Cultivated Crop Production between Alley Cropping Tree Rows in the Great Plains

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Introduction

Agroforestry, the practice of growing trees with agronomic/horticultural crops or pastures and livestock, is emerging rapidly in the temperate zone (Garrett et al. 1994). In the Central Great Plains of the United States, agroforestry has various connotations to rural landowners that include living snowfences; field, farmstead, and livestock windbreaks; filter/buffer strips in riparian areas; alley cropping; wildlife habitat; and woodlots or fuelwood plantations.

Alley cropping with long-term tree crops and agricultural crops planted between trees can provide annual income, while developing a woodlot. Fine hardwoods like oak (Quercus sp.), ash (Faxinus sp.) , and walnut (Juglans sp.) are favored species. Kansas is not heavily wooded but supplies a large amount of high quality hardwoods. Markets for walnut are established, and additional sources are highly desirable.

The black walnut multicropping concept has been tested in Missouri with many agronomic plant species as intercrops and found to be an economically viable land-use alternative (Campbell et al. 1989, Garrett and Kurtz 1983, Kurtz et al. 1984, Garrett et al 1986). The highest returns were associated with more intensive agricultural management regimes (Garrett and Kurtz 1983). Possible intercrops are limited only by the imagination; row crops, Christmas trees, and specialty crops such as melons and clover are all feasible.

Walnut nut production is an important component of this system. Yields from open-grown trees estimated for agroforestry management indicate the importance of growing select trees. Because of between-tree and yearly production variability, using trees with known regular bearing characteristics is highly important (Garrett and Kurtz 1987).

Plastic mulches and drip irrigation have been shown to be beneficial for selected vegetable crops (Bonanno and Lamont 1987; and Schales and Sheldrake 1965). Muskmelons and Scotch pine grown together using black plastic mulch and irrigation have been shown to be compatible (Lamont et al. 1993). Benefit-cost index ratios of relay-intercropped muskmelons were high. The combination provided a significant annual cash flow.

The objective of this effort was to evaluate the costs and benefits from converting a small area into a fine hardwood woodlot using the agroforestry alley cropping technique to provide annual income increments for a 15-year period, followed later by tree sales. Third-year growing season results are presented for some crop comparisons. Both yield and gross cash returns are included.

Methods and Materials

Ten rows of 1:0 seedling trees were established in 300-ft-long rows spaced 40 feet apart with black walnut and Scotch pine trees hand planted alternately 8 ft apart for a total of 380 trees (Figure). Forage (smooth bromegrass); grain (soybeans [Makin variety]), and vegetable (tomatoes [variety Mountain Pride], western shipping type muskmelon [Magnum 45], and decorative pumpkins) crops were planted in the alleys. Black plastic mulch and drip irrigation were utilized with the vegetable crops. Three replicated plantings of smooth bromegrass and soybeans were made in the following fall and spring. A randomized complete block planting design was used for the planting sequences. The soybean and vegetable crops were grown for two consecutive years on the same land and positions were then exchanged in the 3rd year. Two-year rotation cycles are followed. Muskmelons were harvested three times per week, and number, quality, and total weight of the marketable fruit were recorded. Tomatoes were harvested once a week, and total weights of marketable fruit were recorded. A once-over harvest of pumpkins was done, and number and weights were recorded. Survival and total height of the trees were taken at the end of the third growing seasons.

Financial costs and returns were evaluated after three growing seasons for cultivated crops (expected duration of 15 years); Christmas tree products begin at years 5 through 12 from Scotch pine (now being shaped); firewood products after 20 years; walnut nut crop production at 10 to 50 years; and fine hardwood logs at 50 years.

Actual crop rotation schemes will be determined and employed for at least 15 years of cropping.

Results and Discussion

Vegetable crops

A tree row spacing of 40 ft required 6-ft weed barrier rows, thus leaving 30+ ft (75% of available land for site preparation and vegetable crop growing) for alternative crop production. Of this, only 25 ft (60% of the available land) was actually planted to vegetables -- five, raised, black plastic-covered beds (5 ft apart) with drip irrigation were used in this study.

Summer fruit yields (Table 2) from the commercial tomatoes, western-shipping type muskmelons, and pumpkins varied by season (1994, 1995, 1996). Gross returns for wholesale and retail, respectively, are based upon $0.20 and $1.00 /lb for tomatoes, $0.40 and $1.00 /melon for muskmelons, $0.25 and $1.25 for each Munchins pumpkin, and $0.10 and $0.25 /lb for large Jackpot pumpkins. The returns for both muskmelons and large pumpkins were similar, and those for tomatoes were more than double. Cash values are per acre rates; they do not reflect the land used for tree production and are excluded in Table 1. Including land for trees and crops together give combined wholesale annual values of $4,601, $1,846, and $3,674 /acre, respectively for tomatoes, melons, and pumpkins. Net returns for the vegetable crops are about 50% of the gross income.

