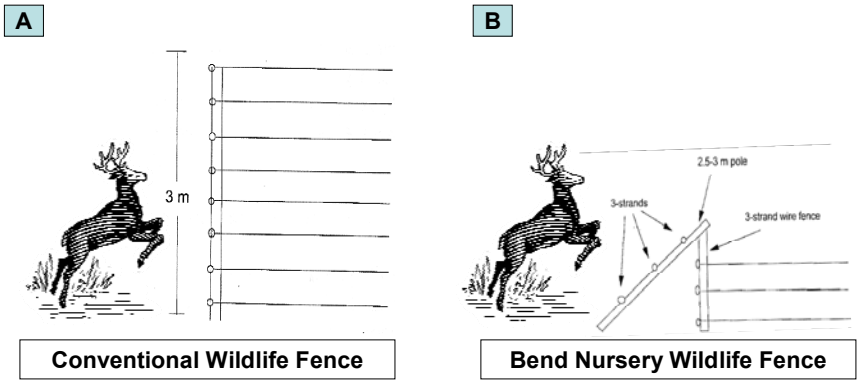
Insect pest will eventually become problematic as the plantation grows in size and acreage. GreenWood Resources has identified insects likely to become problems. Organic production of hybrid poplar is neither feasible nor practical. However, biological control and integrated pest management (IPM) prescriptions should be used. This approach is always the most economical.

Voles and pocket gophers feeding on roots can reduce growth and actually kill trees. Bare ground through adequate weed control is one of the better measures for controlling these pests. Heavy ground cover not only encourages this pest, but also reduces growth through competition for water and nutrients. Additionally, there are pesticides for controlling rodents.

Rabbits and coyotes gnawing on irrigation tubing are best controlled by hunting. Although rabbit fencing can preclude rabbits from damaging the site, it may be cost prohibitive. However, a lack of rabbits on the site may discourage coyotes, as well.

Deer and elk browsing on new shoots or rubbing velvet off antlers are best controlled with proper fencing (Figure 4). An electric fence erected prior to planting can discourage wildlife from entering the area. Deer can be taught to avoid the electric fence by baiting the fence with an attractant, such as peanut butter, well before a food source (poplar shoots) are available. Otherwise, a fence constructed as illustrated in Figure 4 is needed to restrict access. Animals, such as deer and elk, have great vertical leaping ability, but poor horizontal leaping ability. A vertical fence, even a 10 ft (3 m) fence (Figure 4A) will not deter all elk, and some will become trapped in the fence. However, the 'Bend Nursery Wildlife' fence is a relatively inexpensive horizontal fence (Figure 4B) that is an especially good deterrent.

Figure 4a and 4b
Fencing Options to Reduce Deer and Elk Feeding on Young Trees



Pruning: trees managed for dimension lumber or veneer production will need to have the lower branches pruned to increase the percentage of clear lumber. No more than 1/3 of the live crown should be pruned at one time. Generally, growth is not reduced by pruning lower branches if no more than 1/3 of the live crown is removed. Thus, the first log (~18 ft) should be pruned in 2-3 'lifts'. The first 'lift' should occur after the third growing season when the trees are at least 18 ft tall. The lower 6-9 ft of the bole should be pruned carefully of all branches. Care should be taken to not damage the trunk of the tree. Subsequent 'lifts' should be planned every year if trees continue to grown at least 6 ft/yr.

Harvesting with a feller/buncher with on-site debarking is preferred to return high nutrient content slash to soil for next rotation. This would reduce the need for nitrogen in subsequent rotations. Alternatively, debarking could occur at mill site and bark used for co-generation. Manual harvesting with chain saws would create greater employment opportunities for tribal members, but also would increase the harvesting cost.

Potential stumpage

Growth and yield of poplar plantations

Generally, OP-367 grows about 6 ft the first year, and 10 ft to 12 ft in years 2 and 3 (Figure 5A). After three years a DBH of 3" to 5" can be expected (Figure 5B). Growth is dependent on stocking (the Ojinaga, Mexico site had a stocking of 1,000 trees/ac), evaporative demand, and water and nutrient management. Given adequate management, poplars at Bonita Prairie should be 50 ft to 70 ft tall after 10 years (Figure 6). The estimated DBH would be 6" to 8" based on a stocking of 1,000 trees/ac for the Ojinaga, Mexico site (Vallotton et al. 2000).

Fast growing species tend to behave similarly at comparable stocking rates (Figure 7). The time to achieve a given DBH will vary with species and site conditions, but the relationship among stocking levels will be similar. Given a DBH of 5" at 1,000 trees/ac for the Ojinaga site, reducing the stocking to 300-440 trees/ac would increase the average DBH at year-6 (Figure 6) to 7" to 8" at year-6. This is reasonably close to growth curves provided by Stanturf (2002) (Figure 8). Thus, reducing the stocking by 55% to 67% will increase individual log diameter by 25% to 83%, with little to no change in height. Unfortunately, total stand volume will also decrease as individual piece size increases.

Figure 5
Hybrid Poplar Growth in the West

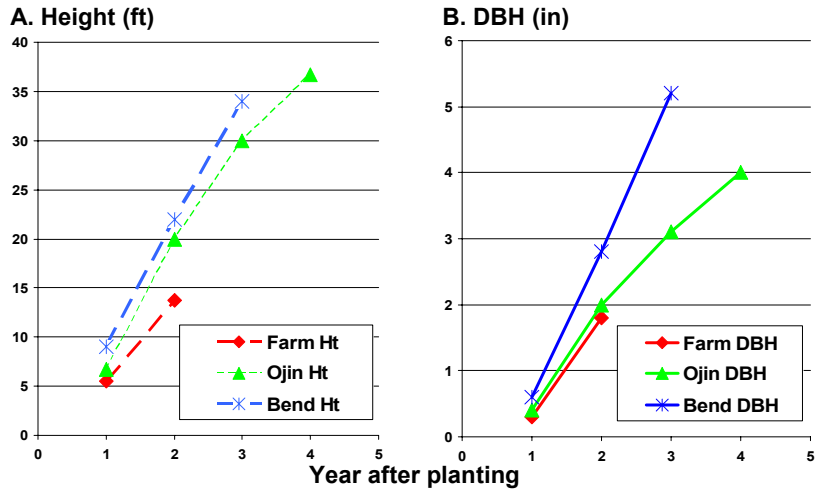


Figure Source: Lombard et al, 2005, Vallotton et al., 2000, Shock et al. 2002.

Figure 6
Estimated Hybrid Poplar Growth Through Year 10 Based on Growth in Ojinaga, Mexico

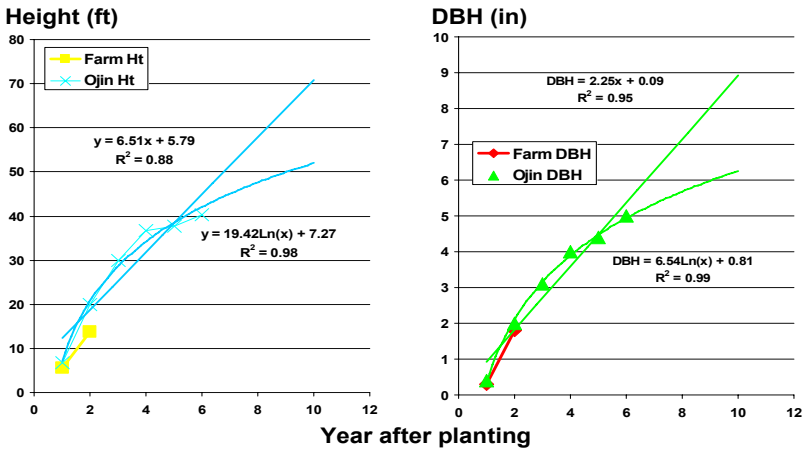


Figure Source: Vallotton et al., 2000.

Figure 7
Diameter Growth of Fast Growing Species at Different Stocking Levels

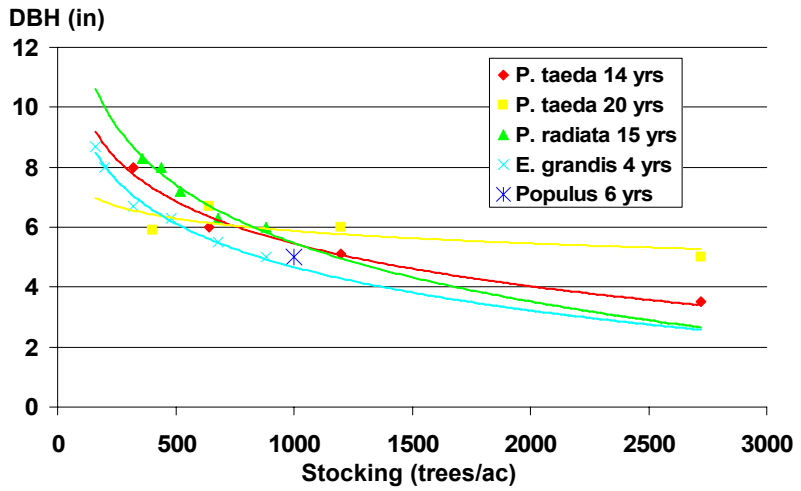


Figure Source: Shepherd 1986, Mexal, unpublished.

Figure 8
Poplar Diameter Growth after Planting at Different Spacings and Thinning Through Time. Diameter Growth at 8 ft x 8 ft Spacing from Ojinaga Study

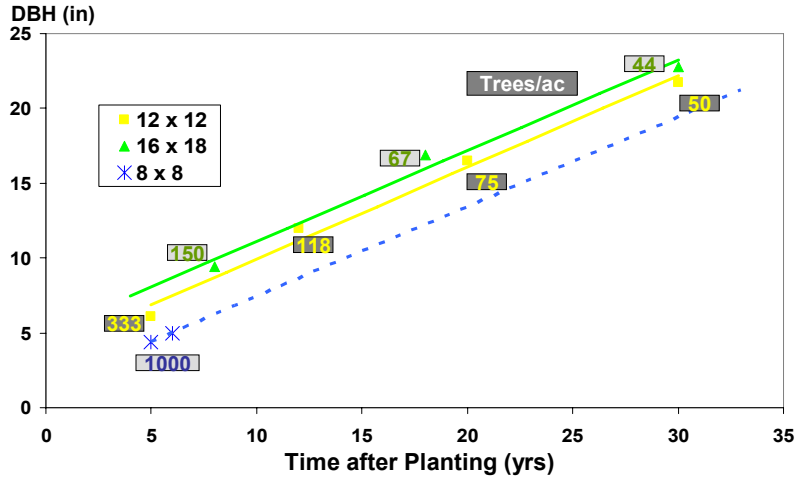


Figure Source: Stanturf et al, 2002, Mexal unpublished.

Stanturf (et al. 2002) developed volume equations for hybrid poplar. His equations calculate total volume (outside bark) and merchantable volume (inside bark):

$$\text{Total Vol (OB)} = 0.06 + 0.002221D^2H,$$

$$\text{Merch Vol (IB)} = -0.86 + 0.001904\ D^2H,$$

where: Vol is in cu ft, D is diameter (in), and H is height (ft). Given these equations, the merchantable volume can then be calculated for a log of a given height and diameter (Figure 9). For example, given a tree height of 60 ft and DBH = 10" the total volume would be 13.4 cu ft/tree and the merchantable volume would be 10.6 cu ft/tree, or 79% of the total volume. For a tree height of 60 ft and DBH = 12" the total volume would be 19.2 cu ft/tree and the merchantable volume would be 15.6 cu ft/tree, or 81% of the total volume.

Assuming an initial stocking of 333 trees/ac with 90% survival, the total volume/ac of the 10" trees would be 4,016 cu ft/ac and the merchantable volume would be 3,180 cu ft/ac at 10 years (Table 3). This is an annual growth of 318 cu ft/ac/yr (3.18 cunits/ac/yr). Trees with an 8" DBH would have only one-half the volume, while trees with a 12" DBH would have 69% more wood volume. Furthermore, at 6 BF/cu ft for a 10" tree (Reynolds 2005), the 3,180 cu ft/ac would equal 19,080 BF/ac at 10 years. Larger diameter trees produce more BF/cu ft (Figure 10), which would argue for lower stocking and longer rotation (see below).

Figure 9
Effect of DBH (in) and Height (ft) on Individual Tree Merchantable Volume (ft^3) of *Populus*

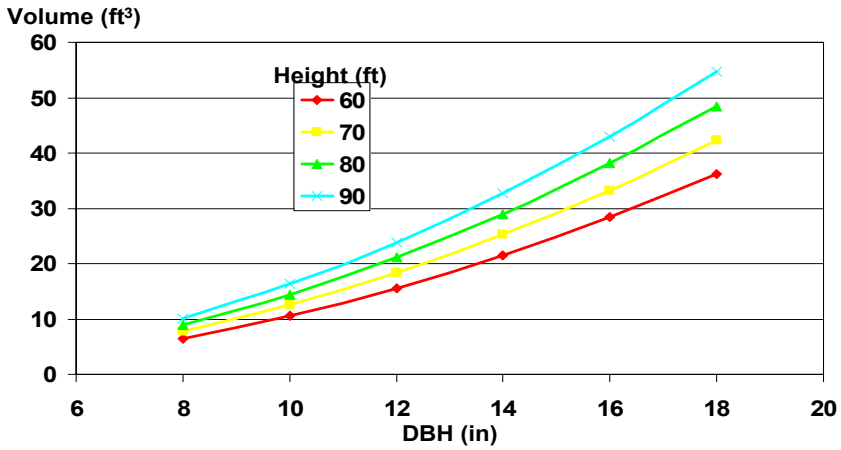


Figure Source: Stanturf, 2002.

Table 4
Mean merchantable volume (cu ft/tree and cu ft/acre (assuming 300 trees/ac)), board feet (BF)/tree and per acre for a plantation with tree heights averaging 60 ft.

Wood Product	DBH (in)		
	8”	10”	12”
Cu. Ft/tree	6.4	10.6	15.6
Cu. Ft/ac (300 tpa)	1,920	3,180	5,148
BF/tree	38	63	49
BF/ac (300 tpa)	11,400	19,080	28,200
BF (% of 10”)	60%	100%	169%

Table Source: Cubic feet to board feet conversion from Reynolds (2005).

Currently, given a harvest of about 40 million BF/yr, the Fort Apache Timber Co. sawmill processes about 100,000 logs/yr with each log having about 400 BF. However, log size has diminished in recent history. Assuming 10,000 ac of Bonito Prairie is planted over 10 years, in year 11, the tribe could harvest nearly 300,000 logs/yr from Bonito Prairie alone. Furthermore, given a yield of 3,180 cu ft/ac or 19,080 BF/ac, the 1,000 acres harvested per year would yield over 3 million cu ft/yr at rotation or over 19 million BF/yr. Thus, about one-half of the current harvest could come from the Bonito Prairie poplar plantation if all 10,000 ac were planted.

Figure 10
Relationship Between Volume, Weight, Board Feet and Price for 80 foot Tree

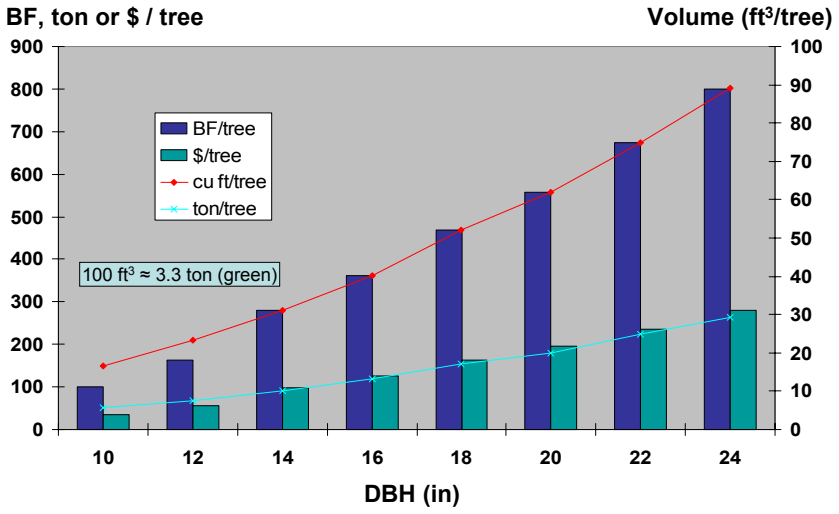


Figure Source: Reynolds 2005.

Wood products

The value of a log is a function of both the diameter of the log, and the end product extracted from that log (Figure 11). Finished wood products (veneer and lumber) have much higher value than pulp or fuelwood. Manufactured products (plywood, OSB) have about a 30% higher value that solid wood (Table 4), and pulp is valued at about 2/3 the value of solid wood. Used newsprint has a value ($57/t) only marginally better than fuelwood.

Other options for utilization of poplar wood include:

- Carbon-credits (estimate price = $20/BDT) are in their infancy. However, New Mexico requires power plants to generate 10% of their energy from green sources by the year 2010. It may be possible to develop a market to Public Service Co. of New Mexico (PNM), Arizona Power Co., or El Paso Electric Co. (EPEC). A knowledgeable contact for carbon credit prices is Jol Hodgson (see below).

- Provide wood for excelsior (environmental bats) to a manufacturing facility in Mancos, CO.

- Louisiana-Pacific closed an OSB plant in Olathe, CO in 2001. Could a reliable source of fiber be an incentive to reopen?

- Fuel for co-generation (estimate price = $10/BDT) requires a nearby facility. Approximately 20% of the volume harvested will be unmerchantable. This material would be ideal for a co-generation facility. This operation could produce over 900 cu ft/ac/yr of unmerchantable volume, or about 15,000 tons/yr from 1,000 harvested acres.

Figure 11
Piece Size Vs. Value

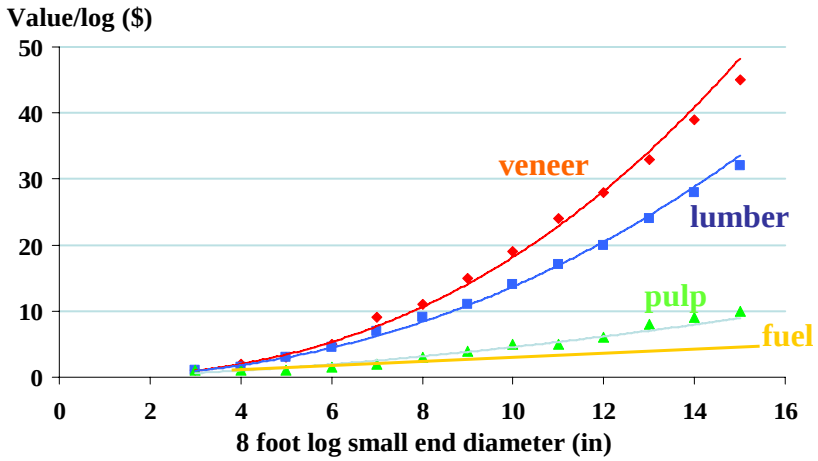


Figure Source: Barbour, USFS - 1999

Table 5
Recent wholesale prices for wood products

Commodity	$/unit	Douglas-fir	Southern Pine
2" X 4"	$/MBF	459	387
Plywood	$/MBF	448	403
OSB	$/MSF		374
Pulp	$/ton		640
Paper	$/ton		358
Newsprint (used)	$/ton		57

Table Source: 2004 Weyerhaeuser Co. Annual Report.

Summary Recommendations:

- Based on the recent soil survey, there are at least 10,000 ac suitable for hybrid poplar plantations in Bonito Prairie. These mapping units should be used to identify planting sites.

- The poplar clone OP-367 should be used for fiber production. Anticipated yield could be 3.57 cunits/ac/yr or over 21,000 BF with a 10 year rotation.

- If this project is pursued, no more than 100 ac should be planted in the first year. These should be planted across Bonito Prairie on different mapping units in 10 to 20 ac blocks. if possible.

- Trials with other clones should be initiated immediately, building on the data collected by NMSU Farmington Agriculture Science Center.

- Products with a higher value (lumber, OSB) should be the primary objective with lower value products (excelsion, fuelwood) as secondary products.

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Appendix I

Task Orders

Task Order No. 1:

1. Participate in a field trip October 28-29, 2005.
2. Prepare a memorandum documenting the field trip;
3. Recommend trees suitable for agroforestry on Fort Apache Indian Reservation;
4. Identify any silviculture requirements and
5. Discuss potential stumpage.

Deliverables:

1. **Field Trip** actually occurred Oct. 30-31, 2005 with Dr. J.T. Fisher.
    a. Depart Sunday, October 30, 2005 about 9:30 am.
    b. Return Monday, October 31, 2005 about 10:30 pm.
2. **Memorandum** documenting field trip:
    - October 30, 2005: Travel to Cibecue, AZ: visit site for potential fruit tree and Christmas tree production. Overnight in HonDah, AZ
    - October 31, 2005: Visit Bonito Prairie (T4N, R23E, Sec. 36)
        - Approximately 9,000 ac predominantly of two soil types.
        - Obvious site differences even within a major soil type.
            - NW area (near entrance) = heavy clay soils with varying amounts of surface rock, vegetation = grama grass (*Bouteloua* sp.) and annual composite species.
            - SW areas = shallow, rocky soils, lacking any grama grass. Vegetation made up entirely of annual composite species. This area unlikely to support any tree species. Need to determine extent of area through more detailed soil survey.
            - East side = very good soils with few rocks. Capable of supporting either hybrid poplar or Christmas tree plantations.
        - Project needs a detailed soil survey with greater sampling intensity than typical SCS survey. A professional soil scientist should be contracted to

conduct detailed soil survey. Possible consultant: Dr. Bruce Buchanan (see below).

- October 31, 2005: Visit Canyon Day
  - Currently in irrigated forage production.
  - Could be irrigated either with wastewater from lagoon systems or fresh water.
  - Seems to be a productive site for fruit production, Christmas trees, or Community Support Agriculture system. If non-food crops (forage, Christmas trees, ornamental trees) are grown, treated wastewater could be used before river water to reduce downstream pollution.
- October 31, 2005: Visit FATCO sawmill, Whiteriver, AZ (Mary Classay, General Manager)
  - Currently, maximum harvest size is 18" logs with minimum 5" top.
  - Harvest: 37.5 MMBF/yr, Cibecue mill can harvest 12 MMBF/yr (closed at this time)
  - Products: utility poles, peeled logs (log homes), 5¼, 6½, 2"X 4" to 2"X 10" lumber.
  - Employees: 250 (may have to lay off employees soon).
  - Will process more roundwood than sawtimber (mill can not handle smaller sized logs currently harvested)
  - According to Mary Classay, Bob Worsley (ReEnergy Co.) is interested in biomass harvesting.
  - According to Mary Classay, there is talk of building an OSB plant (near Snow Flake?)

