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Wayne A. Geyer

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Keeping Up With Research 139

WALNUT and SCOTCH PINE TREES GROWN with FARM CROPS

Wayne A. Geyer

Growing valuable hardwood trees with cash crops could be a profitable long-term alternative to conventional agriculture and forestry practices. Rows or groups of trees can be interspersed within or between horticultural, forage, or grain crops (Figure 1). When grown in widely spaced tree rows, this type of arrangement is termed "alley cropping". It has had success in many parts of the world and is being tested in the mid-western area of the United States. Annual crops can benefit from reduced wind, reduced soil erosion, and improved nutrient cycling from subsoil back to the surface.

Alley cropping is an intensive land-management program that optimizes the benefits from the biophysical interactions that are created when trees and/or shrubs are deliberately combined with crops. It may provide an opportunity for the family farm to produce immediate monetary return from annual crops, intermediate funds from nuts crops, and a long-term veneer-log harvest, converting a small patch of good farm land into a high-value woodlot.

Studies were undertaken in the Manhattan/Junction City vicinity to evaluate the feasibility of alley cropping with black walnut (Juglans nigra L.), interspersed with Scotch pine (Pinus sylvestris L.), in rows between agriculture crops as a means of establishing small woodlots while providing an early cash-crop return.

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Grain crops. Soybeans were planted in 1995, 1996, and 1997, and average yield of the first three soybean harvests was 37.7 bu. At a 10-year average price of $5.72/bu, the gross annual return for soybeans was $155/a. Grain sorghum was planted later in the crop rotation, with an average yield of 46.4 bu/a for a two-year production period. Calculated from a 10-year price average of $2.09/bushel, sorghum gross return was $96/a. Production costs of soybeans have been estimated (K-State Research and Extension) at about 90% of gross returns, depending on commodity prices for the year. In comparison, wheat was estimated to yield 37.5 bu/a and $116/a gross return.

This income should continue each year until tree growth restricts productivity. Side branches may overhang plants, hindering mechanized crop planting and harvest operations, and would need to be trimmed. Cropping may continue for 15 years. Traditional walnut tree plantings would have little to no income for as much as 10 years.

Comparisons. Tree establishment costs were not determined, but costs for operational systems were obtained from published literature (Campbell et al., 1989; Garret and Kurtz, 1987). Estimated cost of management activities for site preparation, groundcover, planting stock, tree planting, and weed control, both before and after tree establishment, is about $700/acre, if the area is planted only to trees at typical hardwood stocking densities in the Central States. With the proposed alley-cropping plan, about 25% of the area is planted with the trees, at a cost of about $125/a (including cropped acres).

Net wholesale annual incomes with the cropping options are shown in Table 2. For the combination of a row of trees every 40 ft and a cultivated crop in the alleys, annual net wholesale incomes were $1,295 to $2,530/a for the vegetable crops, $25/a for the bromegrass, $45/a for fescue grass, $15/a for soybeans, and $10/a for sorghum. The net wholesale income from the vegetable crops was the result of intensive cultural practices that required much more labor input. Mean production costs, as estimated by university agriculture extension professionals, are more than 90% for the grain crops, 35 to 80% for the grasses, and about 40% for vegetable crops.

Conclusions

Typically, early income is lacking in woodlot establishment. The agroforestry alley-cropping technique may be one way to provide annual income to offset forest establishment costs. Annual crops (agricultural/horticultural) grown in the alleys and short-term woody-plant (Christmas trees) crops grown between rows of high quality hardwood species, such as black walnut or green ash, could supply financial returns for the early years of the woodlot.

Clearly, if agroforestry alley cropping can be shown to provide an economic benefit, tree planting could be of great importance to the farming/ranching community striving to diversify by growing alternative crops.

Literature cited

Campbell, G.E., G.L. Lottes, and J.O. Dawson. (1989) An analysis of agroforestry systems in Illinois. Forestry Research Report No. 89-2, Illinois Agricultural Experiment Station, 35p.

Garret, H.E., and W.B. Kurtz (1987) Nut production and its importance in black walnut management. Annual Report, Northern Nut Growers Assocation, pp 23-28.

About the author

Wayne A. Geyer, Professor, Horticulture, Forestry and Recreation Resources, Kansas State University. (E-mail: wgeyer@oznet.ksu.edu)

Recommended publications

Additional information may be found in Kansas Forest Service publications Chemical Weed Control in Tree Plantings, MF-656; Tree Planting Guide, L-596; Conservation Tree Planting Schedule, L-871, available through a local K-State Research and Extension office or on the Web at http://www.oznet.ksu.edu.

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SRL 139 **May 2004**

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Figure 1. Schematic of alley cropping.