Agronomic crops

Soybeans were planted in 1995 and 1996, and average yield of the first two soybean harvest provided a gross return of $326 using an average price of $7.00 /bushel. Every acre planted to trees and soybeans provided an income of $245. Because these beans are for seed stock they will sell at $20/ bu, or a retail value of $1,007/acre rate. This level of income will continue each year until tree growth restricts productivity. Side branches may overhang the soybean plants and hinder mechanized crop planting and harvest operations and need to be trimmed. A traditional tree planting would have no income for up to 10 years. Net returns reflecting production costs have not been determined yet.

Forage crops

Smooth bromegrass was planted at recommended rates in the fall of 1994, and the first two harvests were made in mid-June of 1995 and 1996. Average yield of the replicated plots was 4,410 lb/acre (2.2 tons). Using an average price of $ 65/ton, the gross income from the harvested acres was $143/acre. Thus, every acre planted to trees and bromegrass strips provided a gross return of $107. This level of income will continue for each year until tree growth restricts the productivity of the smooth bromegrass. Production costs have not been determined yet. Three additional plots with Kentucky 31 fescue are included and show similar yields as the bromegrass. Both need supplemental fertilization.

Comparisons

Comparisons can be made among the various agronomic/vegetable crops with interspersed tree rows and trees planted at an 8x10 ft spacing. Costs per acre to establish only trees are estimated at $700/acre, whereas those for the interspersed tree rows are about $125/acre (including cropped acres). Gross wholesale annual income for the first through third year with the cropping options are shown in the Table. For the combination of a row of trees every 40 ft and a cultivated crop in the alleys, annual gross wholesale incomes were of $2,500 to 6,100/acre, (or gross retail income of $6,100 to 30,700/acre), for the vegetable crops, $110/acre the bromegrass , and $245/a for the beans. However, the high gross income from the vegetable crops was the result of intensive cultural practices requiring a high labor input.

Summary and Conclusions

Early income typically is lacking in woodlot establishment. The agroforestry alley cropping technique is one way to provide annual income to offset forest establishment costs. Annual crops (agronomic/horticultural) grown in the alleys and short-term woody plant (tree) crops grown between rows of high quality hardwood species such as black walnut or green ash will supply financial returns for the early years of the life span of the woodlot. Protection of plants in the alleys between the tree rows reduces wind speed and modifies microclimate in sheltered areas is well documented (Brandle et al.).

Clearly, if agroforestry alley cropping can be demonstrated to provide an economic benefit, tree planting could be of great importance to the farming/ranching community as it strives to diversify by including alternative crops.

References

Brandle, JR, L Hodges and J Stuthman (1995) Windbreaks and speciality crops for greater profits . Agroforestry and Sustainable Systems: Symposium Proc. USDA For. Ser. Gen. Tech. Rep. RM-GTR-261.

Bonanno AR and Lamont WJ (1987) Effect of polyethylene mulches, irrigation method, and row covers on soil and air temperature and yield of muskmelon. J. Amer. Soc. Hort. Sci. 112:735-738.

Campbell GE, Lottes GL and Dawson JO. (1989) An analysis of agroforestry systems in Illinois. For. Res. Rep. No. 89-2 Il Agr. Expt. Sta. 35p.

Garrett HE and WB Kurtz WB (1983) Silvicultural and economic relationships of integrated forestry-farming with black walnut. Agrofor. Systs. 1:245-256.

Garrett HE and Kurtz WB (1987) Nut production and its importance in black walnut management. 78 Ann. Rep. NNGA. pp 23-28.

Garrett HE, Kurtz WB, and Slusher JP (1986) Walnut trees and crops: profitable diversification. Adapt 100: 102-103.

Garrett HE, Buck LE, Gold MA, Hardesty LH, Kurtz WB, Lassoie JP, Pearson HA, Slusher JP (1994) Agroforestry: An integrated land-use management system for production and farm conservation. Resource Conservation Act Appraisal Document. SCS, Washington D.C. 58p.

Kurtz WB, Garrett HE and Kincaid WH, Jr.(1984) Investment alternatives for black walnut plantation management. J.For. 82 (10):604-608.

Lamont WJ, Hensley DL, Weist S., and Gaussoin RE (1993) Relay-intercropping muskmelons with Scotch pine Christmas trees using plastic mulch and drip irrigation. Hort. Sci. 28(3): 177-178.

Schales FD and Sheldrake R (1965) Mulch effects on soil conditions and muskmelon response. Proc. Amer.Soc. Hort. Sci. 88:425-480.