Task Order No. 2:

Participate in field trip to evaluate soils at Bonito Prairie (work with Buchanan Consultants, Ltd to develop suitability criteria)

Deliverables:

- Travel to White Mountain Apache Reservation on March 1, 2006 with Dr. J.T. Fisher.
- Evaluate soils and discuss suitability criteria with Dr. Bruce Buchanan on March 2, 2006.

Task Order No. 3:

1. Refine first draft of the Poplar Suitability Report based on Final Soil Survey of the Bonito Prairie, White Mountain Indian Reservation.
2. Refine bulleted format of text in suitability report to paragraph format.

Deliverables:

- Submit revised report by October 18, 2006

Appendix II

English to Metric Conversions

- English to metric conversions Metric to English conversions

English Units →	Metric Units	Metric Units →	English Units
1 ac	0.4 ha	1 ha	2.5 ac
1”	2.54 cm	1 cm	0.4”
1 yd (3’)	0.9 m	1 m	1.09 yd (3.3’)
1 gal	3.78 L	1 L	0.26 gal ((1.06 qt)
1 lb	0.45 kg	1 kg	2.2 lb
1 cu ft	0.02832 m^3	1 m^3	35.3 cu ft
1 lb/ac	1.12 kg/ha	1 kg/ha	0.89 lb/ac

- Other notes:
  - DBH = Diameter at Breast Height (4.5 ft)
  - BDT = Bone Dry Ton
  - MBF = Thousand Board Feet (1000 X [1 ft X 1 ft X 1”])
  - MSF = Thousand Square Feet
  - Log = bole of trunk 16’ (5.3 m) in length
  - 1 m^3 ≈ 450 kg (ρ = 0.45)
  - 1 m^3 ≈ 427 ft^2
  - 1 kg ≈ 1 ft^2
  - 1 MBF = 1 ton

Appendix III

Contacts

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APPENDIX E

Crop Market Analysis for Proposed Crops on the Fort Apache Indian Reservation

ENTRIX

FEBRUARY 2007

Appendix E:
Market Analysis for the Proposed Crops on the Fort Apache Indian Reservation

Draft Report

Prepared for

White Mountain Apache Tribe
Whiteriver, AZ

By

ENTRIX, Inc.
12009 N.E. 99th Street, Suite 1410
Vancouver, WA 98682-2497

January 2007

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Crop Market Analysis

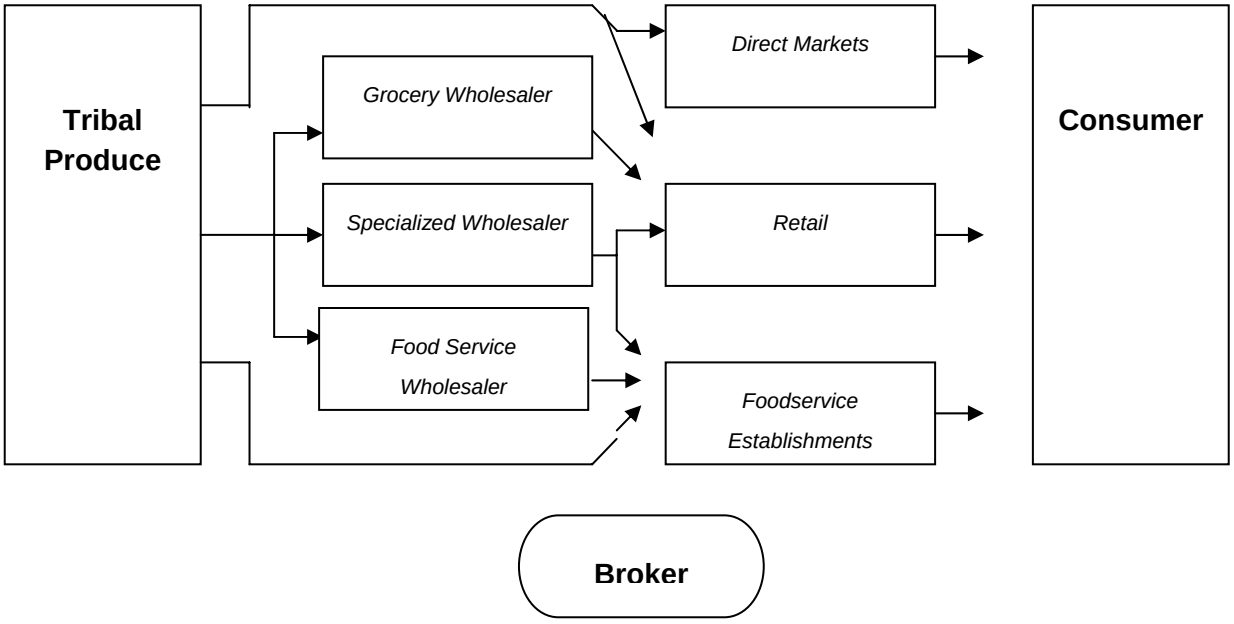
Overview

This section of the report focuses on the marketing channels available to the proposed production on the Reservation. The marketing channel discussion is followed by an analysis of specific markets or metropolitan statistical areas (MSAs) and the resulting derived wholesale farm price that can be expected in each market. Per capita consumption rates are also examined and incorporated into the discussion of a reasonable market limit for each crop.

Marketing Channels Available

There are multiple marketing channels available to the White Mountain Apache Tribe in regard to the proposed fresh market produce. Figure E-1 below provides a flow chart of these marketing channels

Figure E-1
Marketing Channels Available



Source: Understanding the Dynamics of Produce Markets / AIB – 758, Economic Research Service, USDA, August 2000

The market channel diagram above (Figure E-1) does not consider the on-farm flow of produce on the Reservation. The on-farm flow of produce may require packaging of some sort, either in the fields or in a packinghouse. If the produce is not shipped right away, it may have to be stored on the Reservation in cold storage. In this analysis, it is assumed that produce grown on the Reservation is either field packed or transported immediately to the packinghouse to be put into cold storage before being shipped to a wholesaler, direct market, or retail distribution center. A refrigerated truck will be required for transporting some produce, such as cantaloupe. The investigation as to the proposed cost of a packinghouse is discussed in Section 5 of the main report.

There are three different types of wholesale markets identified as marketing channel options for the Tribe. The three types are 1) general line grocery wholesalers; 2) specialized produce wholesalers; and 3) general line food service wholesalers. An explanation of each wholesale market type is addressed below.

General line grocery wholesalers buy produce from the grower, and take title to the product (which they handle). General line grocery wholesalers procure grocery products (food and nonfood) for retailers that lack their own warehousing and store delivery services. These retailers are often individual store retailers or smaller retail chains that

lack sufficient resources to own and operate produce buying offices, warehouses, and trucking fleets.

The Census of Wholesale Trade classifies specialized produce wholesalers as establishments primarily engaged in the wholesale distribution of fresh fruits and vegetables. An example of a specialty produce wholesaler is New Harvest Organics, based out of Rio Rico, Arizona. This company specializes in marketing organically grown produce from Arizona and Mexico. The Tribe has options as to how the proposed packinghouse is organized. It can either be established as an independent specialized produce wholesaler, or possibly form a partnership with an existing wholesaler and operate the packinghouse in accordance with the partnership agreement. Either way, the packinghouse and produce distribution will be organized as a specialized produce wholesaler in this analysis.

General line foodservice wholesalers serve restaurants, hospitals, schools, and hotels; these types of wholesalers handle products specifically for foodservice use. The large foodservice wholesalers, such as Sysco Corporation and Alliant Foodservice, Inc., also carry non-food items that include paper supplies and related equipment (e.g. coffee makers, napkin dispensers, etc.).

There are also direct markets available to the Tribe, including farmer's markets, choose and pick (U-pick) farms, and the Internet. Given the location of the Reservation and the access that visitors have to recreational pursuits therein, there is potential for the Tribal entity to sell produce to customers on-site via farmer's markets or U-Pick farms. However, direct marketing is the most expensive form of marketing and would require setting up a roadside stand or shop on the Reservation for transactions. Any produce sales made directly on the Reservation are not likely to account for a large portion of the Tribe's produce sales. The Internet is another form of direct marketing and would require a significant investment in technology and fulfillment resources before any online sales could occur.

The retail market is another marketing channel available to the Tribe. The recent trend in the produce industry is for large retail grocers (the buyers) to establish direct relationships with growers (the sellers). This supply channel allows retailers the most control over the product, as title to the commodity is taken at the farm gate. This action is important to retailers to assure a fresh and safe product for their customers. In order to facilitate a direct relationship with growers, retailers are now engaging reputable, third party auditing firms as a first step in qualifying their new suppliers and maintaining relationships with their existing ones.

There are also sales agents that could assist the Tribe in marketing their organic produce. Organic Harvest Network, headquartered in San Francisco, California is one example of the grower sales agent. Peter Oszacsky of Organic Harvest Network was contacted for

market data specific to the crops proposed in this feasibility analysis. Peter's firm has contracts with warehouses all over the country, including; New Jersey, Louisiana, Philadelphia, and Los Angeles. Organic Harvest Network expressed a desire to work with the Tribe when the irrigation project becomes operational. Peter also mentioned that the prices in this analysis are conservative. He felt confident that at there is sufficient demand in the marketplace to market and sell the amount of product that is proposed in this analysis.[1]

New Harvest Organics is another organic produce marketing firm in Rio Rico, Arizona. New Harvest Organics handles produce from Arizona, California, Mexico, and South America. They have distribution channels across the United States, Canada, and Great Britain. A contact with New Harvest Organics also confirmed that the prices used in this analysis are conservative.[2]

Finally, Whole Foods Inc. provided useful information as to the market of organic produce in the United States. According to Whole Foods Inc. the interest and demand for organically produced food from the Southwest region will be increasing in the near future. Whole Foods Inc., like almost all of the marketers contacted, expressed interest in working with the Tribe on such a venture.[3]

Due to the focus on product freshness and safety, retailers must ship produce from various parts of the country at specific times of the year, depending on where and when the produce is in season. These transportation challenges and market windows are defining characteristics of the current produce market in the United States. In order to effectively compete, retailers must keep costs down or differentiate their product from the rest of the industry. One method of lowering costs is to buy high quality, reliable produce from sources that are nearest to the end consumer. In this economic analysis, the competing areas of production are reviewed for each organic commodity proposed for the Reservation to gain a better understanding of the transportation costs that major retailers would face if they begin to transport produce to their terminal markets directly from the farm gate.

---

1 Personal Communication with Peter Oszacsky, Organic Harvest Network, January 2, 2007.

2 Personal Communication with Sherrie Burkett, Sales Department of New Harvest Organics, December 14, 2006.

3 Personal Communication with Mark Carrol, Whole Foods Inc., December 14, 2006.

Organic Markets

The United States Department of Agriculture (USDA) introduced national organic standards on October 21, 2002. Following implementation of these standards, U.S. organic sales have continued to grow at rates of over 20 percent or more per year.[4]

Table E-1
Consumer Sales and Growth Rates of Organic Foods, 1997 - 2003

Year	Sales	Growth Rate
	Billion Dollars	Percent
1997	3.6	
1998	4.3	19.7
1999	5.0	18.2
2000	6.1	21.0
2001	7.4	20.7
2002	8.6	17.3
2003	10.4	20.2

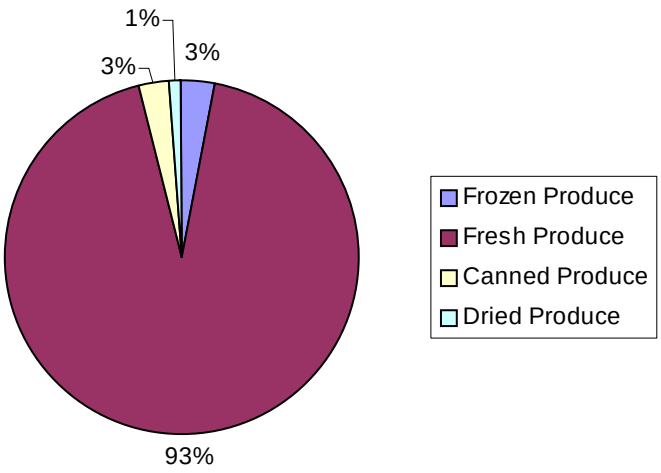
Source: Oberholtzer, Lydia and Carolyn Dimitri and Catherine Greene, May 2005, "Price Premiums Hold on as U.S. Organic Produce Market Expands," Electronic Outlook Report from the Economic Research Service, USDA, VGS-308-01, www.ers.usda.gov.

The sales of organic U.S. produce have been dominated by fresh produce, which has accounted for 93 percent of organic produce sales in 2003.[5] Figure E-2 below shows the breakdown of organic sales by category for 2003.

4 Oberholtzer, Lydia and Carolyn Dimitri and Catherine Greene, May 2005, "Price Premiums Hold on as U.S. Organic Produce Market Expands," Electronic Outlook Report from the Economic Research Service, USDA, VGS-308-01, www.ers.usda.gov.

5 Ibid.

Figure E-2
Sales and Shares of U.S. Organic Produce by Category, 2003



Source: Oberholtzer, Lydia and Carolyn Dimitri and Catherine Greene, "Price Premiums Hold on as U.S. Organic Produce Market Expands," Electronic Outlook Report from the Economic Research Service, USDA, VGS-308-01, www.ers.usda.gov, May 2005.

The increased popularity of organic foods has resulted in supermarket chains beginning to offer produce and other items labeled "organic". Organic products account for only two percent of U.S. food sales; although this is a small proportion, it is a substantial volume in a country with a population of 300 million. "You would not see the big supermarkets making these changes in their stores if it weren't of genuine interest to consumers," said Bob Messenger, publisher of the Morning Cup—a daily online newsletter focused on the food industry.[6]

Many experts in the organic products industry believe that price premiums for organic products need to decrease if organic foods are to penetrate much beyond the two- to three-percent level in the mainstream market. This speculation is backed by economic theory, which suggests that high prices and high profits accrue to the innovators and adopters of new technologies, and that the profitable niche will attract new suppliers—with prices and profitability of the niche product falling over time.[7]

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6 Salisbury, Susan, June 26, 2005, "Supermarket Chains Join the 'Organic Revolution'," *Palm Beach Post*.

7 Oberholtzer, Lydia and Carolyn Dimitri and Catherine Greene, "Price Premiums Hold on as U.S. Organic Produce Market Expands," Electronic Outlook Report from the Economic Research Service, USDA, VGS-308-01, www.ers.usda.gov, May 2005

A Whole Foods market survey (2004) indicates that 54 percent of U.S. consumers have tried organic foods, and that 14 percent of the U.S. population has consumed more organic foods than in the prior year. The Whole Foods survey also reveals that nearly 1 in 10 Americans consume organic products several times per week. Survey respondents have cited health and nutrition (66 percent), taste (38 percent), food safety (30 percent), and the environment (26 percent) as motivating factors behind organic food purchases.[8]

The Economic Research Service is a sector of the USDA and has started tracking acreage of organic crops being grown by state. Table E-2 shows the total, certified organic acreage by crop for the United States as a whole, and specifically for the state of Arizona.

Table E-2
Certified Organic Acreage for Tree Fruits and Nuts, 2001

	Tree Nuts	Citrus	Apples	Grapes	Unclassified / Other*	Total Fruits
			Acres			
U.S. Total	5,883	9,741	12,189	14,532	13,330	55,675
Arizona	62	223	2,190	46	123	2,644
Arizona %	1.1%	2.3%	18.0%	0.3%	0.9%	4.7%

*In addition to unclassified acreage, "other" fruit acreage includes cranberries and other berries, as well as several kinds of tropical and stone fruits.

Source: Economic Research Service, USDA.

Fresh fruits and vegetables have long been an important component of the organic foods sector, and this status is likely to continue into the future. Despite higher prices for organic products than for conventional products, the number of consumers who purchase organic produce is growing; this group is becoming more diverse.[9]

A natural tension results from the effect of organic producers receiving higher prices (and presumably higher profits) for their products. Higher prices and greater profitability encourages existing organic producers to increase production and persuades new producers to enter the organic sector. At some point in the future, if supply begins growing faster than demand, price premiums and profitability may decline. At the same

8. Ibid.

9 Ibid.

time, however, consumers are likely to purchase more organic food because the price differential between organically and conventionally grown products will be diminished.[10]

In the report "Marketing Organic Commodities in California: Structure and Obstacles to Expansion," Roberta Cook states that 78 percent of California's organic farmers have utilized specific organic market outlets. The most common organic outlet used has been organic wholesalers or brokers.[11]

As mentioned above, the proposed packinghouse will enable the Tribe to act as an independent organic wholesaler. For food grain crops, Clarkson Grain Company will be relied upon to market the proposed production. Clarkson Grain Company is an organic merchandizing company that is established in the southwestern part of the United States. Clarkson specializes in organic grains and soybeans, and has many purchasing clients on the West Coast.

Organic Tree Fruits

Overview of Competing Areas of Production

This report segment provides an overview of competing areas of production for three organic tree fruits (apples, peaches, and cherries) that are proposed for production on the Reservation. This overview includes an analysis of some important market factors that affect production and sales of the proposed fruits: geography, climate, and growing requirements; market population; and distance to market. Following the overview is an analysis of tree fruit consumption rates and the derived price that the Tribe can expect to receive from the sale of the organic crops.

Currently, the state of Arizona produces less tree fruit than is consumed by residents within its borders; this shortage of local tree fruit producers presents a unique marketing opportunity for the Tribe. The presence of three, major metropolitan areas near the Reservation— Phoenix, Mesa, and Scottsdale—will allow the Tribe to take advantage of these prime, fresh fruit markets without the need to haul produce over long distances. The marketing of crops produced on the Reservation will be further simplified by the

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10 Oberholtzer, Lydia and Carolyn Dimitri and Catherine Greene, "Price Premiums Hold on as U.S. Organic Produce Market Expands," Electronic Outlook Report from the Economic Research Service, USDA, VGS-308-01, www.ers.usda.gov, May 2005

11 Hall, Charles (Extension Economist Horticulture Marketing), Richard Edwards (Extension Economist, Agribusiness), and Jeff Johnson (Project Assistant), "A Guide to Marketing Organic Produce," Texas A&M University, http://aggiehorticulture.tamu.edu/sustainable/publications/organicproduce/organic.html.

Tribe's access to a local packinghouse facility for washing, grading, packing and storing of fresh produce. The timely refrigeration of harvested fruits and vegetables will keep the produce in good condition for several weeks and reduce the possibility of spoilage or rot. Maintaining product freshness will thus enable the Tribe to accumulate a surplus of produce for sale at regular intervals. This inventory process will help create an orderly marketing system, as produce can be offered for sale into the marketplace on a consistent basis, and at supply levels, which the market will bear. Although price competition from other states can be intense, it is expected that locally grown organic produce will bring a price premium. It is assumed in this analysis that consumers are willing to pay more for the freshest organic produce available.

An analysis of competing areas of production provides an indication of the specific markets that can be targeted for the introduction of fresh organic produce from the Reservation. For organic tree fruit crops such as organic apples, competing production areas are broadly defined. The main apple production areas in the United States include Central Washington, Central California, the vicinity of Lake Michigan, and New York State.

Organic apple production is largely concentrated in the Western United States. The "irrigated desert" portions of the Western United States are sufficiently dry to prohibit the growth of fungal diseases on the fruit and limit the trees' exposure to pests. Also, there is ample agricultural research and extension support available to the western organic fruit industry.[12] Washington State accounts for approximately half of the certified organic apple acreage in the United States, followed by Arizona and California.[13] As presented in Table E-2 above, Arizona has accounted for 18 percent of the certified organic apple acreage in the United States in 2001.

The largest peach producing states are California, South Carolina, Georgia, New Jersey, and Pennsylvania. Few peaches are grown commercially in the Southwestern United States. California produces 55 percent of the peaches grown domestically. Peach production in Arizona includes small scale and U-Pick orchards.[14] Therefore, the five largest peach producing states mentioned above are considered the only competing areas of production to the proposed peach orchard on the Fort Apache Indian Reservation.

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12 Ames, Guy, July 2001, "Considerations in Organic Apple Production, ATTRA's Organic Matters Series," NCAT Agricultural Specialist.

13 Miller, Malinda, (Content Specialist), July 2005, "Organic Apples," Ag Marketing Resource Center, Iowa State University.

14 Diver, Steve and Tracy Mumma, March 2003, "Organic and Low-Spray Peach Production,", Horticulture Production Guide, ATTRA.

Sweet cherries are produced commercially in nine states, of which Washington State, Oregon, California, and Michigan are the largest. Between 2003 and 2005, Washington State comprised 49 percent of the entire U.S. sweet cherry production; California accounted for 24 percent; Oregon comprised 15 percent; and Michigan accounted for 9 percent of total U.S. sweet cherry production.[15] Sweet cherries are not commercially produced on a large scale in the Southwest.

Table E-3 shows the distances from the main tree fruit production areas in the United States to select terminal markets. The production area distances include the proposed, organic tree fruit orchards on the Reservation.

Table E-3
Distances from Organic Tree Fruit Production Areas
to Select Terminal Markets

Crop[1]	Production Area	Phoenix	Dallas	Atlanta	Boston	Los Angeles	St. Louis
P,C,A	Visalia, CA	552	1,517	2,270	3,065	183	1,908
P	Edgefield, SC	1,966	947	165	975	2,336	721
P	Knoxville, GA	1,818	799	80	1,129	2,189	654
P	Woodbury, NJ	2,337	1,451	754	307	2,706	896
P	Chambersburg, PA	2,183	1,330	660	432	2,552	742
C,A	Walla Walla, WA	1,252	1,801	2,404	2,724	1,039	1,856
C	Salem, OR	1,191	1,993	2,595	3,013	914	2,047
C,A	Leland, MI	1,923	1,227	913	925	2,210	589
A	Poughkeepsie, NY	2,500	1,615	950	200	2,830	1,000
	Whiteriver, AZ	171	875	1,647	2,441	542	1,283

Source: Distances generated from www.mapquest.com, March 14, 2006.
[1]P= Peaches, C= Cherries, A= Apples

The metropolitan area of Phoenix, Mesa, and Scottsdale is home to over 3.7 million people, according to the 2004 U.S. Census. As shown in Table E-3, the proposed organic tree fruit production on the Reservation will have the advantage of being located closer to this terminal market than any of the primary fruit tree production areas that currently serve the Phoenix, Mesa, and Scottsdale market. In addition to its close proximity to metropolitan Arizona, the town of Whiteriver, Arizona is also one of the three closest production areas to Dallas, Texas and Los Angeles, California for all three of the fruit crops (apples, peaches, sweet cherries). In regard to St. Louis, Missouri, the town of

15 Rieger, Mark, University of Georgia. Web site accessed in July, 2006, data available at http://www.uga.edu/fruit/cherry.htm.

Whiteriver is one of the three closest production areas for apples and cherries. This prime location gives the Tribe a competitive advantage with respect to transportation costs resulting from product delivery to the identified terminal markets.

The market analysis below addresses per capita consumption rates and the farm price that is derived for each of the three tree fruits proposed for production on the Reservation: organic apples, organic peaches, and organic sweet cherries. This market analysis quantifies a derived farm price for shipping tree fruits from the Reservation to wholesale terminal markets in their respective Metropolitan Statistical Areas (see Table E-2 and Table E-3).

Apples

Apple production and consumption in the United States has changed dramatically since the early American settlers first brought seeds to the East Coast and grafted trees of European tree fruit varieties. According to per capita disappearance data compiled by the USDA's Economic Research Service (ERS), apple demand in the United States has risen over the past thirty years; this rise in demand reverses the downward trend experienced during the first half of the twentieth century. During the 1990's, domestic per capita consumption of apples for all uses averaged much higher than the previous six decades. A combination of factors has been cited for the increased consumption of apples in the United States in the past thirty years. These factors include: production expansion; rising incomes; a growing and more diverse population;, new apple varieties; new products (derived from apples) that better meet changing consumer lifestyles and preferences; and more recently, increased awareness of the importance of fruit in a healthy diet.[16]

Apples are the third most valuable fruit crop in the United States, next to grapes and oranges. Nearly 100 different varieties are now commercially produced in the United States, with 15 of the most popular varieties accounting for 90 percent of apple production.[17]

Average wholesale market prices for apples have been obtained from several terminal markets. In this analysis, a ten percent premium is applied to the wholesale prices to represent the anticipated price of organically produced apples. Table E-4 shows the wholesale prices for the select terminal markets, as well as the derived farm price of apple

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16 Perez, Agnes, Biing-Hwan Lin and Jane Allshouse, September 2001, "Demographic Profile of Apple Consumption in the United States", Special Article, Economic Research Service, USDA, FTS-292.

17 Ibid.

production on the Reservation. The derived farm price, measured in hundred weights (CWT), is determined after accounting for transportation costs.

Table E-4
Derived Farm Prices for Organic Apples

	Average Wholesale	Transportation	Derived Price	
	CWT[A]	CWT [B]	CWT	Ton[C]
Phoenix	$56.61	$3.25	$53.36	$1,067
Dallas	$63.91	$16.63	$47.28	$946
Atlanta	$60.14	$31.28	$28.85	$577
Boston	$69.28	$46.37	-	-
Los Angeles	$56.61	$10.29	$46.32	$926
St. Louis	$58.98	$24.38	$34.60	$692
Tucson	$56.61	$3.72	$52.89	$1,058

A – Wholesale price data is an average price reported by Ag Marketing Service Portal (AMS), for August through October of 2003 – 2005.

B – Transportation costs represent refrigerated truck freight costs.

C – One bin is equivalent to 850 pounds. Numbers may not sum, due to rounding.

The derived, per bin prices calculated in Table E-4 above indicate that all of the markets would generate positive returns that would warrant marketing effort, with the exception of Boston. The markets of Phoenix, Tucson, Dallas, Los Angeles, and St. Louis would all generate farm prices in the $500 to $1,100 per ton range.

In these five metropolitan areas (Phoenix, Tucson, Dallas, Los Angeles, and St. Louis), there are over 30 million people; this figure is according to the 2004 U.S. Census. The market potential for all apples produced for these combined areas is estimated at over 540 million pounds. In this analysis, it is assumed that the Tribe can capture a small percent of this fresh apple market share without impacting the price. The market share percentage is tied to the distance of the MSA from the production area. Five percent is used for MSAs within five hundred miles (Phoenix and Tucson), and the share drops by a percentage for every five hundred miles increment thereafter. This is a conservative estimate based on the expanding demand for organic apples, and the Reservation's prime location (within relatively close shipping distance to several major terminal markets). Therefore, the market limit for production of apples on the Reservation is limited to 615 acres. The additional production on this acreage will not significantly affect the regional market price. The introduction of the proposed 615 acres of organic apple production on

the Reservation would represent .02 percent of the total domestic fresh apple production.[18]

Peaches

Peaches are produced and consumed within the United States on a large scale. Over three billion of the thirty billion pounds of peaches grown worldwide are produced domestically. Other large peach producing countries include Italy, Spain, Greece, France, Turkey, Iran, Chile and Egypt. The Mediterranean climate is ideal for peach production, although peach trees have been bred to perform in many other climates—from the warm tropics to colder regions of Canada. Southern China is where peach cultivation is thought to have originated. The climate in Southern China is comparable to the climate in the Southeastern United States, where much of the peach production occurs.[19] See Table E-3 above for locations of domestic competing areas of peach production.

The total acreage of organic peaches has increased over the past five years in California.[20] Figure E-3 below depicts the U.S. Peach acreage and productivity for the years 1993 through 2205.

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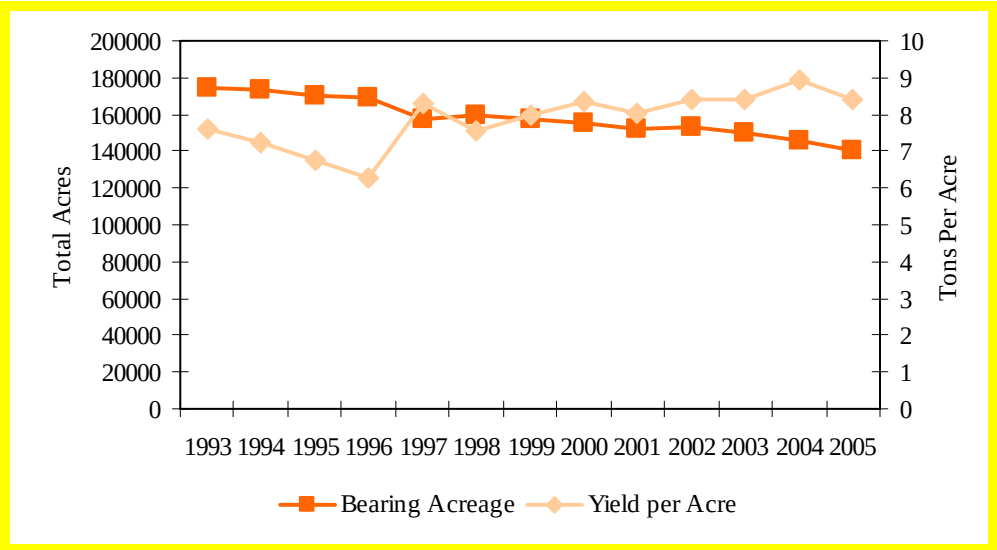
18 USDA, March 31, 2005, *Commodity Highlights* – Apples, Fruit and Tree Nuts Outlook, FTS 315, ERS.

19 Rieger, Mark, "Peach-Prunus Persica," University of Georgia, Data obtained from website in July 2006, available at www.uga.edu/fruit/peach.htm.

20 California Organic Program, State of California. Data obtained from website in July 2006, available at www.cdfa.ca.gov/is/fveqc/organic.htm.

Figure E-3
U.S. Peach Acreage and Productivity



Source: USDA, ERS

Three major types of peaches are grown within the United States. Freestone peaches and nectarines are sold fresh, while clingstone peaches are used chiefly for canning. Nineteen varieties of peaches are proposed for the Reservation's agricultural plan. These peach varieties include Harrow Diamond, Brightstar, Saturn, Blazingstar, Contender, and Autumnstar and will be sold fresh from the beginning of July to the middle of September. Peach season peaks in July and decreases through October; therefore, the proposed peach varieties produced on the Reservation will capture the mid- to late-season market.

A transportation cost and shipping analysis has been performed to gain an understanding of the location of markets that could potentially be served by organic peach production on the Reservation. Table E-5 below shows the derived farm price of specific wholesale markets available for fresh peaches. The derived farm price is determined after accounting for transportation costs.

Table E-5
Derived Farm Prices for Organic Peaches

	Average Wholesale	Transportation	Derived Price	
	CWT[A]	CWT [B]	CWT	Box[C]
Atlanta	$69.03	$31.28	-	-
Boston	$94.32	$46.37	$47.95	$11.99
Dallas	$77.44	$16.63	$60.81	$15.20
Los Angeles	$99.59	$10.29	$89.30	$22.33
St. Louis	$75.03	$24.38	$50.65	$12.66
Phoenix	$99.59	$3.25	$96.34	$24.09
Tucson	$99.59	$3.72	$95.87	$23.97

A – Wholesale price data is an average price reported by Ag Marketing Service Portal (AMS), for August through September of 2003 – 2005.

B – Transportation costs represent refrigerated truck freight costs.

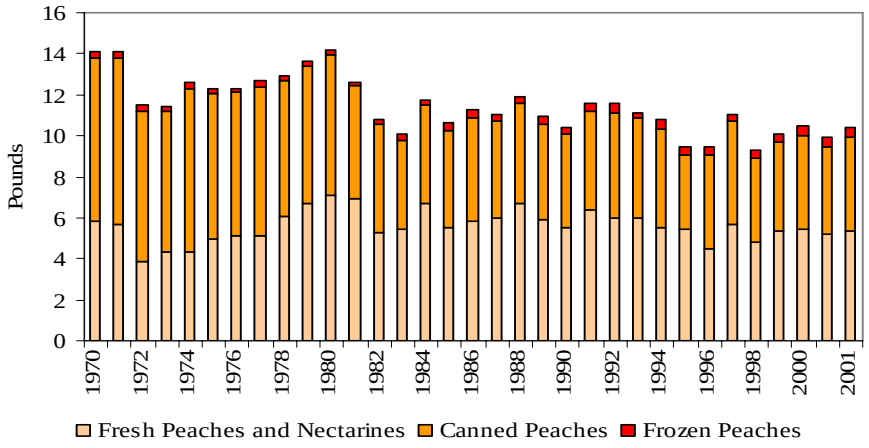
C – One box is equivalent to 25 pounds.

The minimum derived farm price is found in the Atlanta market, which is also very close to one of the largest peach production areas in the United States. Excluding the Atlanta market, the select terminal markets have derived farm prices ranging from $11.99 per box to $24.09 per box. These derived farm prices would allow for net returns to irrigation Based on the results shown in Table E-5, the target markets for the regional analysis of demand include all terminal markets mentioned in Table E-3 above, with the exception of Atlanta.

As stated earlier in the report, there are over 30 million people living in the metropolitan areas of Phoenix, Tucson, Dallas, Boston, Los Angeles, and St. Louis. In spite of the population growth in U.S. metropolitan areas, the domestic, per capita peach consumption has declined over the last two decades. This decrease in peach consumption is attributed to consumers' lack of understanding about the difference between ripe and mature peaches.[21] Peaches are consumed in a variety of forms: fresh, canned, frozen, dried, as jam, as juice, and as baby food. Figure E-4 shows U.S. peach consumption by sector over the past 30 years.

[21] Crisosto, Carlos,"Tips to Increase Peach Consumption," Department of Pomology, University of California, Davis, Data obtained from website accessed in June 2006, available at zimmer.csufresno.edu.

Figure E-4
U.S. Peaches per Capita Consumption, 1970 - 2001



Source: USDA ESS

Over 10 percent of domestic peaches have been exported to countries in Asia, North America and Latin America in 2001. Extensive data is not available on imports, but small amounts of peaches are imported from Chile and Mexico in the winter and spring, respectively. Per capita, adjusted annual fresh peach consumption over the past seven years is 5.3 pounds per person. The typical shelf life of peaches is two weeks under most conditions. Peaches can be stored at freezing temperatures to maximize the shelf life because they are not susceptible to chilling injury.[22]

Based on the normalized average of per capita consumption shown in Figure E-4 above and the population of the markets identified previously, there are 161 million pounds of fresh peaches consumed in the region. In this analysis, it is assumed that the Reservation can supply a small percent of this regional consumption without impacting prices. The market share percentage is tied to the distance of the MSA from the production area. Five percent is used for MSAs within five hundred miles (Phoenix and Tucson), and the share drops by a percentage for every five hundred miles increment thereafter. This assumption results in a market limit of 310 acres for organic peaches produced on the Reservation.

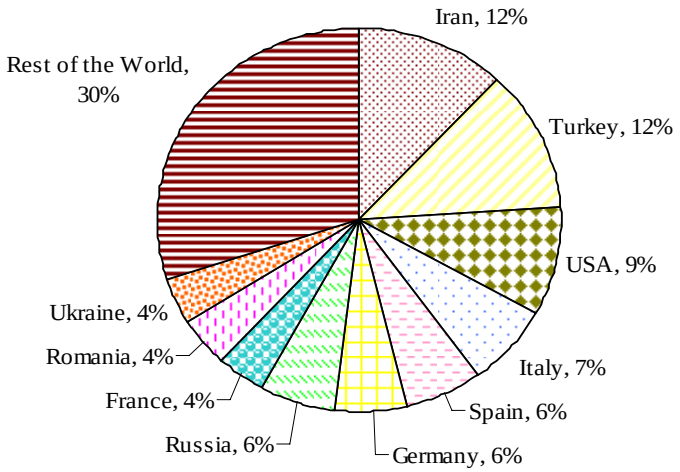
Cherries

The United States is the third largest producer of sweet cherries worldwide—producing nine percent of the 3.8 billion pounds produced globally (see Figure E-5). This translates

22 Rieger, Mark, "Peach-Prunus Persica."University of Georgia, Data accessed from website in July 2006, available at www.uga.edu/fruit/peach.htm.

to roughly 342 million pounds of sweet cherries grown domestically. Other countries that produce sweet cherries include Iran, Turkey, Italy, Spain, Germany, Russia, France, Romania, and the Ukraine. Sweet cherries are thought to have originated in the area between the Black and Caspian seas in Asia Minor. Birds then carried cherry seeds to Europe, where the Greeks, and later the Romans, began sweet cherry cultivation.[23]

Figure E-5
Worldwide Sweet Cherry Production



Source: Mark Rieger, University of Georgia

The recommended varieties of cherries for use on the Fort Apache Indian Reservation include six types of sweet cherries and one variety of tart cherry.[24] The seven varieties are White Gold, Benton, Black Gold, Lapins, Skeena, Sweetheart, and Balaton. A brief description of each cherry follows.

The White Gold sweet cherry is a moderate- to large-sized fruit and is sold fresh in mid-season. The Benton sweet cherry is a large, firm cherry that is dark mahogany red; this particular variety is sold mid-season directly after the Bing cherry. Black Gold is a moderately large, sweet cherry that is dark red in color. Black Gold is also sold mid-season. The Lapins sweet cherry is a large, high quality fruit that is sold late in the season. The Skeena sweet cherry is also a large, high quality cherry that is dark mahogany red; this variety is sold fresh in the middle to late part of the season. Sweetheart sweet cherries are bright to dark red, firm, and range in size from medium to

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23 Mark Rieger, University of Georgia, Website accessed in July, 2006, data available at http://www.uga.edu/fruit/cherry.htm.

24 Walser, Ron, October 19, 2006, "Appendix A: Suitability Report for Tree Fruits, Berries, and Other Fruits and Vegetables," Urban Small Farm Specialist, NMSU.

large; they are sold fresh very late in the season. The Balaton tart cherry is a sweet, yet tart cherry, with dark burgundy skin; this cherry variety is sold fresh at the end of the season, which is mid-July to early August.

As all of the recommended cherry varieties (proposed in this analysis) are harvested toward the latter part of the season, and the cherry season typically extends from May to July, this situation opens a unique market window for the Tribe. With this late harvest on the Reservation, there will be little competition in the fresh cherry marketplace. In general, U.S. sweet cherry producers are competitive on the international market—exporting an average of 34 percent of domestic production during the 1990s. U.S. sweet cherries are imported by Canada, Taiwan, Hong Kong, Japan, and the United Kingdom.

The transportation cost and shipping analysis reveal the potential markets that could be served from cherry production on the Reservation. Table E-6 below shows the derived farm price of specific wholesale markets available for fresh cherries. The derived farm price is determined after accounting for transportation costs.

Table E-6
Derived Farm Prices for Organic Cherries

	Average Wholesale	Transportation	Derived Price	
	CWT[A]	CWT [B]	CWT	Pounds[C]
Phoenix	$253.37	$3.25	$250.12	$2.50
Dallas	$249.11	$16.63	$232.48	$2.32
Atlanta	$212.12	$31.28	$180.83	$1.80
Boston	$298.01	$46.37	$251.63	$2.52
Los Angeles	$253.37	$10.29	$243.09	$2.43
St. Louis	$261.10	$24.38	$236.72	$2.37
Tucson	$253.37	$3.72	$249.65	$2.50

A – Wholesale Price data is an average price reported by Ag Marketing Service Portal (AMS), for August through September of 2003 – 2005.

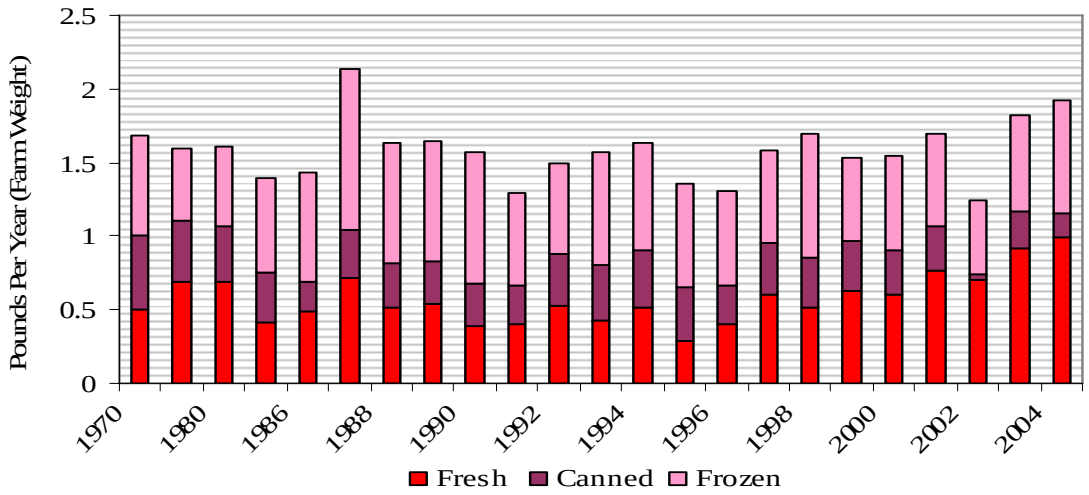
B – Transportation costs represent refrigerated truck freight costs.

C – There are 100 pounds (lb) in a hundred weight (cwt).

The minimum derived farm price in the select terminal markets is $1.80 per pound, which would allow for net returns that would warrant investment and effort into marketing. In addition, the town of Whiteriver is one of two cherry production locations that are closest to all of the terminal markets, in comparison to other, major cherry producing areas. Based on these results, all terminal markets mentioned previously in Table E-3 have been included as target markets for the regional analysis of demand.

Sweet cherries are typically harvested from May to July and are consumed in various forms: fresh, brined (maraschino), frozen, canned, as juice, as wine, and as brandy. In 2002 the majority of sweet cherry consumption has been the fresh form, followed by brined. Figure E-6 below illustrates the U.S. per capita cherry consumption by sector, for selective years.

Figure E-6
U.S. Cherries per Capita Consumption, 1970 - 2004



Source: USDA, ERS

The adjusted, per capita consumption rate of fresh cherries is 0.724 pounds per year. Currently, there are 35 million people living in the target market areas for cherry distribution from Whiteriver.[25] Using the adjusted per capita consumption rate, the yearly demand for fresh cherries in the region is 25.4 million pounds. The shelf life of fresh cherries is 3 to 4 days at room temperature, or two weeks at 32 degrees Fahrenheit. In this analysis, it is assumed that the Reservation can supply a small percent of this regional consumption without impacting prices. The market share percentage is tied to the distance of the MSA from the production area. Five percent is used for MSAs within five hundred miles (Phoenix and Tucson), and the share drops by a percentage for every five hundred mile increment thereafter. The resulting market limit is 96 acres.

Using the seven-year normalized consumption rate to calculate the market limit likely underestimates current cherry consumption. Fresh cherry consumption worldwide has increased from a rate of.29 pounds per person in 1995 to .99 pounds per person in 2004.

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[25] U.S. Census Bureau, January 2006, "Annual Estimates of the Population of Metropolitan and Micropolitan Statistical Areas," Population Division.

This steady increase suggests that current consumption rates of fresh cherries are higher than the seven-year, normalized average that has been used in the aforementioned calculation. Furthermore, exports of fresh cherries from the United States have steadily increased since 1984 to current levels of 15 percent to 20 percent of production each year, which implies a steady demand for fresh cherries abroad.

Organic Vine Crops

As mentioned previously, there has been tremendous growth in the organic produce markets in the United States. Recently, this trend has been gaining momentum in the organic wine market as well. According to the California Department of Food and Agriculture, 7,940 acres of organic wine grapes had been grown in the U.S. in 2003. This figure represents only a small portion of the total wine grape acreage in production (organic plus non-organic), which is reported as 529,000 acres by the California Department of Food and Agriculture.[26] Even though organic wine grape production is still a niche market, it is likely "headed for the mainstream" due to the category's growing popularity.[27]

Napa Valley, California is often referred to as the so-called wine Mecca of North America. However, wine grapes have been grown (and the resulting wine products consumed) in Arizona long before the Napa Valley region acquired this special distinction. Spanish settlers brought wine grapes to the Nogales area more than 100 years before California missions were established. In fact, Arizona, Texas and New Mexico combine to form the oldest "wine region" in America.[28]

Today there are thirteen wineries in Arizona, and more are in the licensing and planning stages. Kokopelli Winery, the largest organic winery in the Southwestern United States, is located in Chandler, Arizona. The Kokopelli Winery uses wine grapes grown in the Bonita Valley of Southeastern Arizona (4,400 feet in elevation).[29]

According to Rod Keeling, contact for the Arizona Wine Grape Association (AWGA), it is very difficult to buy "Arizona grown" wine grapes for a stand-alone winery. This

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26 California Department of Food and Agriculture, May 24, 2005, "2003 California Grape Acreage Report," California Agricultural Statistics Service.

27 Thompson, Courtney. "Organically Inclined," Organic Trade Association. Web site, accessed at www.ota.com/MarketWatch.html.

28 Billet, Jay, "History of Arizona Wine, Arizona Correspondent," Kokopelli Winery web site accessed at http://kokopelliwinery.com/kokoh.htm.