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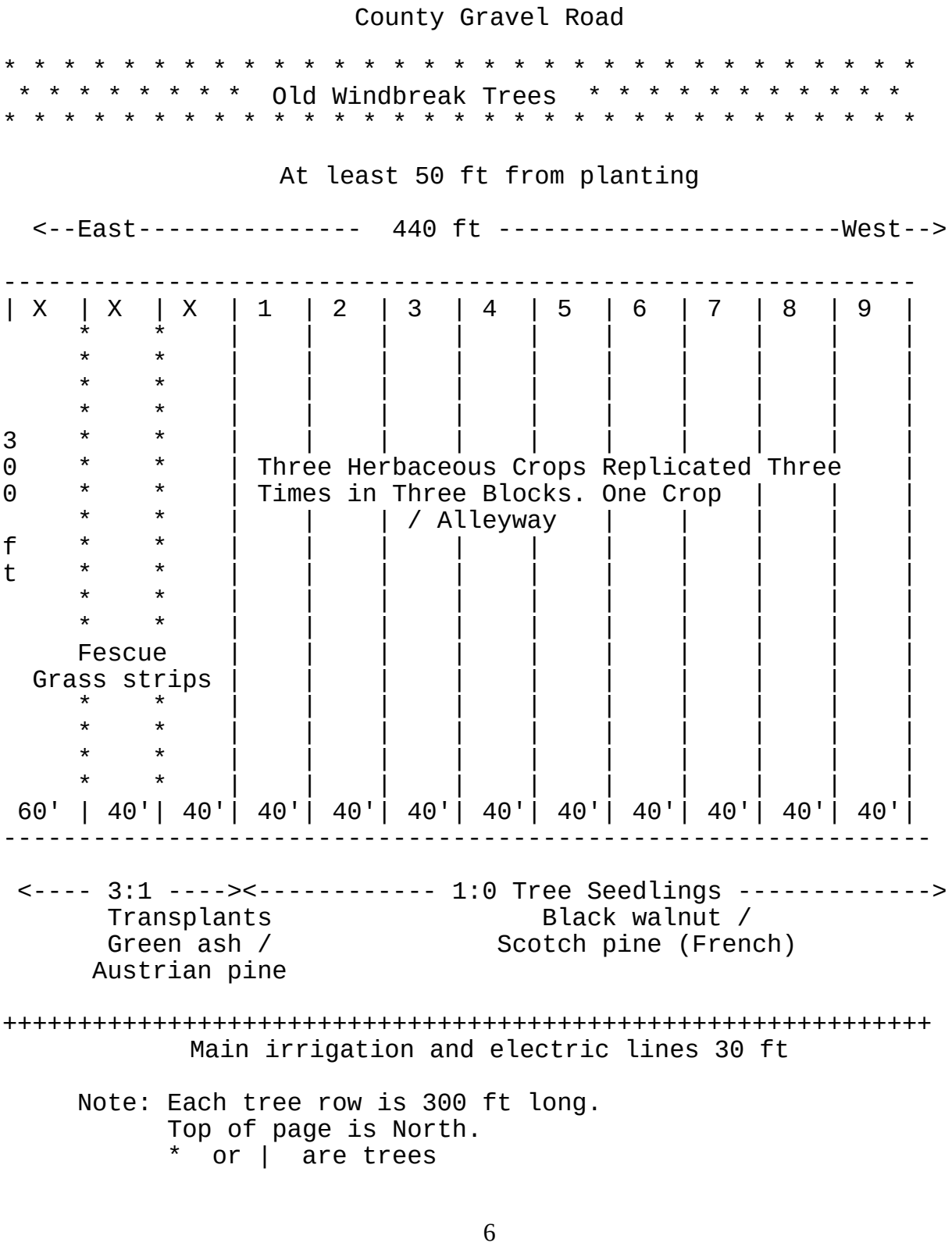
Table . Three-year crop yields and gross returns from agroforestry alley cropping study.

Horticulture Crop (number)	Yield (lbs)	Wholesale ($)	Retail ($)
(Per acre rates)			
Tomatoes (3 yrs) --	30,695	6,135	30,675
Melons (3 yrs) 6,155	24,845	2,462	6,155
Pumpkins			
Munchins (1 yr) 8,107	3,949	2,027	10,134
Jackpot (3 Yrs) 2,352	28,771	2,877	7,193
Agronomic/Forage Crops	**Yield (lbs.) (bu)**	**Wholesale ($)**	**Retail ($)**
Soybeans (2 yrs) 2,976	50.3	327	1,007
Bromegrass (3 yrs) 4,410	--	143	--
Fescue 31 (1 yr) 4,017	--	131	--

Note: Area in tree rows (25%) is not included in these per acre rate evaluations, and cost for tree establishment is excluded. Thus all values should be reduced by 25% to reflect land used for the trees in this system. Horticultural costs are about 50% of the gross returns.

Figure. Planting design for agroforestry alley cropping study.



Note: Each tree row is 300 ft long.
Top of page is North.
* or | are trees