29 Ibid.

purchasing difficulty for individual wineries without access to their own vineyards indicates that demand for locally grown, organic wine grapes is currently strong. Most Arizona grapes are estate bottled by the grower.[30]

Among the agricultural options available to the Tribe is the value added activity of using the wine grapes produced on the Reservation as the basis for a start-up winery. In this analysis, it is estimated that 200 acres of wine grapes will need to be planted and cultivated in order for the Tribe to market "Arizona grown" wine grapes or begin operating an organic winery.[31]

In summary, there are two different marketing options available to the White Mountain Apache Tribe in regard to organic wine grapes. First, wine grapes that are grown could be marketed as "Arizona Grown" wine grapes and sold directly to existing and future wineries in the state of Arizona. Second, the Tribe could invest in a winery for the Reservation, and the wine grapes could then be used to produce wine that is estate bottled by the grower (the Tribe). In this analysis it is assumed that the wine grapes are sold to wineries in Arizona. It is likely, however, that there would be a greater profit margin if a winery were to be established on the Reservation.

The target market for organic wine grapes is likely to have a narrow focus. In Arizona, it is difficult to find "Arizona grown" wine grapes that are not used by the producers themselves. A label marked, "Arizona grown" on the Tribe's produce packaging, however, will have marketing appeal to Arizona wineries; therefore, it is likely that the wine grapes produced on the Reservation will be purchased by an organic winery within the state. Kokopelli Winery is the likely target market for the organic grapes produced on the Reservation, as their specialty is organic wine grapes. Furthermore, Kokopelli Winery is the largest organic winery in the Southwestern United States. The winery currently uses grapes exclusively from their own vineyards, but they intend to purchase grapes from other sources in the future to accommodate their planned expansion of the winery.[32]

The Wine Institute reports that in 1999, the per capita consumption of wine was slightly over 2 gallons. Based on this consumption rate, the production of wine grapes in the

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30 Personal Communication with Rod Keeling, Arizona Wine Grape Association, December 15, 2005.

31 Personal Communication with Bill Gorman, New Mexico State University, July 29, 2005.

32 Personal Communication with Melissa, Kokopelli Winery, September 28th, 2006.

proposed project would meet the demand of 64,000 people; this figure is equivalent to approximately 1.7 percent of the Phoenix metropolitan area market.[33]

Organic Berries

Red Raspberries

According to the 2002 Census of Agriculture, 4,521 farms in 46 states within the U.S. had produced raspberries in 2002; however, most of this red raspberry production has been concentrated in Washington State, California, and Oregon. These three states have had the largest acreage devoted to raspberry production in 2002, and together they have accounted for 80 percent of the total U.S. agricultural production for this type of fruit.

Michigan, Pennsylvania, New York, Ohio, Minnesota, Wisconsin, and Massachusetts have had the next largest acreages of raspberry production in the U.S—a total of 13 percent in 2002, according to the 2002 Census of Agriculture. As raspberries require relatively cool summers for optimal cultivation, commercial production has not adapted very well to the intense, summertime heat of the Southern United States. In 2002, red raspberry acreage in the Southern United States had accounted for less than one percent of the national acreage.

While the top three raspberry producing states (Washington State, Oregon, and California) all grow the raspberries, the two northwestern states differ from California in their choice of target markets. Red raspberry production in Washington State and Oregon is geared almost entirely toward the processed berries market. In the past five years, producers in Washington State have marketed an average of 96 percent of their raspberry crop to processors. Likewise in Oregon (and for that same time frame), an average of 90 percent of the state's raspberry production has also been marketed to processors. In contrast, it is estimated that producers in California will sell approximately 95 percent of their raspberry crop to the fresh market.[34]

The processing sector is still the largest market for domestically produced raspberries; however, fresh market production has increased more rapidly in recent years; California's focus on the fresh market is one example of this growth. The increase in fresh market production has brought these figures closer to the output seen in the processing sector. Prices received by growers for fresh market raspberries are almost always at a premium

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33 There were over 3.7 million people reported in the Phoenix Metropolitan area in the 2004 Population Census.

34 USDA, July 26, 2006, "Fruit and Tree Nuts Outlook," FTS 323, Economic Research Service.

over the berries for processing. Partly contributing to the higher value in the fresh market is the higher harvesting and marketing costs associated with hand picking the delicate berries and packaging most of them in retail sized containers.[35] Not all of the hand picked berries will be of high enough quality for introduction into the fresh market, however. Hand picked berries that are not selected for fresh market will be used in the processed market. (A description of how raspberries are used in the processed market is addressed subsequent to a review of organic raspberry consumption rates and health benefits.)

Raspberries rank as the third most popular berry in the United States for fresh use, behind strawberries and blueberries. In spite of its rank, the per capita raspberry consumption increases from years 2000 through 2005 have actually averaged three to seven percent higher than for strawberries and blueberries.[36] The per capita, frozen red raspberry consumption in the United States doubled between 1980 and 2000, from .08 pounds to .16 pounds.[37] A large part of the overall increase in red raspberry consumption is thought to be attributable to the health benefits of the berry. Health is "undoubtedly, the direction of the world's food industry," according to David Ropa, Director of the U.S. Midwestern regional office of TJP Market Development.[38]

The health benefits of red raspberries are numerous. Raspberries provide one gram of dietary fiber for every 7.69 calories. Compared with other fruits, this ratio is the most dietary fiber intake for the fewest calories consumed.[39] The most exceptional benefit that red raspberries hold for consumers is their substantial quantity of ellagic acid. Clinical tests conducted at the Hollings Center Institute at the Medical University of South Carolina (MUSC) show that ellagic acid, a naturally occurring plant phenol, may provide a potent mechanism to prevent cancer, inhibit the growth of cancer cells, and arrest the growth of cancer in subjects with a genetic predisposition for the disease.

There are many food products that make use of raspberries. Much of the fruit destined for processing is frozen in bulk containers for institutional use, or is reprocessed into jams, jellies, preserves, pie filing, ice cream, and yogurt. Some of the fruit is combined with

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35 Ibid.

36 Ibid.

37 Buccola, Steven and Munisamy Gopinath, February 27, 2004, "Demand, Supply, and Trade: National and Northwest Raspberries, Blueberries, Strawberries, Sweet Corn, and Snap Beans," for University of CA Ag Issues Center, Draft.

38 Ropa, David, "The Role of Red Raspberries in Today's Market," Washington Red Raspberry Commission, http://www.red-raspberry.org/PDF/ifisarticle.pdf.

39 Ibid.

sugar and packaged in containers sized for retail sales use. Whole fruit that is of the best quality is typically preferred for processing into Individually Quick Frozen (IQF) berries; the lower quality fruit is usually destined for juice.[40]

Three large jam manufacturers are key players in the worldwide demand for raspberries: the JM Smucker Company in the United States, Swartzscoff, GmbH in Germany, and Nestlé, S.A in Switzerland. The American processor, Ocean Spray Cranberries, Inc., also purchases large quantities of raspberries for its mixed raspberry and cranberry drink.[41] In the IQF market, there are several marketers of organic berries, including Cascadian Farms. The current demand for organic berries has prompted Cascadian Farms to actively search for organic berry growers all over the Western United States.[42]

In addition to the health benefits of red raspberries that make them appealing for consumers and, therefore, for use in food products, there are technical advantages. The technical advantages of red raspberries, such as their use as natural colorants, flavorings, and natural juice sweeteners, make them a major ingredient in several of the new products introduced around the world each year. Recent examples of product introductions include the following: Breyers® Raspberry Cobbler Ice Cream™ (Good Humor® – Breyers Ice Cream Company of Green Bay, Wisconsin); Simply Nutritious St. John's Peach Berry with Raspberry™ (R.W. Knudsen® of Chico, California); and Organic Apple Sauce Extensions with Raspberry (Solana Gold Organics of Sebastopol, California). Manufacturers are incorporating red raspberries into food products for its visual appeal, taste, nutrition and upscale image.[43]

Blackberries

While no data is available for fresh blackberry consumption, it has been estimated that fresh blackberry consumption is one tenth that of raspberries.[44] However, the only geographic area where blackberry production is tracked is in the Northwestern corner of the United States, in Oregon and Washington State. In fact, it is estimated that Oregon's

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40 USDA, July 26, 2006, "Fruit and Tree Nuts Outlook," FTS 323, Economic Research Service.

41 Raspberry Review: Characteristics of the World Market for Raspberries, www.maf.govt.nz/mafnet/rural-nz/profitability-and-economics/producer-boards/raspberry-review/raspberry.

42 Personal Communication with Brian Quigley, Cascadian Farms, July 17, 2006.

43 Ibid.

44 Small Farm and Specialty Crop Newsletter, University of California, Davis, accessed online at http://cesantabarbara.ucdavis.edu/smfnws10.htm

Willamette Valley alone produces 80 percent of the nation's bramble crops. California is not a producer of any significance in the fresh blackberry market.

Target Markets and Expected Berry Yields

The shelf life of processed red raspberries and blackberries is much longer than the shelf life of fresh berries; therefore, processed berries can be transported greater distances to markets without impacting their quality. In this analysis, the entire United States is identified as the target market for the Tribe, due to ease of transporting processed berries wherever and whenever they can be sold. It is likely, however, that market penetration will be easier and heavier in the Southwest and lighter in the Northwest and other parts of the country. Nevertheless, it is prudent to consider the aggregate U.S. population and national, per capita consumption of processed berries in this analysis of target markets.

The national population in 2005 was 296.4 million, based on reports from the Population Division of the U.S. Census Bureau. The per capita consumption of processed berries in the United States is shown in Table E-7 below for years 1998 - 2004.

Table E-7
U.S. Processed Berries per Capita Consumption, 1998 - 2004

Year	Blackberries	Raspberries
1998	0.10	0.19
1999	0.09	0.11
2000	0.09	0.16
2001	0.08	0.18
2002	0.08	0.09
2003	0.08	0.25
2004	0.07	0.21
Adjusted Average	0.084	0.17

Source: Fruit and Tree Nuts Situation and Outlook Yearbook, FTS-2005, October 2005, ERS, USDA.

Based on the per capita consumption figures in Table E-7 above, the total domestic market for processed raspberries is 50.4 million pounds, and the total domestic market for processed blackberries is 24.9 million pounds. In this analysis, it is assumed that the Tribe's proposed organic berry operation can capture five percent of the total U.S. market. Given the yields expected on the Reservation, this translates into a market limit

of 315 acres for processed raspberries and 130 acres for processed blackberries. When combined with the fresh market limits for these crops, the "not exceed" point is 340 acres for red raspberries and 180 acres for blackberries.

The metropolitan areas of Phoenix and Tucson have been identified as two of the main regional target markets for fresh red raspberries and blackberries proposed for production on the Reservation. Other heavily populated areas within a day's drive of Whiteriver include Flagstaff, Albuquerque, and Farmington. Due to the fact that fresh berry production only occurs in a limited number of areas, mainly California in the United States, it is likely that a national distribution of fresh berries could be accomplished with berries produced on the Reservation. These berries are not processed in any way, but are instead hand picked and sold in clam shells or flats.

The Tribe is positioned well to capture a significant percent of the total market for organic berries, given the emphasis on the health benefits of the raspberry, the fact that there is little to no production of raspberries or blackberries in the Southwest region, and the expectation that the trend of increased consumption rates will continue. Additionally, the Reservation's unique location at a higher elevation (unlike more arid parts of the Southwest) means that summer temperatures are not as extreme as in the desert valley; this higher altitude allows for the cooler temperatures necessary for optimal berry cultivation and harvesting. For this reason, and others outlined in Dr. Walser's agronomy report of red raspberries and blackberries, berry plantings on the Reservation are expected to produce high quality, high yield berries.

Given the four market factors described above, it is assumed that the Tribe could capture a significant percentage of the total regional and national markets. According to information obtained from various produce marketing firms, the distribution channels for organic fresh market berries would likely stretch across the United States. Further information on the produce marketing firms is contained in the *Marketing Channels Available* section above.

Market limits were determined by taking into account the market factors described above, information obtained from the grower's agent, and the high level of crop suitability reported from Dr. Walser. The market limits for fresh red raspberries is set at 100 acres and the limit for fresh blackberries is set at 70 acres.

Other Fruits and Vegetables

Asparagus

Asparagus officinalis, or simply Asparagus, is a vegetable crop that is a member of the Lily family. Asparagus has been cultivated for its tender, edible shoots for more than 2,000 years, since its beginnings in the eastern part of the Mediterranian region. According to the California Asparagus Commission, asparagus was first planted in California in the late 1850's.

Presently, the states of California, Washington, Michigan, New Jersey, and Illinois produce a majority of the asparagus cultivated within the United States. California alone constitutes nearly three-fourths of the total domestic production.45 Arizona cultivates a limited amount of asparagus, but specific data for this state has been unattainable due to protective measures for individual farmers.46

Asparagus production in California is centered in three areas: the southern desert valleys (Imperial and Riverside Counties), the Sacramento-San Joaquin River Delta (San Joaquin County), and the Central Coast (Monterey and Santa Barbara County).47 California's environmental conditions provide farmers with a competitive advantage, as the state's wide range of micro climates allows for fresh asparagus to be grown and available for sale for essentially nine months of the year; this timeframe is a much larger window of product availability than experienced by competing states.48

Asparagus acreage in the United States has substantially decreased since 1990, causing domestic production to follow suit. Figure E-7 below illustrates these trends. This progression can also be attributed to two factors: 1) the introduction of the North American Free Trade Agreement (NAFTA) in 1994; and 2) the swell of imported asparagus (mostly from Mexico) that has increasingly satisfied domestic demand.

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45 USDA, Economic Research Service, February 23, 2003, "Commodity Highlight Brief: Fresh-Market Asparagus," Document available online at: http://www.ers.usda.gov/briefing/Vegetables/vegpdf/AsparagusHigh.pdf.

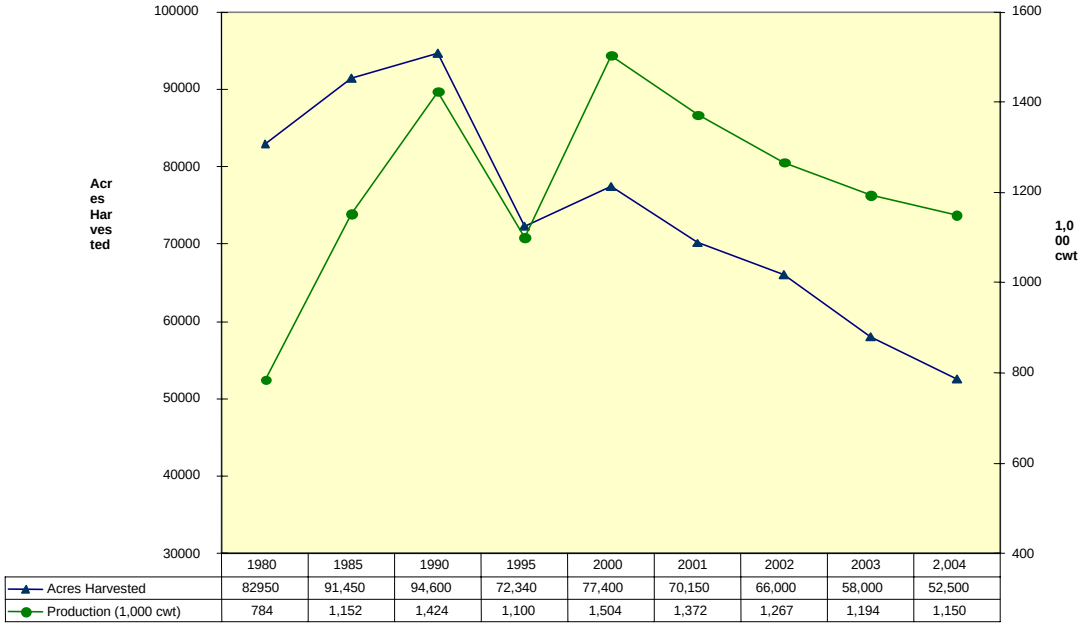
46 USDA, Economic Research Service website

47 University of California Davis, Division of Agriculture and Natural Resources, "Asparagus Production in California," Publication 7234, Document available for viewing at: http://anrcatalog.ucdavis.edu/pdf/7234.pdf.

48 California Asparagus Commission's website, "Industry: Growing and Harvest page, Accessed at: http://www.calasparagus.com/industry/growing.htm.

Production initially dipped, then rebounded after the implementation of NAFTA, but it has steadily declined since 2000.

Figure E-7
U.S. Asparagus Acres Harvested and Productivity



	1980	1985	1990	1995	2000	2001	2002	2003	2,004
Acres Harvested	82950	91,450	94,600	72,340	77,400	70,150	66,000	58,000	52,500
Production (1,000 cwt)	784	1,152	1,424	1,100	1,504	1,372	1,267	1,194	1,150

Source: United Nations Food and Agricultural Organization statistical database

Asparagus is mostly consumed fresh, but it is also available in canned or frozen forms. Asparagus is an extremely perishable product and must be rapidly cooled immediately after harvest to preserve its flavor, vitamins, texture, and integrity—regardless of its intended use.[49] Once harvested, asparagus must be quenched of the heat it collected in the field; a variety of techniques can be implemented to accomplish this task. One common technique is hydro cooling, where the stalks are drenched in chlorinated water at 34° - 37°F for approximately 15 minutes.[50] Even if the asparagus is intended to be frozen, it must first be cooled for quality assurance purposes before freezing. Traditionally, asparagus has been frozen in bunches with a method referred to as “block freezing”; however, freezing the stalks individually using a technique known as "individual quick freezing" (IQF) allows for easier storage, more accurate measurements of weights, and improved preservation.

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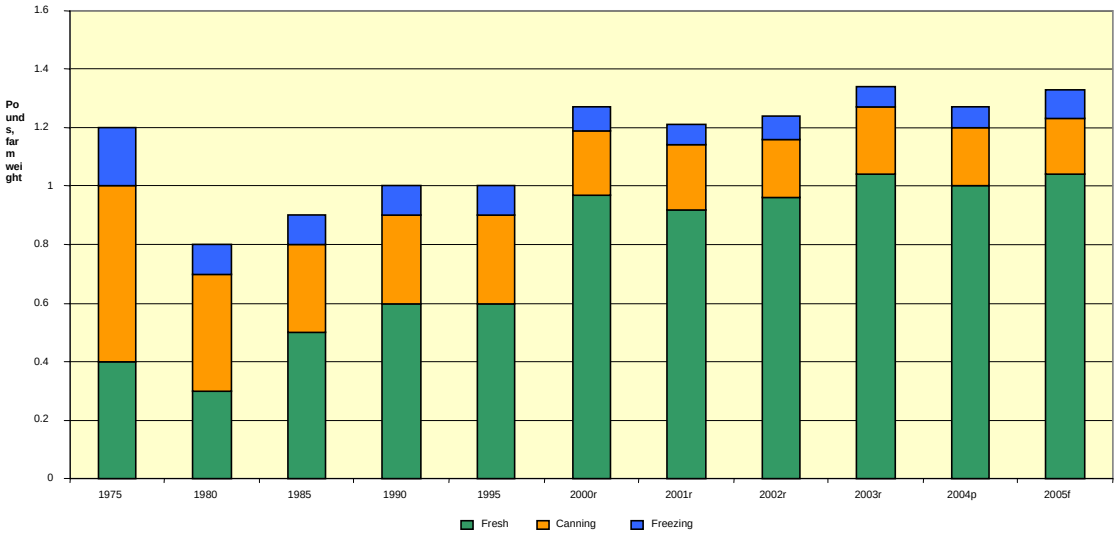
49 University of California, Division of Agriculture and Natural Resources, “Asparagus Production in California,” Publication 7234, Accessed at http://anrcatalog.ucdavis.edu/pdf/7234.pdf.

50 Ibid.

As with domestic production, consumption rates for American-grown asparagus have been affected (since the beginning of the late 1990s) due to the introduction of NAFTA in the mid-1990s. NAFTA created market conditions where imported asparagus surpassed domestic production in 2000. This influx of fresh, imported asparagus has resulted in a decrease in the domestic price of this commodity; therefore, consumption has subsequently increased in recent years. Furthermore, NAFTA has enabled asparagus imports to continue to rapidly gain ground on domestic production. The net margin between domestic production and imported asparagus continues to widen. Figure E-8 below depicts the per capita consumption of asparagus in the U.S., for the years 1975 through 2005. The adjusted per capita, fresh asparagus consumption over the past seven years is .96 pounds per person.[51]

Figure E-8
U.S. Asparagus per Capita Consumption, 1975 - 2005



Data for exhibit obtained from US Department of Agriculture, Economic Research Service, *Vegetables Processing: Selected US Per Capita Utilization, 1975-2004*. Accessed June 2006. Available online at: http://usda.mannlib.cornell.edu/

Organic asparagus is the type of asparagus proposed for production on the Reservation. Organic asparagus is currently grown in California.[52] California had cultivated 571.67

51 USDA Economic Research Service, "Fresh Asparagus," accessed on August 25, 2006, available at http://www.ers.usda.gov/data/foodconsumption/spreadsheets/vegfr.xls#Asparagus!a1.

52 California Inspection and Compliance Branch of the California Organic Program, accessed on Aug. 25, 2006, available at http://www.cdfa.ca.gov/is/fveqc/organic.htm.

acres of organic asparagus—worth $816,394 in gross sales—in calendar year 2000.[53] Four years later, the state had grown 325.29 acres of fresh asparagus worth $2,024,880 in gross sales.[54] Though the acreage devoted to organic asparagus production in California has decreased in recent years (congruent with the overall decline in U.S. acreage shown in Figure E-8), the gross profit per acre has increased 400 percent over the same time period. In 2000, the average gross profit per acre for organic asparagus grown in California was $1,429, but by 2004, the average gross profit per acre had increased to $6,230.[55]

An analysis of the transportation and shipping costs for organic asparagus have revealed potential markets that could be served from production of this organic vegetable on the Reservation. Table E-8 below shows the derived farm price of specific wholesale markets available for fresh asparagus. The derived farm price is determined after accounting for transportation costs.

Table E-8
Derived Farm Prices for Asparagus

	Average Wholesale	Transportation	Derived Price	
	CWT[A]	CWT [B]	CWT	Pounds[C]
Phoenix	$177.50	$3.25	$174.25	$1.74
Dallas	$187.28	$16.63	$170.66	$1.71
Atlanta	$172.37	$31.28	$141.09	$1.41
Boston	$173.96	$46.37	$127.59	$1.28
Los Angeles	$177.50	$10.29	$167.21	$1.67
St. Louis	$163.21	$24.38	$138.83	$1.39
Tucson	$177.50	$3.72	$173.78	$1.74

A –Wholesale price data is an average price reported by Ag Marketing Service Portal (AMS), for May through June for the years 2003. – 2005.

B – Transportation costs represent refrigerated truck freight costs.

C – There are 100 pounds (lb) in a hundred weight (cwt).

53 Value is reported in 2006 dollars. Original value is $609,826 in 2000 dollars.

54 Value is reported in 2006 dollars. Original value is $1,879,606 in 2004 dollars.

55 Values reported in 2006 dollars.

Shipping organic asparagus to the Boston market results in the lowest derived farm price for asparagus, shown in Table E-8 as $1.28 per pound, yet if this price were used in the production budget it would generate net returns in excess of $1,500 per acre. Based on these results, and the fact that California produces three-fourths of the domestic production of organic asparagus, it is assumed that all MSAs can be served as target markets with varying degrees of market share. The market share percentage is tied to the distance of the MSA from the production area. Five percent is used for MSAs within five hundred miles (Phoenix and Tucson), and the share drops by a percentage for every five hundred mile increment thereafter.

There are over 35 million people living in the combined metropolitan statistical areas of Dallas, Atlanta, Phoenix, Boston, Los Angeles, Tucson and St. Louis. The total consumption of fresh asparagus in this targeted region is over 33.7 million pounds. It is estimated that the proposed production on the Reservation could supply about 1.1 million pounds.

Cantaloupe Melons

The cantaloupe melon species has its origins in North Africa and Persia, The seeds of the cantaloupe melon came to America with the arrival of Christopher Columbus on his second voyage. Thereafter, the Native American Indians put the seeds into crop production. In the United States, what is referred to, as cantaloupe is actually muskmelon. True cantaloupe is common in Europe and lacks the characteristic, netted rind of the muskmelon. In this analysis, the term "cantaloupe" is used to refer to the muskmelon.[56]

Cantaloupes are classified in the U.S. by location. The Eastern-type cantaloupe melon is usually sutured and netted; it is not intended for long distance shipping. In contrast, the Western-type cantaloupe melon is round to slightly oval, without sutures, very well netted, and with a firm flesh that keeps well when shipped over long distances; their shelf life tends to be longer. The Western-type cantaloupe melon is generally smaller than the Eastern-type (averaging three to four pounds) and matures a bit earlier (80 days).[57] In this economic analysis, the Western-type melon is proposed for production on the Reservation.

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56 USDA, Economic Research Service, August 1998, "Melons: Food for the Angels?" Cantaloupe Commodity Spotlight, *Agricultural Outlook*.

57 University of Georgia web site, accessed online at http://www.uga.edu/vegetable/melon.html#crophistory .

The United States is the world's leading melon importer. In total, the United States accounts for 34 percent of global cantaloupe imports. Two factors that have led to the large number of U.S. imports are: 1) the increase in off-season (winter/early spring) domestic demand; and 2) the proximity to low cost melon producers in Mexico and Central America. Mexico provided 54 percent of the total cantaloupe imports to the United States in 1997. [58]

Arizona is the second leading producer of cantaloupes in the United States, accounting for approximately 22 percent of national production. The state of Arizona harvests both a spring and fall crop of the melon, with shipments to customers that occur from May through November; peak volume of melon shipments from Arizona occurs in early summer. In this analysis, the fall cantaloupe variety is considered for production on the Fort Apache Indian Reservation.[59] Harvest of the fall cantaloupe crop is expected in mid- to late September, and a cooling facility is proposed to be built on the Reservation to allow for storage of the harvested melon. This strategy opens up a market window for the Reservation crop that is past the usual timeframe for peak domestic shipments—giving the Tribe an opportunity to capitalize on the late season and off-season market demand for cantaloupes.

Cantaloupe melons are consumed frequently as desserts, snacks, fruit salads, breakfast foods, picnic foods, edible plant garnishes, drinks, and are used creatively in a variety of menus. Figure E-9 shows the U.S. per capita consumption of cantaloupe, which indicates a trend of increased consumption in the 1990s and the early 2000s. The adjusted, per capita consumption of cantaloupe in the U.S. is 10.9 pounds per year.

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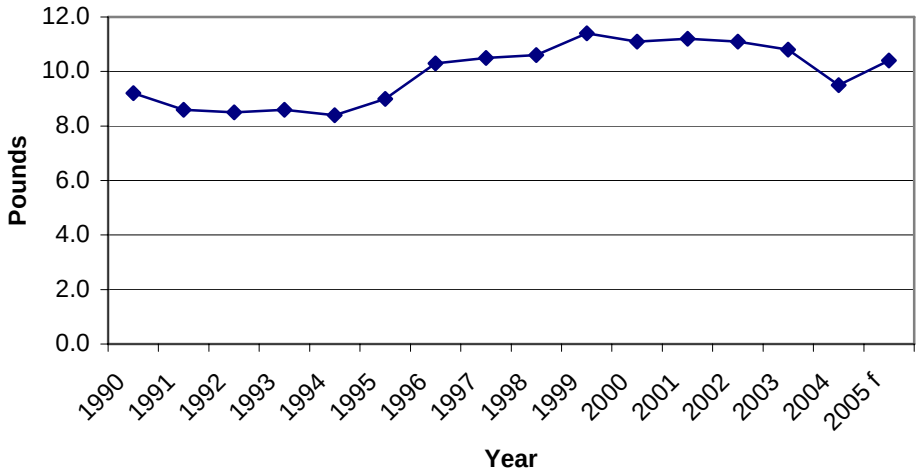
58 USDA, Economic Research Service, August 1998, "Melons: Food for the Angels?" Cantaloupe Commodity Spotlight, *Agricultural Outlook*.

59 Ibid.

Figure E-9
U.S. Cantaloupes per Capita Consumption, 1990 – 2005



Source: Vegetables and Melons Situation and Outlook Yearbook, VGS 2005, July 21, 2005, Economic Research Service, USDA, p77.

Cantaloupe melon consumption is on the rise for a number of reasons, such as: the emergence of a year round consumer demand and product availability, an increase in health consciousness among consumers, strong economic growth, more creative marketing, and the adoption of improved melon varieties. Cantaloupes are reportedly purchased more often than any other melon. By weight, however, watermelon is the most-consumed melon in the U.S., followed by cantaloupe and honeydew.[60]

A recent trend in the produce industry is for large retail grocers to establish direct relationships with growers to provide themselves with assurances that they are offering fresh, high-quality, and safe products for their customers to consume. For this reason, supermarket chain buyers are demanding longer shelf lives from cantaloupes, as well as more produce that is packed and palletized. Agricultural producers that can consistently provide premium quality melons and full marketing services (including grading, forced-air cooling, custom packing, and sales directly to retail buyers) can stabilize seasonal prices and maximize their market position throughout the entire marketing period.

As stated previously, the market window for cantaloupe harvest on the Fort Apache Indian Reservation is from mid- to late September. The major competing areas for

60 USDA, Economic Research Service, August 1998, "Melons: Food for the Angels?" Cantaloupe Commodity Spotlight, *Agricultural Outlook.*

cantaloupe shipments during this time are producers located in Central California and fall cantaloupe producers located in the valley region of Arizona.

California has two main areas for cantaloupe production: the southern desert valley (Imperial and Southern Riverside Counties) and the San Joaquin Valley (Kern, Fresno, Kings, Merced, and Stanislaus Counties). Cantaloupes from the southern desert areas are harvested from May through early July, whereas the harvest in the San Joaquin Valley is from late June through October.[61] Overall, the California production areas provide an extremely long (May through October) market window of fresh cantaloupe melon supplies. The Tribe's major area of competition in California for their proposed project is the San Joaquin Valley, with its fall harvest period. Table E-9 below provides a description of the competing production areas as well as the corresponding distances to terminal markets.

Table E-9
Distances from Cantaloupe Production Areas to Terminal Markets

	Phoenix	Dallas	Atlanta	Boston	Los Angeles	St. Louis
Arizona Valley	0	1,070	1,850	2,700	370	1,500
Central California	560	1,530	2,280	3,085	190	1,930
Colorado	795	645	1,410	2,040	1,120	854
Whiteriver, AZ	171	875	1,647	2,441	542	1,283

The wholesale prices for cantaloupe melons in these major terminal markets seem to be reflective of the distance to the production areas. In other words, the wholesale prices appear to increase as the distances increase from the major producing areas in the U.S. to the terminal markets. If the Tribe were to transport cantaloupe directly to these terminal markets, they would need to pay transportation costs in the form of trucking freight. Transportation costs to the select terminal markets from the Reservation are identified in the third column from the left, in the next table (Table E-10 below).[62] The transportation costs include the use of refrigerated trucks, given the distances described in Table E-9

61 Hartz, Timothy, *Cantaloupe Production in California.*

62 Transportation costs are based on a $.018 / cwt rate, per the Agricultural Refrigerated Truck Quarterly, 2005. This rate was confirmed via personal communication with Far West Express (Toni), based out of Phoenix AZ, based on rates for a deadhead, refrigerated truck shipment from Show Low to Phoenix, March 1, 2006. ("Deadhead" refers to miles traveled by a driver with an empty load in order to move the truck to a destination where he/she can pick up a paying load.)

above. Also included in the cost of production are fees for cold storage and handling of the cantaloupe crop in the proposed cold storage facility.

Table E-10
Derived Farm Prices for Cantaloupe Production

	Average Wholesale	Transportation	Derived Price	
	CWT[A]	CWT [B]	CWT	Pounds[C]
Phoenix	$21.58	$3.25	$18.33	$0.18
Dallas	$33.71	$16.63	$17.08	$0.17
Atlanta	$34.43	$31.28	-	-
Boston	$36.84	$46.37	-	-
Los Angeles	$21.58	$10.29	$11.29	$0.11
St. Louis	$32.45	$24.38	-	-
Tucson	$21.58	$3.72	$18.33	$0.18

A –Wholesale price data is an average price reported by Ag Marketing Service Portal (AMS), for May through June for the years 2003. – 2005.

B – Transportation costs represent refrigerated truck freight.

C – There are 100 pounds (lb) in a hundred weight (cwt).

The proposed production on the Reservation is within 1,000 miles of the MSAs of Phoenix, Tucson, Dallas, and Los Angeles; therefore, these four metropolitan statistical areas (Phoenix, Los Angeles, and Dallas) are the target markets for melon production on the Reservation. In this analysis, it is assumed that these four MSAs can be served as target markets with varying degrees of market share. The market share percentage is tied to the distance of the MSA from the production area. Five percent is used for MSAs within five hundred miles (Phoenix and Tucson), whereas the market share is reduced to four percent for MSAs between 500 and 1,000 miles distance (Los Angeles and Dallas).

There are over 23 million people living in the four MSAs identified as target markets for cantaloupe production. As stated previously, the adjusted per capita consumption of cantaloupe is 10.9 pounds annually. Therefore, the total market size of cantaloupe production in the defined region is 253.4 million pounds. Based on the market share assumptions described above, and the proposed yield of cantaloupe production, the market limit for cantaloupe production on the Reservation is 532 acres.

The proposed production of 532 acres of cantaloupe melons on the Reservation will increase overall production of cantaloupes in the California and Arizona areas by 0.5

percent, based on the National Agricultural Statistical Service (NASS) production estimates for these states.[63]

Onions

The booming economy of the 1990's propelled demand from home cooked meals to pre-packaged and away-from-home foods, many of which feature onions as an ingredient. Onions are flavorful and colorful, with red, yellow, or white outer skins. Onions have natural qualities that make them attractive to consumers, particularly in today's health conscious market. Research shows that onions contain antioxidants, can reduce blood cholesterol levels, are low in calories, and are a source of dietary fiber. Bulb onions also provide vitamin C, with one medium onion providing 15 to 20 percent of the daily requirement.[64] Onions can be divided into two categories: spring/summer fresh onions and fall/winter storage onions. Both types of onions can be produced on the Reservation, but for purposes of this analysis, the fresh onion is the crop proposed.

Production of onions in the U.S. had risen in 2004 to a record high of 7.39 billion pounds, which is equivalent to an average yield of 490 cwt. This dramatic increase in production had been largely due to the record high, annual yield reported for the second, consecutive year; this 2004 figure represented an increase of 11percent from the year prior.[65]

Consumption trends indicate that fresh and dehydrated onion demand has increased over the past three decades. While processed onion use has been almost flat, fresh consumption of onions has experienced a strong upward trend. In general, total, per capita onion consumption has been fairly uniform across all regions of the United States.[66] Figure E-10 below shows the U.S. per capita consumption of fresh and dehydrated onions for the timeframe 1995 – 2005.

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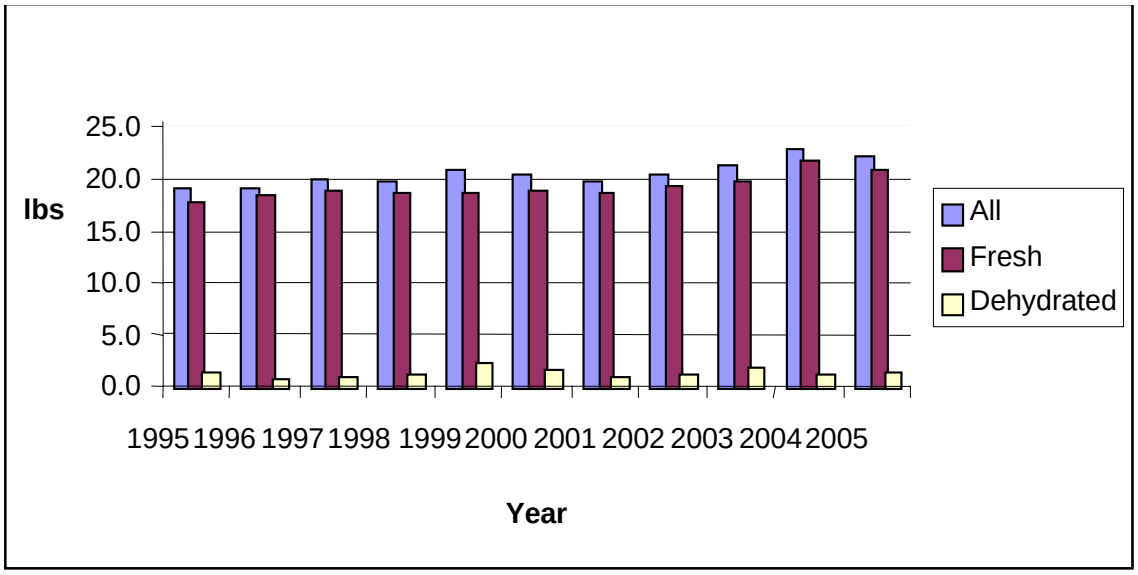
63 Production data obtained online at www.nass.usda.gov. Reservation production is calculated with a yield of 200 cwt per acre.

64 USDA, Economic Research Service, April 2001, "Vegetables and Specialties Situation and Outlook," VGS – 283.

65 USDA, Economic Research Service, July 21, 2005, "Vegetables and Melons Situation and Outlook Yearbook," VGS – 2005.

66 Ibid.

Figure E-10
U.S. Onions per Capita Consumption, 1995 - 2005



Source: Vegetables & Melons Situation and Outlook Yearbook, ERS, USDA, VGS – 2005, July 21, 2005.

The adjusted, per capita consumption of onions over the past seven years is 20.7 pounds annually. Although the onion is not a major plate vegetable, the onion ranks fifth among all vegetables in terms of both consumption and value.[67]

The primary competing areas for onion production include the valley regions in Arizona, Central California, New Mexico, Texas, and Washington State. The primary region for onion production in New Mexico is the southwestern portion of the state, in the Mesilla Valley; close to eighty percent of the state's onion production occurs in this valley. The representative location for the Mesilla Valley used in this analysis is the town of Las Cruces, New Mexico. Some onion production also occurs at the Navajo Agricultural Products Industry (NAPI) project site in Northwestern New Mexico. The NAPI project is located only a few hundred miles away from the proposed irrigation project on the Reservation. The representative city used in this analysis for the NAPI project is Farmington, New Mexico.

In the state of Texas, there are several onion production areas; these areas include the southern tip of Texas (near Rio Grande City) and the area around San Antonio, Texas. During the market window that onions are also being shipped from Washington State,

67 Ibid.

this analysis uses the city of Walla Walla, Washington as the representative city for these onion shipments.

Following the assignment of representative, onion producing areas, a comparison has been made as to the distances between the shipping points of origin and the shipping destinations during the market window. Table E-11 below shows the representative distances for each of the major onion production areas to the major terminal markets.

Table E-11
Distances from Onion Production Areas to Terminal Markets

	Phoenix	Dallas	Atlanta	Boston	Los Angeles	St. Louis
Las Cruces, NM	390	680	1,465	2,460	760	1,270
Visalia, CA	560	1,530	2,280	3,085	190	1,930
Rio Grande City, TX	1,240	535	1,195	2,260	1,610	1,225
San Antonio, TX	980	275	990	2,055	1,355	965
Walla Walla, WA	1,295	1,960	2,430	2,920	1,105	1,880
Phoenix, AZ	0	1,070	1,850	2,700	370	1,500
Farmington, NM	450	825	1,575	2,415	770	1,225
Whiteriver, AZ	171	875	1,647	2,441	542	1,283

Comparing the distances to major produce terminal markets shows the relative, competitive advantages that each of the production areas may hold. Shorter distances in the same market window indicate lower transportation costs. The distances from Farmington, New Mexico production areas to terminal markets are similar to those originating from Whiteriver, Arizona. In all but one market, the distance from Farmington to terminal markets is approximately 100 miles shorter than the distance from Whiteriver to those same markets. The NAPI project, which is located near Farmington, has onion storage facilities. These climate-controlled storage facilities allow a longer market window for onions produced at the NAPI project site, by maintaining product freshness; this longer market window is an option that the Tribe would likely benefit from also if storage options was a commodity chosen. In this analysis, fresh market

onions are the proposed crop, which limits the requirements of storage to packing after harvest and then hauling it to the market destination.

The average wholesale prices in the major terminal markets have been collected and compared against the costs of transportation for the proposed irrigation project on the Fort Apache Indian Reservation. The resulting farm price is derived after accounting for the transportation costs.

Table E-12
Derived Farm Prices for Onion Production

	Average Wholesale	Transportation	Derived Price	
	CWT[A]	CWT [B]	CWT	Pound[C]
Phoenix	$25.43	$3.25	$22.18	$0.22
Dallas	$27.97	$16.63	$11.34	$0.11
Atlanta	$30.83	$31.28	-	-
Boston	$29.49	$46.37	-	-
Los Angeles	$25.43	$10.29	$15.14	$0.15
St. Louis	$29.20	$24.38	-	-
Tucson	$25.43	$3.72	$22.18	$0.22

A –Wholesale price data is an average price reported by Ag Marketing Service Portal (AMS), for May through June for the years 2003. – 2005.

B – Transportation costs represent refrigerated truck freight costs.

C – There are 100 pounds (lb) in a hundred weight (cwt).

The derived farm price is representative of what the Tribe can expect to receive if they were to market their onions in the wholesale terminal markets referred to in Table E-12 above. The highest derived farm prices for Tribal produce can be realized in the Phoenix, Tucson, and Los Angeles terminal markets. Profitable derived farm prices were also found in Dallas.

In this analysis, it is assumed that these four MSAs can be served as target markets with varying degrees of market share. The market share percentage is tied to the distance of the MSA from the production area. Five percent is used for MSAs within five hundred miles (Phoenix and Tucson), whereas the market share is reduced by one percent for every incremental 500 miles in distance. Therefore, four percent market share is assumed in the Los Angeles and Dallas MSAs.

There are a total of 23 million people currently living in these four MSAs based on 2005 population data published by the Population Division of the U.S. Census Bureau. As discussed previously, the per capita consumption rate for onions is 20.7 pounds annually. This results in a total market demand of over 481 million pounds of onions in the defined region. Based on the market share assumptions discussed above, and the yields identified for onions, the market limit for production of onions on the Reservation is 475 acres.

The organic certification is likely to enable merchandisers to capitalize on the marketing channels already established for the conventional onion. An increase in production of the proposed amount is not anticipated to affect the market price.

Chili Peppers

Chili peppers were brought to Europe by Christopher Columbus after his infamous attempt to reach the East Indies, and the pepper's popularity has steadily increased since then.[68] The present day Southwestern U.S. was home to one of the five groups of prehistoric peoples to domesticate the plant.[69]

The United States is the fifth largest producer of chili peppers worldwide. China, Mexico, Turkey, and Spain, all lead the U.S. in chili pepper production.[70] Within the U.S., the majority of chili peppers are grown in the Southwestern states; New Mexico accounts for 50 percent of domestic chili pepper production.[71] Following New Mexico, the states of Arizona, California and Texas are the next largest producers of chili peppers in the US.

New Mexico processes close to 297.5 million pounds[72] of chili peppers each year, which is about half of all chilies processed annually within the United States. Close to 23 thousand pounds of these peppers are dried red chili peppers produced in New Mexico; this figure represents all but 67 pounds of the red chili peppers produced in the entire

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68 Eshbaugh, W.H., 1993, "*History and Exploitation of a Serendipitous New Crop Discovery*," In: J. Janick and J.E. Simon (eds.), *New Crops*, Wiley, New York, p. 132-139, Accessed at www.hort.purdue.edu/newcrop/proceedings1993/v2-132.html on 9/20/06.

69 Wikipedia data accessed at en.wikipedia.org/wiki/Chile_pepper on 9/21/06.

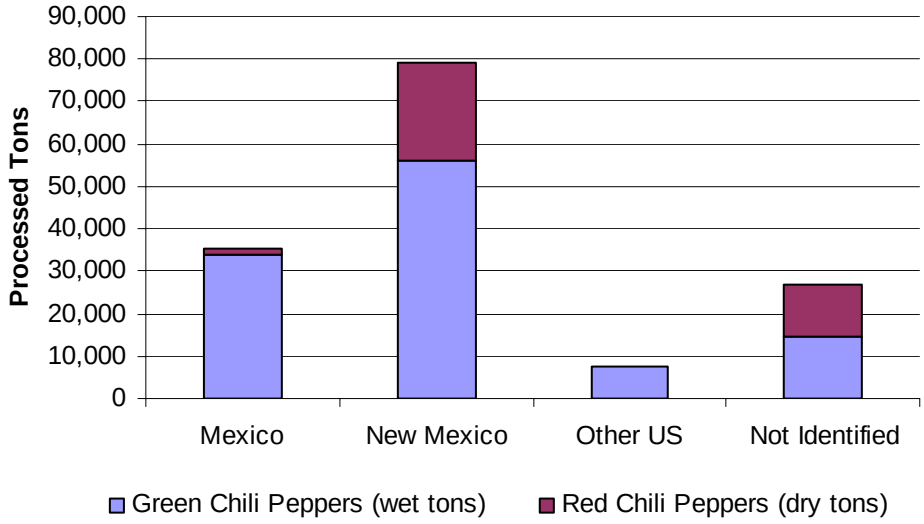
70 Hall, T.Y. and R.K. Skaggs, May 2003, "New Mexico's Chile Pepper Industry: Chile Types and Product Sourcing," New Mexico Chile Task Force data accessed at cahe.nmsu.edu/pubs/research/ on 9/20/2006.

71 USDA, National Agricultural Statistics Service, data accessed at www.nass.usda.gov on 9/20/06

72 Hall, T.Y. and R.K. Skaggs, May 2003, "New Mexico's Chile Pepper Industry: Chile Types and Product Sourcing," New Mexico Chile Task Force data accessed at cahe.nmsu.edu/pubs/research/ on 9/20/2006.

U.S. and processed within the state.[73] The chili peppers processed within the state of New Mexico are a combination of the peppers produced in the U.S. and those imported from Mexico. Figure E-11 shows the amount of chili peppers processed within New Mexico from each growing region.

Figure E-11
Chili Peppers Processed in Southern New Mexico by Growing Region



Note: green chili peppers includes cayenne and jalapeno peppers

Note: Data represented as 'Not Identified' may include Mexico, New Mexico and other US states.

Note: data gathered from May 2001 through September 2001

Source: Hall, T.Y. and R.K. Skaggs, New Mexico's Chile Pepper Industry: Chile Types and Product Sourcing. May 2003. New Mexico Chile Task Force data accessed at cahe.nmsu.edu/pubs/research/ on 9/20/2006.

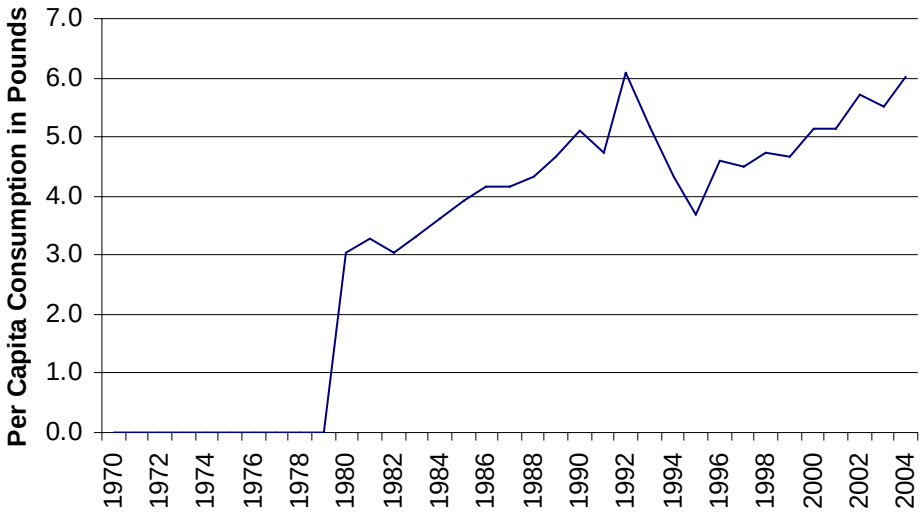
Chili peppers are consumed fresh, roasted, peeled, frozen, canned, smoked, pickled, dehydrated, and powdered. Paprika and chili powder are red chili peppers dried and ground into a powder. Green chili peppers are often roasted and peeled to eat fresh, canned, or frozen. In order to create chipotle sauce, jalapeño chili peppers are smoked over mesquite wood or hardwood and dried into chipotle. Jalapeño chili peppers are also

[73] Ibid.

consumed as a condiment, often over nacho chips. Chili pepper juice can be extracted to create pepper spray, which is a popular weapon used by police departments.[74]

Chili pepper consumption in the United States has increased drastically since the 1970s. Figure E-12 shows chili pepper consumption from 1970 to 2004. The per capita consumption rate has increased from zero pounds per year in 1970 to six pounds per year in 2004. The seven-year, normalized per capita chili pepper consumption rate is 5.2 pounds.[75]

Figure E-12
U.S. Chili Peppers per Capita Consumption, 1970 - 2004



Source: USDA/Economic Research Service. Accessed 9/20/06

There is a large volume of chili peppers processed in the neighboring state of New Mexico each year. The region analyzed as the chili pepper destination markets include the following cities: Phoenix, Tucson, Atlanta, Boston, Dallas/Forth Worth, Los Angeles, and Saint Louis. An analysis of transportation costs and wholesale market prices is included in Table E-13 below.

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74 Bosland, P.W., November, 1994, "The Wonders of New Mexico Chile," *New Mexico Journal of Science*, Vol. 34, Accessed at weather.nmsu.edu/nmcrops/chile/chiledi.html on 9/21/06.

75 USDA, Economic Research Service, Accessed at http://www.ers.usda.gov/data/FoodConsumption/ on 9/20/06.

Table E-13
Derived Farm Price for Chili Pepper Production

	Average Wholesale	Transportation	Derived Price	
	CWT[A]	CWT [B]	CWT	Pound[C]
Phoenix	$67.66	$3.25	$64.41	$0.64
Dallas	$166.03	$16.63	$149.41	$1.49
Atlanta	$125.90	$31.28	$94.62	$0.95
Boston	$183.01	$46.37	$136.64	$1.37
Los Angeles	$67.66	$10.29	$57.37	$0.57
St. Louis	$113.67	$24.38	$89.29	$0.89
Tucson	$67.66	$3.72	$64.41	$0.64

A –Wholesale price data is an average price reported by Ag Marketing Service Portal (AMS), for May through June for the years 2003. – 2005.

B – Transportation costs represent refrigerated truck freight costs.

C – There are 100 pounds (lb) in a hundred weight (cwt).

The derived farm price analysis above indicates that the highest prices for chili peppers are in Dallas, and Boston. However, all of the markets analyzed show a strong potential for profitability. In this analysis it is assumed that a small percentage of the market demand in each of the identified MSAs can be captured by Tribal production without impacting market price. In the markets closest to the Reservation (Phoenix and Tucson) it is assumed that 5 percent of market demand can be produced on the Reservation. This percentage is lowered by one point for every incremental 500 miles in distance from the Reservation. This is likely an underestimate in the regional demand for chili peppers, as the neighboring state of New Mexico is home to several chili pepper processing plants.

There are over 35 million people reportedly living in the MSAs identified above.[76] Based on the per capita consumption of chili peppers annually, this region is home to a market demand of approximately 182.7 million pounds of chili peppers. Based on the market demand assumption described above, and the projected yields for chili peppers the market limit for chili pepper production on the Reservation is 566 acres.

76 U.S. Bureau of Population Statistics, April 2000 to July 2004, "Annual Estimates of Population for Micropolitan and Metropolitan Areas."

The United States produced 32,700 acres of chili peppers in 2005, of which the proposed Reservation production would account for less than two percent of total US acres harvested.[77]

The value of organic chili peppers has increased in recent history. Between 2000 and 2004, the gross sales in dollars per acre for organic chili peppers in California increased from $2,600 to $7,540 per acre.[78] Overall the total gross sales for California organic peppers increased from $2.6 million[79] to $6.1 million[80], this figure is an increase in gross sales per acre of close to 300 percent over the four-year period. [81]

Organic Food Grains

This next segment reviews the organic food grain crops proposed for production on the Reservation. These food crops are as follows: blue corn, spring wheat, and soybeans. There is no large, open market for the three organic food grains considered in this analysis. Most of the production of organic blue corn, organic wheat, and organic soybeans in the United States occurs under contract with a grain company. Clarkson Grain Company of Decatur, Illinois has been identified as the most likely company for the White Mountain Apache Tribe to collaborate with in producing these organic crops for specialty food use. Lynn Clarkson, founder of Clarkson Grain Company, visited the Reservation and shared his initial impressions about the opportunities for organic grain production on the Reservation in a memorandum. This memorandum is attached to this report as Appendix F.

Blue Corn

Blue corn is an open pollinated flour corn. Blue corn gets its name from the color it turns when the kernels dry; this grain has long been a staple of the Native American diet. Blue corn contains soft starch that is useful in the milling of specialty foods. Currently, these specialty foods include tortillas, pancake mixes, cornbread mixes, corn chips, and cereal. Blue corn products are marketed to Mexican restaurants, health food stores, and some

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77 USDA data accessed at usda.manlib.cornell.edu/usda/ on 9/25/06.

78 California Organic Program accessed at www.cdfa.ca.gov/is/fveqc/organic.htm on 9/20/06.

79 Value inflated to 2005 dollars. In 2000 dollars, the value is $2,316,417.

80 Value inflated to 2005 dollars. In 2004 dollars, the value is $5,886,960.

81 In 2000, gross sales per acre were $2,700. In 2004, gross sales per acre were $7,911. All values in 2005 dollars.

supermarkets.[82] Demand for these products is increasing at a rate of 20 percent annually; however, the acreage devoted to the cultivation of blue corn is only increasing at a rate of approximately 6 percent annually.[83] This gap between demand and supply provides the White Mountain Apache Tribe with a market opportunity to grow organic blue corn on the Reservation, as proposed in this analysis.

Food grains like blue corn are usually grown under a production contract. The Clarkson Grain Company has production contracts in place for about one quarter of the blue corn acreage in the United States, of which the overwhelming majority is organically produced. The Clarkson Grain Company has production contracts with the Navajo Agricultural Products Industry (NAPI) project near Farmington, New Mexico. This site is just a few hundred miles north of the Fort Apache Indian Reservation. Recently, NAPI opened a cleaning and bagging center specifically for organic food grains. Entering into contracts with Southwestern Tribes like NAPI is a strategic move by Clarkson Grain Company due to the large portion of the market for organic blue corn that is located near Los Angeles, California. The distance from the NAPI project to Los Angeles is one third of the distance from their original center in Decatur, Illinois to Los Angeles. Even though the NAPI project is under contract to grow organic blue corn and soybeans, Clarkson Grain Company has indicated that they are actively seeking more growers in the regional area for blue corn production. In fact, according to Lynn Clarkson the company would be willing to work with the Tribe to establish production contracts for growing at least 1,000 acres of organic blue corn on the Fort Apache Indian Reservation.[84]

In this analysis, it is assumed that 1,000 acres of organic blue corn could be added to the existing market without impacting the price of organic blue corn. This acreage is a conservative estimate, based on the expressed demand of the commodity as communicated by managers at the Clarkson Grain Company.

Spring Wheat

Wheat is a versatile food grain that has been a cornerstone of the human diet for thousands of years. It is thought that people cultivated weeds and grasses in the fertile Middle East, which produced what is now known as wheat and barley. Wheat later made its way to England and then on to the New World, where it has become a popular grain in

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82 Johnson, Duane, and Mirta N. Jha, "Blue Corn," Purdue Horticulture Department Publication, accessed online at www.hort.purdue.edu/newcrop/proceedings1993/v2-228.html.

83 Personal Communication with Lynn Clarkson, Clarkson Grain Company, December 12, 2005.

84 Ibid.

the American diet, due to its health-promoting substances,[85] Today, organic wheat is largely used for organic baking products, such as in breads, cakes, and pastas.

There are six types of wheat grown in the United States: Durham wheat, hard red spring wheat, hard red winter wheat, hard white wheat, soft red winter wheat, and soft white wheat.[86] For purposes of this analysis, winter wheat and Durham wheat have been identified by Dr. Glover as suitable for production on the Reservation.[87]

Similar to organic blue corn mentioned above, organic wheat is another food crop that is largely grown on contract. In this analysis, organic wheat is rotated with organic blue corn and organic soybeans.

Due to the rotational requirement of organic blue corn, the Clarkson Grain Company has offered to work with the Tribe in contracting acreage for organic wheat as well. In this analysis, the market limit for organic wheat is 1,000 acres, or the same acreage as that for organic blue corn.

Soybeans

Glycine max, or Soybean, has become one of the most versatile and widely used crops in the world. Among its many other uses, the soybean acts as the base for soy meal, soy flour, soy milk, tofu, textured vegetable protein, tempeh, soy lecithin, soybean oil, and, of course, soy sauce. The bushy, green soybean plant is a legume related to clover peas and alfalfa, with origins dating back thousands of years to China. Planting typically occurs in late spring, and the pea-sized soybeans are harvested in early fall.[88]

Global and domestic cultivation of soybeans have increased substantially since the early 1960s as demand for soy-based products has steadily escalated. Figure E-13 below provides global and domestic soybean cultivation trends for the years 1975 through 2005.

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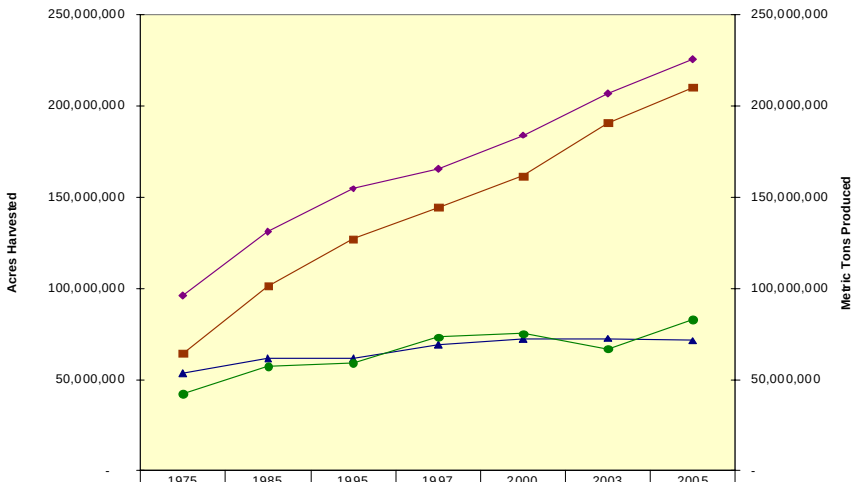
85 Whole Grains Bureau web site accessed online at http://www.wholegrainsbureau.ca/about_wg/history_of_wg.html.

86 Wheat classes from http://ohioline.osu.edu/agf-fact/0146.html.

87 See Appendix B: Agronomic Crop Recommendation for the White Mountain Apache Tribe.

88 Info taken from http://agebb.missouri.edu/mass/indepth/soybean/sbhistry.htm

Figure E-13
Trends in Global and U.S. Soybean Acreage and Production, 1975 - 2005



	1975	1985	1995	1997	2000	2003	2005
Global Ac. Harvested	95,792,550	131,125,856	154,462,128	165,442,590	183,840,255	206,600,135	225,600,553
US Ac. Harvested	53,615,086	61,582,262	61,542,726	69,106,457	72,407,194	72,475,196	71,269,224
Global Production (mt)	64,248,541	101,156,045	126,981,470	144,415,860	161,406,339	190,595,747	209,975,643
US Production (mt)	42,139,728	57,128,000	59,174,000	73,177,000	75,055,288	66,777,820	82,820,048

Figure derived from the United Nations Food and Agriculture Organization statistical databanks. Data obtained on 6.20.2006 from FAOSTAT website, available at: http://faostat.fao.org/faostat/form?collection=Production.Crops.Primary&Domain=Production&servlet=1&hasbulk=0&version=ext&language=EN

Figure E-13 above conveys the expansion of this market in response to a burgeoning demand for relatively inexpensive soy-based products. Organic soybean cultivation has outpaced the growth rate of newly cultivated acres of conventionally grown legumes. Between 1997 and 2003, cultivation of organic soybeans in the US had risen by 33 percent—from 82,000 to 122,400 acres—in comparison to a 5 percent increase of acres harvested of conventionally cultivated soybean during this same period.[89]

Organic soybean, organic corn, and organic wheat cultivation comprise less than 0.1 percent of total acreage for the respective crops in the U.S, organic food grain market; however, farmers enjoy substantial price premiums in this niche market (See Appendix F: Clarkson Grain Company Investigative Organic Cropping Potential at WMAT Reservation).

Table E-14 below compares the price premiums for organic grains and oilseed crops (such as canola and safflower) produced between 1995 and 2000. As of 2003, the USDA Economic Research Service (ERS) reported that soybeans have not been

89 UNFAO State Bank and USDA Economic Research Service (ERS).

organically cultivated in Arizona; however, the Navajo Agriculture Products Industry (NAPI) recently began organic soybean production.[90]

Table E-14
Price Premium Percentages for Organic Grains and Oilseed Crops*, 1995 - 2001

	1995	1996	1997	1998	1999	2000	2001
Soybean	114%	85%	141%	202%	217%	175%	177%
Corn	35%	43%	73%	88%	98%	89%	59%
Spring Wheat	54%	59%	73%	8%	87%	103%	94%
Oats	35%	59%	73%	83%	77%	71%	41%

* These premiums are reported as the incremental percent increase in the prices between conventional and organically produced commodities.

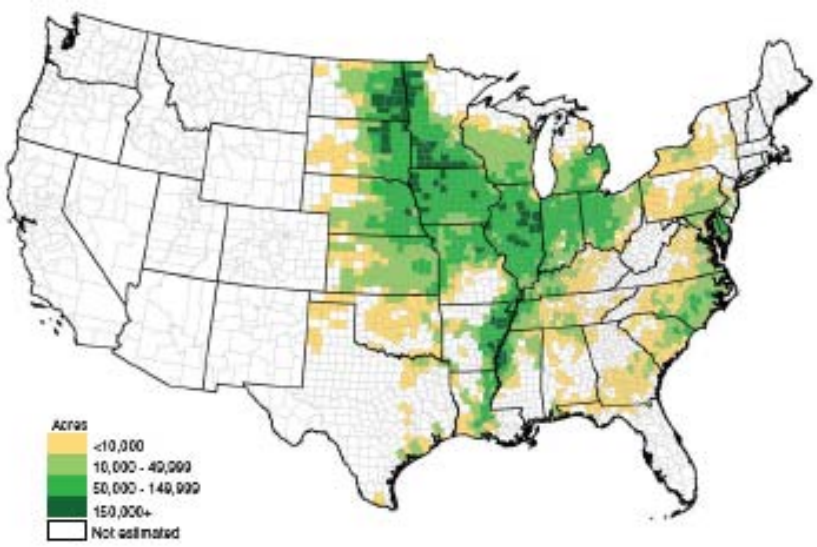
Source: Bertramsen, Sherry K., and Thomas L. Dobbs of Economics Commentator, February 22, 2002.

The soybean plant is commonly used as a rotation crop with corn in locations where soybean legumes leach nitrogen and other minerals into the soils. It is therefore no surprise that the majority of soybean cultivation occurs in the U.S. "grain belt" and Mississippi River valley, as observed in Figure 16 below. The crop yields in the Midwest and the Gulf states of the U.S., however, have been hampered by the introduction of Phakopsora pachyrhiz, which is commonly known as soybean "rust". The spread of soybean rust depends on various climate conditions such as altitude and humidity. The proposed cultivation site on the Fort Apache Indian Reservation is of an altitude and climate that are not conducive to soybean rust; therefore, the threat of local soybean rust dissemination is considered negligible.[91]

[90] Personal communication with Lynn Clarkson of Clarkson Grain Company.

[91] Personal Communication with Lynn Clarkson, Director of the Clarkson Grain Company, June 2006.

Figure E-14
Acres Planted for Soybean Cultivation by County, 2004



Taken directly from USDA ERS *Soybean Backgrounder*, April 2006. Document available for viewing at: http://www.ers.usda.gov/publications/OCS/apr06/OCS200601/OCS200601_lowres.pdf

Organic food crops such as soybean and corn can also be cultivated for livestock feed. Feed soybeans generally experience higher yields and lower protein content, while food soybeans produce lower yields but are held to the standard of 40 percent to 48 percent protein.[92] According to information reported in the Fourth National Organic Farmers' Survey (2004), it appears that feed soybeans are primarily sold in commodity markets, whereas food soybeans are sold more to processors than sold as commodities.

As stated earlier, there is no large, open market for the organic food grains considered in this analysis. Most of the U.S. production of organic blue corn, organic wheat, and organic soybeans occurs under contract with a grain company. Clarkson Grain Company has been identified as the most likely company for the Tribe to work with in producing these organic food grain crops. They company is headquartered in Illinois, but they have contracts with the NAPI project. The NAPI project is located near Farmington, New Mexico, which is just a few hundred miles north of the Fort Apache Indian Reservation. Currently, Clarkson Grain Company controls about 25 percent of the blue corn production in the United States and has contracts in place for production of these crops in Illinois and at the NAPI project location. One of the Clarkson Grain Company's main target markets is the Los Angeles area, as blue corn is often used for milling specialty foods. Table E-15 shows the distance advantages of producing these organic food grains

92 Ibid.

in Arizona and shipping them from New Mexico as compared to shipping the products to Illinois.

Table E-15
Distances from Organic Food Grain Production Areas to Terminal Market

	Los Angeles CA
Decatur IL	1,960
Farmington NM	770
Difference	1,190

As Table E-15 indicates, the distance from existing and potential production areas in New Mexico and Arizona is almost 1,200 miles closer to the main target market for blue corn than the former production area in Illinois. Thus, Clarkson Grain Company will likely enjoy a potentially large cost savings with its focus on locating its production areas closer to the target market in Los Angeles. For this reason, soybeans are another crop that the Clarkson Grain Company would like to contract out to the White Mountain Apache Tribe. In this analysis, soybeans are assigned the same market limit of 1,000 acres that is indicated as the market limits for organic wheat and organic blue corn production on the Reservation.

Organic Crops for Beef Operation

Organic beef production on the Reservation is an economic development activity with great potential for the Reservation. Appendix G evaluates the profit potential of such an operation on the Reservation. In preparation for this venture, there are explicit, national organic standards that must be met first, in order for a cattle herd to be certified organic. For example, feed products for the beef cattle must be 100 percent organic. For this reason, five organic rotational crops are selected for use in the organic beef operation. These organic rotational crops are as follows: alfalfa hay, corn silage, grain corn, oats, and green manure. The demand for these crops is derived from the demand that is produced from the final product, which in this case is organic beef. These rotational crops will be valuable to the Tribe because they indirectly satisfy the input requirements for the organic beef operation. In other words, the organic beef operation will be most successful if the Tribe's organic crop production is also a success.

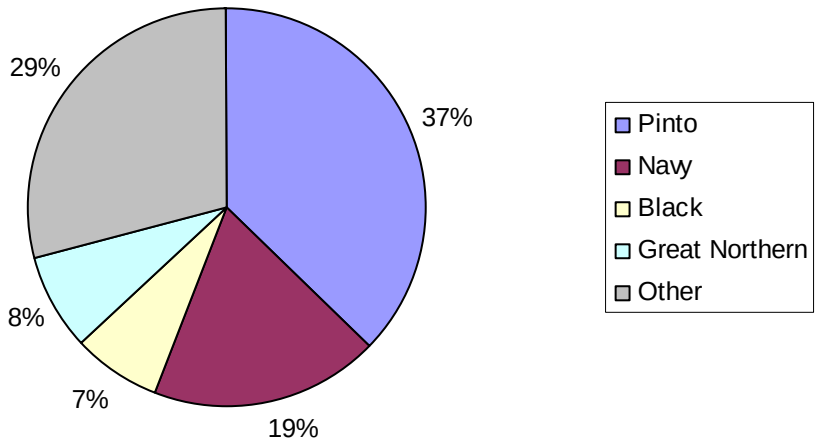
In this analysis, it is assumed that a herd of 1,000 head of organic beef cattle can be sustained on the Reservation through the production of organic feed crops. To accommodate this demand, it is estimated that the following crop quantities will need to be grown and harvested on an annual basis: 527 tons of alfalfa, 24,188 bushels of grain corn, 1,678 tons of corn silage, and 17,500 bushels of oats. Given the annual yields

anticipated for these organic rotational crops, it has been determined that the following farm acreage is needed to supply the inputs necessary for the organic beef operation; 148 acres of alfalfa hay (rotation three and six), 176 acres of grain corn (rotation two, three, and four), 84 acres of corn silage (rotation six), and 175 acres of oats (rotation two, three, and six).[93] See Appendix G for a complete description of the organic beef operation.

Edible Dry Beans

There are 13 classes of edible dry beans that are grown in the U.S. These edible dry bean varieties are listed as follows: small red bean, black bean, great northern bean, pinto bean, pink bean, light red kidney bean, dark red kidney bean, cranberry bean, lima bean, garbanzo bean, black-eyed bean, small white bean, and the navy bean. Figure E-15 depicts the U.S. production figures for edible dry beans by class.

Figure E-15



U.S. Edible Dry Beans Production By Class

Source: NASS, USDA Edible Dry Bean Quick Stats, 1998, http://www.nass.usda.gov/Charts_and_Maps/Dry_Beans,_Dry_Peas,_and_Lentils/dbclass.asp

The pinto bean is the most commonly produced bean type in the United States. In this analysis, pinto beans are used as the representative crop for all edible dry beans. The pinto bean is named for its mottled skin. It is often used in whole or mashed form and is

93 Crop rotations are listed in Section 5.7 of the Main Report.

a staple in Latino cooking. When fully cooked, the bean loses its mottled appearance. The pinto bean is most commonly used as a filling for burritos. The pinto bean shares the spotlight as New Mexico's official state vegetable with the chili.[94] Pinto bean data as far back as 1995 suggest that Americans consume approximately three to three and one-half pounds of pinto beans per capita annually.[95]

Pinto bean data is not available for the state of Arizona, but the state of New Mexico reports production, yield, and price data for all edible dry beans. The adjusted average for edible dry bean production in New Mexico is 154,800 cwt annually.[96] New Mexico, however, is considered a minor producing state of edible dry beans.

The major dry bean production areas in the United States (in terms of value of production) in 2005 have included North Dakota, Michigan, Nebraska, California, and Minnesota. Table E-16 below shows the value of production by state for all edible dry beans in 2005.

Table E-16
All Edible Dry Beans, 2005

State Rank	State	Value of Production (in Thousand Dollars)
1	North Dakota	135,690
2	Michigan	75,072
3	Nebraska	67,338
4	California	55,954
5	Minnesota	48,600

Source: USDA, NASS web-site for Quick Stats, http://www.nass.usda.gov:8080/QuickStats/index2.jsp

As shown in Table E-16, North Dakota is the top ranked state, with a value of production listed at over $135 million. In comparison, New Mexico produced nearly $4.4 million worth of all edible dry beans in 2005.

94 Wikipedia, "Common Bean," accessed online at http://en.wikipedia.org/wiki/Pinto_bean#Pinto_or_mottled_beans.

95 USDA Economic Research Service, July 21, 2005, "Vegetables and Melons Situation and Outlook Yearbook," VGS 2005, p141.

96 New Mexico National Agricultural Statistics Service, accessed online at http://www.nass.usda.gov/Statistics_by_State/New_Mexico/index.asp.

The nearest elevator that handles pinto beans for storage is located at the NAPI project near Farmington New Mexico, which is approximately 200 miles away. The NAPI project already has marketing channels established for conventionally grown pinto beans, as well as the means to store large volumes of beans. It may be advantageous for the Tribe to enter into a storage contract or marketing deal with NAPI for the storage and marketing of the proposed production of organic pinto beans. The large Hispanic populations in Southern California provide a large market for the pinto beans grown in the Southwestern region.

In this analysis, it is assumed that the Southwest regional market (Arizona and New Mexico) can accommodate a maximum five percent increase in production without measurably affecting the price of pinto beans. Given the crop yield expected on the Fort Apache Indian Reservation, this translates into a market limit of 387 acres of pinto beans.

Christmas Trees

Christmas tree plantations have developed as a result of the conservation movement in the United States, which occurred early in the twentieth century. Conservationists have long viewed the cutting of Christmas trees as one of the major, contributing factors to the degradation of U.S. national forests. The concept of growing Christmas trees as a farm crop, therefore, has originated from this historical emphasis on preserving national forests.[97]

At the present time, there are approximately one million acres of Christmas tree farms in the United States. This acreage produces a harvest of 34 million to 36 million trees every year, out of the half billion trees that are being grown on these farmlands. It takes six to ten years for a tree to develop to a marketable height (six to eight feet tall).[98]

In this analysis, census information have been reviewed to provide aggregate U.S. data about four aspects of Christmas tree farm operations and their crops: 1) the number of Christmas tree farms in operation in the U.S; 2) the number of tree acres planted; 3) the number of trees harvested; and 4) the number of trees sold in relation to farm size. The Christmas tree census category is fairly new, having been added to the federal agricultural census in 1997, when responsibility for the census shifted from the U.S. Department of Commerce to the U.S. Department of Agriculture. Presently, the U.S.

97 Washington State University, "Crop Profile for Christmas Trees in Washington," accessed online at http://www.tricity.wsu.edu/~cdaniels/profiles/chritree.pdf.

98 Ibid.

Census of Agriculture is conducted every five years. Excerpts from the 2002 U.S. Census of Agriculture reveal the following statistics:[99]

- There are 21,904 farms that have been producing conifers for the cut Christmas tree market in the United States;
- A total of 446,996 acres have been planted for Christmas tree growing and harvesting operations;
- There are 13,849 farms that have harvested cut trees;

According to the census referenced above, the state of Oregon has been the top Christmas tree producing state in the country in 2002, harvesting a total of 6.5 million trees in that year. This Oregon statistic represents more than twice the harvest level (2.9 million trees) recorded in 2002 for the second ranked Christmas tree producing state—North Carolina. In the Southwest, the state of New Mexico has harvested 2,935 trees from 22 farms in 2002. The census reports that Arizona has a total of six Christmas tree farms in operation in 2002; however, the number of trees harvested in Arizona has been kept confidential.[100]

Overseas and foreign markets for Christmas trees exported from the 48 contiguous states in the U.S. include the following: the U.S. states of Alaska and Hawaii; the Commonwealth of Puerto Rico; Japan; China; Hong Kong Special Administrative Region; Republic of Philippines; Mexico; Guam; and Samoa.[101] Recently, the South Korean market has been opened to Christmas trees growers from the United States. South Korea's population of approximately 50 million people presents an enormous and potentially lucrative opportunity for U.S. exports of fresh, natural Christmas trees.[102]

There are two main types of Christmas tree operations in the United States: wholesale and "choose and cut" (U-cut). Wholesalers are businesses that sell Christmas trees to grocery stores and tree brokers. U-cut operators sell Christmas trees directly to consumers by allowing each potential customer to traipse through the operators' fields and choose a tree for purchase; the U-cut operator will then cut the tree for the purchaser

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99 National Christmas Tree Association: Industry Statistics, Real Tree Ag Census, www.floriculture.net/statistics_industry.cfm.

100 Ibid.

101 Ibid.

102 Pokarney, Bruce, "Oregon Christmas Trees Begin Their Journey," Oregon Department of Agriculture, www.oda.state.or.us/information/news/2000/christmas_trees_2000.html.

or allow the purchaser to cut his/her own tree onsite. U-cut Christmas tree operations are located in every state, and they are often concentrated near large population centers.[103]

A consumer survey, by the National Christmas Tree Association, has been conducted to compare the sales of fresh, natural Christmas trees to that of man-made, artificial Christmas trees. The results of the survey regarding Christmas tree purchases has found that, on average, households in the U.S. account for approximately 25 million fresh, natural Christmas tree purchases each year. Table E-17 shows the annual breakdown of Christmas tree purchases for fresh, natural trees vs. sales of man-made, artificial trees.

Table E-17
Christmas Trees Purchased, in Millions of Households

Natural	27.8	22.2	23.4	27.1	25.1
Artificial	7.3	7.4	9.6	9.0	8.3

Source: Consumer Survey Results, National Christmas Tree Association, accessed online at http://www.floriculture.net/industry.cfm

The results from this consumer survey also indicate that in 2004, 81 percent of the fresh, natural trees have been purchased as pre-cut (from grocery stores or tree brokers), whereas 19 percent have been purchased as U-cut trees (from "choose and cut" operations). According to the survey, the most popular place to buy a Christmas tree in 2004 has been the Choose and Harvest Farm, accounting for 27 percent of total sales for fresh, natural trees in that year. Garden centers, chain stores, and retail lots have accounted for 19 percent, 16 percent, and 13 percent of fresh, natural tree sales respectively. Non-profit groups and other locations completed the list of purchase locations, with sales to consumers representing 8 percent and 7 percent of the market, respectively.[104]

The target market for the Christmas tree operation on the Reservation will be the Phoenix and Tucson metropolitan areas. In the Phoenix area there are eight incorporated cities with populations of 100,000 or more. These cities are as follows: Chandler, Gilbert, Glendale, Mesa, Peoria, Phoenix, Scottsdale, and Tempe.[105]

It is estimated that Christmas trees from farms in the Pacific Northwest account for 80 to 85 percent of the Christmas trees sold in Arizona each year. Interestingly, less than one

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[103] Washington State University, “Crop Profile for Christmas Trees in Washington,” accessed online at http://www.tricity.wsu.edu/~cdaniels/profiles/chritree.pdf.

[104] National Christmas Tree Association, “Consumer Survey Results,” www.floriculture.net/industry.cfm.

[105] Population Statistics, http://phoenix.about.com/cs/living/a/census01_2.htm.

half of a percent of Christmas trees sold in Arizona are actually grown in the state.[106] Tim Mitchell's Christmas Trees is a retail operation in the state of Arizona, with retail lots in the Arizona cities of Scottsdale, Mesa, and Gilbert. In 2004, all of the trees sold on these retail lots have come from Oregon or Washington State. According to sources at the company, there would be interest in buying wholesale Christmas trees from Arizona growers (such as the Reservation) for the company to sell at retail prices on their lots, provided the Arizona-grown trees are of good quality. The main reason for this interest in buying locally is that trees produced in the region (as opposed to out-of-state) would significantly reduce the company's freight costs.

In this analysis, it has been estimated that 500 acres of fir and spruce Christmas trees can be produced on the Fort Apache Indian Reservation without significantly affecting the market price; this acreage amounts to a harvest of approximately 71 acres annually (387 trees harvested per acre in year six and 775 harvested in year seven) which translates into 82,500 trees anticipated to be sold when the plantation reaches full production level. This volume translates into only 0.3 percent of the fresh, natural trees sold across the nation in 2004.[107]

The focus of the Christmas tree operation on the Reservation will be two fold. Ninety five percent of the trees, or close to 78,400 trees annually, will be produced for the wholesale market; five percent of the trees (4,150) will be destined for the U-cut operation. The Bonito Prairie site on the Reservation has adequate land to produce high quality Christmas trees, and is located a short distance from Highway 73, which is the major highway that runs through the Reservation.

The Tribe's U-cut Christmas tree operation will be geared toward the time-honored, American tradition of selecting and cutting the family Christmas tree. The staff of the U-cut location will help customers with the saw, twine, and loading aspects of the trees to prepare them for transport in the customers' vehicles. The Bonito Prairie location is approximately a three hour drive away from the Phoenix metropolitan area. This site will provide an ideal getaway for the "family adventure", providing breathtaking mountain views, opportunity for outdoor activities, and the chance for families to establish or continue the tradition of harvesting their own Christmas tree. Also, the proximity of the U-cut tree farm to the Tribe's Sunrise Ski resort will likely generate winter traffic and added customer interest. The Sunrise Ski resort has averaged 135,000 visitors annually

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106 Personal Communication Scott Raitz, Tim Mitchell's Christmas Trees, January 3, 2006.

107 National tree sales totaled 27 million in 2004, National Christmas Tree Association, Consumer Survey, http://www.christmastree.org/statistics_consumer.cfm#retail

over the past eight years.[108] This provides significant traffic through the Reservation during the winter months.

In addition to selling U-cut Christmas trees, there are many other spin off products and auxiliary industries that the Tribe will have available to them with the introduction of a Christmas tree farm. The additional merchandising opportunities that are natural accompaniments to Christmas tree production include the following wreaths, garlands, and other crafts involving evergreen tree boughs. The additional industries that are associated with Christmas tree production include the following: commercial reforestation, commercial nursery, and Christmas tree nursery stock. Further information regarding production methods and potential markets for Christmas trees is located in Appendix C.

Hybrid Poplars

The hybrid poplar is a versatile tree species that has a multitude of uses in the farming, manufacturing, and wood products industries. Traditionally, landowners and farmers have relied on hybrid poplar trees as shelterbelts for their gardens and crops, as these trees grow relatively fast. During the petroleum crisis of the 1970's, the hybrid poplar was envisioned as an energy crop but was ultimately not used for this purpose. Instead, the hybrid poplar gained popularity in the mid-1980's as a fiber crop for the pulp and paper manufacturing industries. In the early 2000's, woodchip prices hit near record lows; the hybrid poplar was again retooled for production of a variety of commodities, including those destined for the solid wood market.[109] Today, as the influences of climate change become more pronounced, the role of trees as crops has become increasingly appealing. At the same time, landowners are seeking to diversify their agricultural operations, making hybrid poplars even more attractive.[110]

The characteristics of hybrid poplars are strikingly similar to clear aspen: the wood is bright and light in terms of color, is lightweight, and has an even grain. These characteristics bode well for marketing the hybrid poplar as a light wood, but the hybrid

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108 Information obtained from Myra Wagner, Mountain Operations Manager, Sunrise Park Resort, January 17, 2006.

109 Stanton, Brian, Jake Eaton, Jon Johnson, Don Rice, Bill Schuette, and Brian Moser, June 2002, "Hybrid Poplar in the Pacific Northwest, The Effects of Market Driven Management," *Journal of Forestry*.

110 Agroforestry Unit of the Saskatchewan Forest Centre, Technical Sheet Series #2002/05, Accessed Online November 21, 2005 at http://www.saskforestcentre.ca.

poplar can also be stained or painted to compete in markets where there is demand for darker wood.[111]

Although the appearances of hybrid poplar and aspen trees are very similar, the differences in the mechanical properties of poplar trees make them less desirable for structural applications. Various studies testing different hybrid poplar clones have suggested that the species is comparable to other low- to moderate-density woods in terms of its machining, fastening, laminating, and finishing characteristics. Products that have been successfully produced and tested using hybrid poplar include the following: desks, bookcases, tongue and groove paneling, trim moldings, and thin-walled decorative boxes. The hybrid poplar is still a relatively new wood species to the market; yet, it has already begun to claim a niche within the specialty wood market as a source for edge-glued paneling that is used in the cabinetry, paneling, and door markets.[112]

In 2002, the provincial government of Saskatchewan, Canada had initiated a study to evaluate rapidly grown, short-rotation hybrid poplar as a potential, high quality fiber source to supplement the natural forest resources traditionally used in the manufacturing of laminated veneer lumber (LVL), plywood, and oriented strand board (OSB). The study findings have indicated that hybrid poplar could likely be used interchangeably with aspen or spruce in structural sheathing panels.

Plywood panels made from 100 percent hybrid poplar have testing values that are close to those of panels made with stress grade aspen or spruce. Hybrid poplar also appears to be an appropriate substitute for aspen or spruce in appearance grade plywood. The lower grades of hybrid poplar veneer would be suitable for plywood core stock. Peeling and visual grading of hybrid poplar veneer could fit in directly with the existing plywood industry, according to the results of the Canadian study. Test results also indicate that OSB panels made from 100 percent hybrid poplar (or a 50:50 mixture of hybrid poplar and commercial aspen strands) are fully equivalent to OSB made from 100 percent commercial aspen strands and meet all Canadian standards. Furthermore, the findings of the Canadian study suggest that hybrid poplar can be substituted for aspen at any substitution level—with no detrimental effect on OSB properties. Except for the hybrid poplar's higher moisture content, few difficulties are anticipated in processing hybrid poplar trees for OSB.[113]

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111 Ibid.

112 Ibid.

113 Ibid.

To summarize, hybrid poplars are fast becoming a reliable substitute for aspen, alder, pine, and spruce in many of the current markets for these four types of woods. The supply of hybrid poplars can be managed for stability and specific harvest amounts, year after year. In addition, the short rotation allows for harvests on hybrid poplar trees that are six to ten years old, compared to fifty years or more for Ponderosa pine trees. As proven in the Canadian study and through practical application, the hybrid poplar tree species is effective in a variety of applications, including, but not limited to: veneer, panels, select and common grade lumber, molding, chips, and oriented strand board.

Appendix K is a more complete market analysis for poplars, specific to the market conditions for wood products on the Reservation. Suitability of poplars on the Reservation, and specifically Bonito Prairie is located in Appendix D. Production information for the proposed hybrid poplar plantation is located in Appendix J.

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APPENDIX F

Investigating Organic Crop Potential

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FEBRUARY 2007

Appendix F - Investigation of Organic Cropping Potential on the Fort Apache Indian Reservation

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Introduction

Project:	*Investigate organic cropping potential at Fort Apache Indian Reservation*
Consultant: Travel:	Lynn Clarkson, Clarkson Grain Co., Inc.
On-site:	June 22-24, 2006 7 AM to 2 PM 6/23/2006
Question:	What would be the best production application of the White Mountain Apache tribe's farmable land?
Situation:	The Fort Apache Indian Reservation lies a few hours northeast of Phoenix. The Tribe has land, water, and human resources there that could work very well for organic farm production. ENTRIX, a consulting firm, and Bob Brauchli, water rights attorney for the tribe, arranged for me to visit the reservation, personally investigate the available resources, offer recommendations on how I would use the resources and place Apache managers in contact with individuals and/or companies with an interest in developing the organic production potential.

Recommendations:

Market driven

Organic markets currently pay over twice as much for agricultural products as conventional markets. In general, demand is growing at about 20% per year with domestic supply growing at only 6%. Since organic operating costs are about the same as conventional, the result is net returns several times higher than conventional returns. I strongly recommend that both Canyon Day and Ft. Apache lands be dedicated to organic production. Whether the production will be horticulture, row crops, hay or animals, organic production offers much higher returns than conventional agriculture. Local, regional and national organic markets want the production. The environmental mix appears suitable.

Big advantage:

Most of the Fort Apache Indian Reservation land can be instantly certified as organic under the USDA's rules since it has not been treated with petroleum based fertilizers and chemicals for at least three years. Most farmable land in the US has to go through a three year cleansing period for organic certification. The Tribe's lands (with a slight exception) already qualify.

Area available for organic production starting 2007

Canyon Day:

Roughly 1200 acres available, 800 for immediate certification and 400 for certification in three years. Depending on future water storage (long term), another 4000 to 5000 acres might become available.

Ft. Apache:

Roughly 350 acres available for immediate certification. That could be doubled should neighboring farms agree to participate.

Horticulture production:

I agree with Dr. Walser that both areas lend themselves to organic horticulture. Organic markets reward production much more highly than conventional. The land, climate and irrigation work for berries and trees. The advantage for horticulture is the economic return and, perhaps, the opportunity to employ large numbers of people. The disadvantages include the high operating costs and large infrastructure development. Dedication of 50 to 100 acres to horticulture as an initial investment seems very attractive.

Row crop production:

Since there is far more land than can be reasonably handled, at least for the present, by horticulture, I would recommend that you consider using the bulk of the land for a three crop rotation featuring:

- blue corn, hybrid
- "food grade" soybeans
- sunflowers (black oil), barley or wheat

I would estimate that the corn would provide a net return of $650/acre, soybeans $400 - 500 per acre and sunflowers about $400/acre. Barley and wheat would both sell for something

more than twice the conventional price. Both are in demand for organic dairy feed. Wheat is in demand for both organic feed and food uses. Organic feed wheat goes for about $6/bu; organic food wheat, $7.50/bu. Unfortunately, I am not familiar with regional yields and consequently cannot predict the net for either barley or wheat except to project it at over twice the net for conventional wheat. The Tribe's fields at both the Ft. Apache site and the Canyon Day site would appear to work well for this rotation.

Vegetable production:

Both farms lend themselves well to selected vegetable and perhaps herb production. Such crops are somewhat outside my area of expertise. However, profitability for vegetables could rival that of berries and fruits. Again, the operating and infrastructure costs are higher than those for row crops.

Infrastructure requirements:

Irrigation remains the key infrastructure development. Much of that seems to be in place or nearly in place. For row crops, center pivots seem to work the best. For horticulture and vegetables, drip irrigation and other alternatives also appeal. For horticulture, building may need to be constructed for cooling and packing the crop. For row crop production, storage silos may need to be built to hold the crop at harvest.

With horticulture crops such as berries and fruit trees, I suggest finding someone to work with the tribe to make the development and operate the farm.

With respect to row crops and vegetables, I recommend that the tribe either lease the land for cash or crop shares to a farming operation with the appropriate machinery and skills. If the operator is expected to make infrastructure investments, I would recommend offering a 10 year lease. If the tribe makes the infrastructure investments and leaves just the operating expenses to the operator, I would offer a three year lease.

Contract interest:

Clarkson Grain would welcome the opportunity to buy on long term contracts any row crops being raised on the farm. Since that cannot happen without successful production, I offer to contact row crop farmers potentially interested in working the land plus a few of the sophisticated vegetable operations based in California that are looking for additional

production. For row crop operators, I would work both commercial and academic research contacts with the goal of developing a model organic farm that would be turned over to the Apache's themselves to run at the end of the lease period. For vegetables, I will search for interested parties but lack the expertise to advise you on how to develop that line of production.

Organic dairy:

The demand for organic milk is soaring. Dairy production favors land between 5000 and 6000 feet elevation. Local and regional markets offer excellent consumption demand. I would recommend that the tribe consider an organic dairy herd. Once again, infrastructure and operating costs greatly exceed those for row crops but also offer attractive returns.

Farm sites visited:

Canyon Day

- Potential 6,000 acres of reservation land with more from individual Apaches
- Existing irrigation system
- Potential irrigation system
- Current and potential use
- Quick certification and organic production
- Soil Quality
- Crop Suitability

Fort Apache Farm

- 350 Acres of Reservation land with more from individual Apaches
- Existing irrigation system
- Potential irrigation system
- Current and potential use

- Quick certification and organic production
- Soil Quality
- Crop Suitability

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APPENDIX G

Organic Beef Production for the White Mountain Apache Tribe on the Fort Apache Indian Reservation

ENTRIX

FEBRUARY 2007

Appendix G - Organic Beef Production for the White Mountain Apache Tribe on the Fort Apache Indian Reservation

Draft Report

Prepared for

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Introduction

Overview

The White Mountain Apache Tribe is exploring agricultural enterprises that are suitable for the climate of the Fort Apache Indian Reservation (Reservation) and that meet the overall goals and objectives of the White Mountain Apache Tribe (Tribe). The Tribe seeks to improve the economic conditions of the Reservation through sustainable agriculture and growth of new markets.

The Reservation, home to the White Mountain Apache Tribe, is located 194 miles northeast of Phoenix in east-central Arizona. The Reservation lands comprise approximately 1.6 million acres in Navajo, Apache and Gila counties. Terrain and climate vary widely. This diversity is largely due to differences in elevations on the Reservation. These climate disparities range from mountainous, forested land at 11,000 feet to desert foothills at 3,000 feet in the Salt River Canyon area. Much of the Reservation land is currently used as rangeland.

Current Beef Production

The Tribe currently grazes cattle on their Reservation rangeland. The current number of cattle owned by the Tribe is over 1,000 head, with another 5,000-plus head of cattle owned privately by individual Tribal members. All of these cattle herds are operated through livestock associations within designated districts.

The Tribe's current beef cattle production process includes cow/calf through backgrounding operations. The Tribe or its members do not currently have a finishing operation. A brief description of each of the various stages of the beef production process (cow/calf, backgrounding, and finishing) is included below for clarification.

The cow/calf operation is the first stage of beef production and consists of breeding stock cows that produce offspring (referred to as a "calf crop") every spring. When the calves are weaned, at around eight months of age, they enter the second stage known as "backgrounding". The backgrounding stage is a management operation where recently weaned calves and yearling cattle graze on pastureland (or are fed hay in winter) for a little more than a year, after which they enter the finishing stage.

The finishing stage of the operation is the timeframe when the cattle are fed a high fiber ration of grains for a short period of time (usually three to five months) for fattening purposes. When the "finished" cattle are at their desired market weight, they are ready for slaughter.

New Opportunities

Currently, the Tribe is considering the option of cultivating organic food crops on Reservation lands; this business opportunity would, in turn, stimulate new growth opportunities in their existing cattle operation. The Reservation is an optimal location to produce organic crops, including feed crops used in organic beef production. Reservation lands have the potential to support organic production of alfalfa hay, corn for grain and silage, oats, and possibly soybeans to be used as a protein supplement. The production of these organic feed crops would enable the Tribe to provide an organic diet for their cattle that is produced almost entirely on the Reservation. This proposed organic crop production would result in a reduction of transportation costs and other marketing expenses that would otherwise be included in the price of organic feed purchased from an outside producer or supplier.

Assumptions

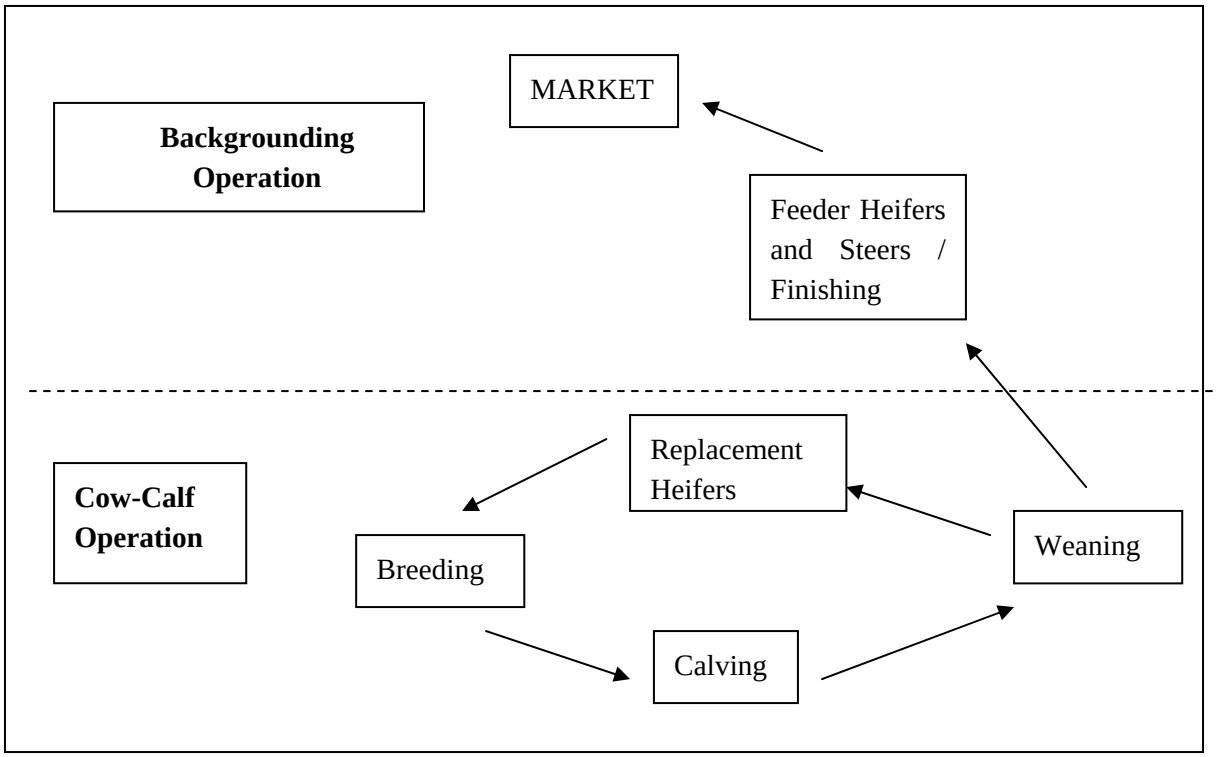
Cattle Composition

Initially, the Tribe's herd of beef cattle would presumably consist of 1,000 cows and 67 bulls. Within three years from the start of transitioning to organic beef production, however, it is assumed that the Tribe would own an organic herd comprised of 1,000 cows, 67 bulls, and 1,400 feeder heifers and steers. Overall, the cattle venture would include both a cow/calf operation and a backgrounding/finishing operation (heifers and steers) with the following annual production assumptions: an 80% calf crop; 100 replacement heifers kept each breeding season, and a 1:15 ratio of bulls to cows. This composition of livestock would translate to 800 cows with calves at calving time each year. When the calves are weaned, at about 8 months of age, an additional 700 feeder heifers and steers would enter the backgrounding stage. Heifers would be weaned at about 300 pounds and steers would be weaned at about 400 pounds.

Cattle Production Stages and Weights

The backgrounding phase, when cattle spend the majority of their time grazing on Tribal rangeland, takes about 13 to 14 months. The finishing phase, which follows the backgrounding phase, incorporates the additional feeding of corn, oats, protein supplements, and hay to cattle that also continue to graze. This stage of production takes about three to five months. At the end of the backgrounding phase, heifers weigh 700 to 750 pounds, and steers weigh between 850 and 875 pounds. For optimal results, heifers should weigh approximately 1,050 pounds (live market weight), and steers should average 1,150 pounds at market time. These operations are shown in Figure 1.

Figure 1 – Organic Beef Operation



Budgets

Costs of production for the Tribe's cow/calf operation (i.e. cow/calf budget) are based primarily on a conventional cow/calf operating budget for the Plateau Region of Arizona, which has been converted by the staff of ENTRIX to an organic cow/calf operating budget. The costs of production for the backgrounding and finishing operations for the Tribe are based on cost data from conventional budgets for the states of Tennessee and Minnesota. The data from these budgets were converted to costs for organic production, where appropriate, by ENTRIX staff, to develop an organic beef operating budget for the Tribe.

The proposed operating budgets for organic beef production on the Reservation reflect the estimated price paid for organic beef through an organic beef cooperative. This price is based on the following assumptions: 1) the product is USDA Choice Grade beef; and 2) the organic beef cooperative takes the live animal and pays on the hot/hanging carcass weight.

The U.S. Department of Agriculture grades beef based on the degree of marbling (fat vs. lean areas within the meat) and the degree of maturity of the beef carcass. As USDA Choice Grade beef is a quality grade of meat, and the organic cooperative the ENTRIX received information from purchases only Choice Grade beef, it is assumed that the Tribe's organic beef will achieve this grade. The hot/hanging carcass weight refers to the "hot" or non-chilled weight of the beef carcass in pounds (taken as a measurement shortly after slaughter.)

In this analysis, it is assumed that the organic beef cooperative will use this measurement in determining the price to pay the Tribe for its organic beef.

Given these assumptions and the related analysis, it is estimated that within two to three years from its inception, the Tribe's entire beef operation—from calf to market—could be completely organic. The Tribe will need to acquire USDA organic certification during this timeframe, but because the Reservation is in a secluded area, with less likelihood of neighboring chemical use on the land, and the Tribe has been raising beef on its Reservation for an extended time, the transition to organic ranching is expected to be uncomplicated.

Production Process

Organic Production Requirements

According to information from the Sustainable Agricultural Research and Education Institute (SARE), there are explicit, national organic standards that must be met in order for a herd of beef cattle to be certified organic. These standards apply to animals raised for meat, milk, eggs, and other animal products. In general, the standards state that only all-natural substances are allowed in organic production. The standards for cattle certified as organic include the following stipulations:

1. Beef animals raised for slaughter must be managed under organic practices from the last third of gestation;
2. Feed products for the beef must be 100 percent organic, but certain vitamin and mineral supplements are allowed;
3. No hormones for growth promotion or antibiotics for any reason are to be given to any organic beef animal, but preventative management, including vaccines, will be used to keep animals healthy;
4. Treatment of sick or injured animals cannot be withheld, but animals treated with medication cannot be sold as organic; and
5. All organic beef must have regular access to pasture throughout the production process.[1]

[1] SARE 2003.

Cow/Calf Operation

The cow/calf phase of the organic beef operation is a continuous process, from one breeding season to the next. Cows are bred in June, and they calve the following March. Then the calves are weaned around late October, at about eight months of age, at which time they enter the backgrounding phase of the operation.

Backgrounding and Finishing Operations

The backgrounding stage of cattle production on the Reservation is characterized by a "preconditioning" of cattle between the weaning stage and the subsequent finishing phase. The backgrounding phase begins when the calves are weaned from the cows, at about eight months of age, typically around the end of October, and continues for 13 to 14 months, through the end of the following November. This is essentially the first phase of the feeder program, when the cattle spend most of their time grazing on Tribal rangelands, although cattle are provided hay supplementation in the winter.

After the backgrounding phase concludes (usually around December), the cattle enter the finishing phase. During this phase, the cattle may spend part of the time in the feed lot (dry-lotted), as long as they have some regular access to pasture. On average, the finishing phase of the Tribe's beef cattle operation is expected to take three to five months. Therefore, it is estimated that the cattle are ready for slaughter by at least April of the following year.

On average, the backgrounding and finishing phases of cattle production are estimated to occur over a period of 16 to 19 months. The backgrounding and finishing phases are a continual process on the Reservation, with weanlings (recently weaned calves) entering the backgrounding phase, yearling cattle remaining in the backgrounding phase, and older steers and heifers completing the backgrounding phase and moving into the finishing phase of the production operation.

Crop Production Relationship

The organic beef operation will be most successful if the Tribe’s organic crop production is also successful. The relatively low cost of organic feed inputs to the beef operation, when the organic feed crops are produced on the Reservation, enables the Tribe to “purchase” the feed at cost. This action results in lower total costs and higher associated returns for both the beef cattle production and the Tribal operations as a whole. As stated previously, the organic crops proposed for supporting the beef cattle operation on the Reservation are as follows: alfalfa hay, grain corn, corn silage, oats, and potentially soybeans (used as a protein

supplement). The proposed organic beef operation would require the feed crops in the amounts and associated acreage shown in Table 1.

Table 1
Organic Feed Crop Requirements

Proposed Crop	Unit of Measurement	Feed Requirement	Acreage Requirement
Organic Alfalfa Hay	Tons	527	148
Organic Grain Corn	Thousand Bushels	24.2	176
Organic Corn Silage	Tons	1,678	84
Organic Oats	Thousand Bushels	17.5	175
Organic Soybeans	Thousand Bushels	TBD*	TBD*
Total Crop Acreage			583

*To be determined.

The feed requirement for organic soybeans is unclear at this time, pending the determination of the amount of protein supplementation (if any) required in the grain mixture for the beef cattle operation. If the Tribe begins producing a soybean crop, however, the organic soybean harvest could be used as an input at cost.

By "purchasing" organic soybean feed at cost, the Tribe would no longer be required to purchase this protein supplement from an outside organic producer or supplier. Therefore, operating costs for beef cattle production on the Reservation could potentially decline from estimates developed in the current analysis. In turn, this action will generate associated higher returns for the Tribe's organic beef operation.

Marketing

There are several marketing methods available for marketing organic beef to customers. The two most commonly used marketing methods—organic beef cooperatives and direct marketing—are addressed in this section. All costs and associated returns included in the proposed cow/calf and backgrounding/finishing budgets for the Tribe are based on the assumption that the Tribe markets the organic beef as a member of an organic beef cooperative.

The Tribe as Cooperative Members

Agricultural cooperatives are formed by farmers or ranchers to achieve some or all of the advantages of large-scale marketing. Marketing costs are minimized if the Tribe becomes a member of an organic beef cooperative, which is one of the most common methods of marketing organic foods. Under this method, marketing costs would primarily consist of transportation costs related to hauling the organic beef cattle from the feedlot to slaughtering facilities. If the Tribe does not become a cooperative member, marketing costs would need to be incorporated into both budgets.

Direct Marketing Channels

Direct marketing is an alternate marketing method for organic producers who do not join cooperatives. The Tribe could select from one of the following direct marketing channels (or even a combination thereof) to market their organic beef to customers:

1. Promote and sell organic beef directly to wholesalers at the farm gate (in this case, the Reservation);
2. Set up a web site on the Internet for online product promotion and sales of organic beef; and/or
3. Promote and sell organic beef directly to local retailers at the farm gate (in this case, the Reservation).

The first direct marketing option involves the Tribe selling organic beef to general line grocery wholesalers or general line foodservice wholesalers, or both. General line grocery wholesalers buy products from the producer, and take title to the product (which they handle). General line foodservice wholesalers serve restaurants, hospitals, schools, and hotels; these types of wholesalers handle products specifically for foodservice use.

The second direct marketing option (Internet sales) would require a significant investment in technology and fulfillment resources before any online sales could occur. Presently, the Tribe does not have this type of business venture in place.

The third direct marketing option can be advantageous as many retailers are now stocking organic foods in their grocery stores due to increased consumer demand. Potential retail customers for the Tribe could include national and regional retailers of organic beef, such as Safeway® Inc., Costco Wholesale Corp., Whole Foods Market®, Wild Oats Natural Marketplace, and Fred Meyer (a division of Kroger Co.), as well as many local retail markets.

Returns

Costs of Production

The costs of production for the proposed organic beef operation on the Reservation are divided into two categories: the cow/calf operating costs and the feeder operating costs. Production costs for the feeder operation include costs associated with the backgrounding and finishing phases of beef cattle production.

The costs of production for the cow/calf part of the proposed beef cattle business are shown in Table 2 below, while the costs of production for the Feeder portion of the business are shown in Table 3. For accounting purposes, the costs to "purchase" the feeder steers and heifers are estimated as the cost per head of cattle for the cow/calf operation. This vertical integration of operations lowers the costs of production for the entire process.

Table 2
Organic Cow/Calf Production Costs

Organic Feed Costs	Units Of Measure	Quantity	Price Per Unit	Price Per Cow	Number Of Head	Total Cost
Organic Alfalfa Hay	Tons	113	$116.44	$13.10	1000	$13,100
Pasture	AUY*	100%	$-	$-	1000	$-
Salt and Minerals	Tons	28	$266.98	$7.34	1000	$7,342
Organic Protein Supplement	Tons	75	$304.01	$22.80	1000	$22,801
Total Feed Costs						**$43,242**
Veterinary and Medicine		1	$15,000	$15.00	1000	$15,000
Marketing and Transportation		1	$2,764	$2.76	1000	$2,764
Hired Labor		1	$26,532	$26.53	1000	$26,532
Operating Costs, Equipment		1	$2,764	$2.76	1000	$2,764
Operating Costs, Machinery		1	$995	$0.99	1000	$995
Operating Costs, Vehicles		1	$5,085	$5.09	1000	$5,085
Ranch Maintenance		1	$1,327	$1.33	1000	$1,327
Miscellaneous		1	$5,528	$5.53	1000	$5,528
Interest on Operating Capital	Percent	7.65%	$6,895	$6.90	1000	$6,895
Total Other Variable Costs						**$66,889**
Taxes and Insurance			$61,911	$61.91	1000	$61,911
Overhead			$11,055	$11.06	1000	$11,055
Purchased Livestock			$27,638	$27.64	1000	$27,638
Interest on Investment (Retained Livestock)			$55,275	$55.28	1000	$55,275
Fences			$10,931	$10.93	1000	$10,931
Buildings			$5,466	$5.47	1000	$5,466
Management and Operation Labor	Percent	6.5%	$19,670	$19.67	1000	$19,670
Total Ownership and Other Fixed Costs						**$191,946**
TOTAL COSTS				**$302**		**$302,078**

*AUY is Animal Unit per Year, defined by USDA as “the feeding or grazing requirements for one year of a mature cow weighing 1000 pounds and a calf up to weaning (approximately age 6 months) or the equivalent”

Table 3
Organic Feeder Cattle Production Costs

Organic Feeder Costs	Units Of Measure	Quantity	Weight	Price Per Head	Number Of Head	Total Cost
Steer Calves	cwt	400	5	$440	400	$176,000
Heifers Calves	cwt	300	4.75	$380	300	$114,000
Total Cost of Calves						**$290,000**
		Quantity	**Price per Unit**	**Price per Head**	**Number of Head**	
Organic Alfalfa Hay	Tons	0.59	$116.44	$68.87	700	$48,212
Pasture	AUY*	0.00	$-	$-	700	$-
Salt and Mineral	Tons	0.02	$266.98	$5.47	700	$3,828
Organic Corn	Bushels	34.55	$3.32	$114.72	700	$80,303
Organic Corn Silage	Tons	2.40	$26.72	$64.06	700	$44,840
Organic Oats	Bushels	25.00	$3.19	$79.75	700	$55,826
Organic Protein Supplement	Tons	0.25	$304.01	$77.07	700	$53,947
Total Feed Costs						**$286,955**
Veterinary and Medicine		1	$14,099	$20.00	700	$14,099
Marketing and Transportation		1	$-	$32.00	700	$22,716
Hired Labor		1	$-	$28.00	700	$19,582
Maintenance, Repair, and Fuel		1	$-	$11.00	700	$7,833
Interest on Feed and Other Costs	Percent	7.65%	$9,387	$13.00	700	$9,387
Beef Checkoff**		1	$-	$1.00	700	$700
Total Other Variable Costs						**$74,317**
Taxes and Insurance				$10.07	700	$7,050
Overhead, Including Facilities and Utilities				$44.76	700	$31,332
Organic Certification Fee			$3,862	$5.52	700	$3,862
Management and Operation Labor	Percent	6.5%	$61,727	$88.18	700	$61,727
Total Ownership and Other Fixed Costs						**$103,970**
TOTAL COSTS				**$1,079**		**$755,242**

*AUY is Animal Unit per Year, defined by USDA as "the feeding or grazing requirements for one year of a mature cow weighing 1000 pounds and a calf up to weaning (approximately age 6 months) or the equivalent"

** Beef checkoff is mandatory and assesses $1 per head on the sale of live domestic and imported cattle, in addition to a comparable assessment on imported beef and beef products. The checkoff is collected by qualified state beef councils, which retain up to 50 cents on the dollar. The state councils forward the other 50 cents per head to the Cattlemen's Beef Promotion and Research Board, which oversees the national checkoff program, subject to USDA review. The 108 members of the Cattlemen's Beef Board represent all segments of the beef industry, including beef, veal and dairy producers and importers, and are nominated by industry organizations and importers and appointed by the U.S. Secretary of Agriculture.

Returns to the Operation

While the cost of inputs to produce organic beef is higher than that of conventional beef production, so are the returns. Irrelevant of the type of marketing deemed appropriate by the Tribe, the returns to the producer of organic beef products (in this case, the Tribe) can be expected to be significantly higher than the returns to conventional beef producers. This is due to a nationwide, increased demand for organic products, which results in retailers charging price premiums for organic products. As with the costs of production, a return to the operation will be calculated, and a comprehensive enterprise budget will be completed, if the Tribe decides to transition their existing beef operation on the Reservation to one that is entirely certified organic.

Cow/Calf Returns

As stated previously, the returns to the Tribe's cow/calf operation are essentially equivalent to the costs "to purchase" the feeder steers and heifers (that have moved forward to the backgrounding and finishing phases and are therefore listed in the feeder budget). Additionally the budget includes the annual sale of 93 cull cows (those being replaced by heifers) and 3 cull bulls (those being replaced by younger bulls). The prices for these cull animals are assumed to be slightly more than half the price of their younger counterparts (heifers for cows and steers for bulls).

Backgrounding and Finishing Returns

Returns to the backgrounding and finishing operation are based on the prices paid by an organic cooperative in July 2005.[2] The quoted price in July 2005 was two dollars per pound,

[2] Moody 2005b.

paid on hot carcass weight for USDA Choice Grade beef. With steers weighing 1150 pounds and heifers weighing 1050 pounds at slaughter, and assuming a 62.2 percent adjustment to hot carcass weight, each steer would return $1,431, and each heifer would return $1,306 to the operation. These figures, when combined with the returns to cull cows, cull bulls, and the feeder cattle (see Table 3), result in an average return of $241 per head or $329 per acre of organic feed produced. These net return results for the Tribe's proposed organic beef operation are shown in Table 4.

Table 4
Net Returns to Organic Beef Operations

Revenues	Quantity	Finish Weight (Lbs)	Hot Carcass Weight* (Lbs)	Price Paid By Co-Op	Average Price Per Head	Total Receipts
Finished Steers	400	1150	715.3	$2.00	$1,431	$572,240
Finished Heifers	300	1050	653.1	$2.00	$1,306	$391,860
Subtotal	700				$1,377	$964,100
Less Death Losses	1.50%				$21	$14,462
Total Receipts					$1,357	$949,638
Total Costs (from Table 3)					$1,079	$755,242
Net Revenues					$278	$194,396
Cow/Calf Returns Above Cost						$537
Total Beef Returns					$241	$194,933
Acres in Organic Crops						583
Return to Acreage						$334

*Hot carcass weight is the "hot" or non-chilled weight in pounds (taken as a measurement shortly after slaughter). The hot carcass weight is assumed to be 62.2 percent of the finished weight.

Conclusion

The combination of available resources on the Reservation, such as the land for grazing, land for crop production, and water supply for growing input crops, create an ideal situation for an organic beef operation. In addition, Tribal members have expertise in raising cattle and there is existing stock currently grazing on the Reservation that could be transitioned to a certified organic herd.

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