Procedures

An alley cropping arrangement was planted in 1994, alternating single rows of tree species with agricultural cash crops. Ten rows of 1:0 seedlings of black walnut and Scotch pine were planted alternately 8 ft apart in 40-ft rows, for a total of 380 trees. A randomized complete block field design was used. Weed control was with herbicides or one of two types of plastic weed barrier. Field measurements included survival, total height, diameter, stem form, and crown shape.

The crops planted in the alleys were forages (smooth bromegrass - *Bromus inermis* Leyss.); grains (soybean - *Glycine max* (L.) Merr. 'Makin'); milo - *Sorghum bicolor* L.); or vegetables (tomatoes - *Lycopersicon esculentum* Mill. 'Mountain Pride'; western shipping type muskmelon - *Curcurbita pepo* L. 'Magnum 45'; large and decorative pumpkins; and sweet corn - *Zea mays* L.). Black woven fiber plastic mulch and drip irrigation were used with the vegetable crops in three replicated plantings. Smooth bromegrass and soybean plantings were made the following fall and spring in six additional plots. The soybean and vegetable crops were grown on the same land for two consecutive years, then their positions were exchanged in the third year. Two-year rotation cycles were followed. Muskmelons were harvested three times a 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. At fall har-vest, the number and weights of pumpkins were recorded. During the fourth planting season (1997), three types of sweet corn each were planted in two full-length plot rows. In succeeding years, milo was planted in the agricultural plots. Tall fescue was grown in the borders.

Financial costs and returns (1997) were evaluated after seven growing seasons for cultivated crops (expected duration of 15 years) according to K-State Research and Extension Farm and Horticultural Management Guide sheets. All analyses include rent for farmland. Returns from Christmas tree products begin at years 8 through 12 from Scotch pine, from firewood products after 20 years, from walnut nut-crop production at 10 to 50 years, and from fine hardwood logs at 50 years.

Results and Discussion

Tree crops. Seventh-year survival of the trees did not differ among weed-control methods. Most tree mortality occurs during the first season of growth. Overall survival of the walnut was more than 98%. Mean height of the walnut trees was13.5 ft. (Table 1). At three years, total height of the trees in the herbicide treated plots was only 63% that of the fabric-mulched plots, but at seven years the height of the herbicide treated plots improved to 83% that of the fabric-mulched plots. Diameter growth for trees treated with herbicides was 73% of that for trees in fabric-mulched plots. A few walnut trees bore nuts at five years. Overall survival of pines was 97.4%. Mean height of pines was 3.97 ft, with no difference between treatments. Trees can begin to be harvested for Christmas tree use when they are at least six ft tall.

Table 1. Seventh-year growth of black walnut and pine in an alley-cropping configuration.

	Walnut	Pine
Survival	98.5%	97.4%
Height	13.5 ft	3.97 ft
Diameter	2.29 in	

Stem form (lower 10 ft of the bole) of the walnut at this early age included many poorly shaped boles. The number of straight boles was about 25% (Figure 2), less than expected. The trees were spaced at 8 by 40 ft. apart, thus they are more susceptible to wind damage. Herbicides were not as effective as expected, possibly because they were applied late and weather was dry, resulting in weed competition and reduced growth.

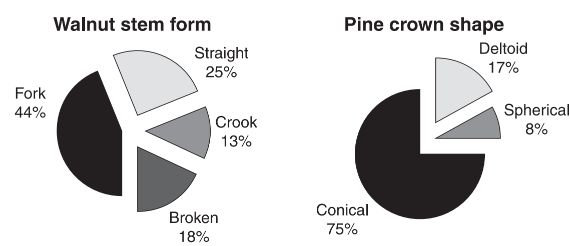

Figure 2. Stem form of walnut and crown form of pine trees.

Crown shape of the pine was excellent; 75% of the trees had a conical shape, but some were of poor form, even after three years of shearing (Figure 2).

Vegetable crops. A tree row spacing of 40 ft with 6-ft weed-barrier rows left about 34 ft (75% of available land) for alternative crop production. Five raised, black-plastic-covered beds (5 ft apart) with drip irrigation were used in this study. Summer fruit yields (Table 2) differed by year for the commercial tomatoes, western-shipping type muskmelons, and pumpkins (1994, 1995, 1996). Gross annual returns for wholesale and retail sales, respectively, were based on prices of \$0.20 and \$1.00/lb for tomatoes, \$0.40 and \$1.00 each for muskmelons, \$0.25 and \$1.25 each for Munchins pumpkin, \$0.10 and \$0.25/lb for large Jackpot pumpkins, and \$1.75 and \$3.00 per dozen for sweet corn. The return for muskmelons was half that of tomatoes and pumpkins. Cash values are per-acre rates (Table 2) that include the land used for tree production (25%). Costs for the vegetable crops are estimated to be about 40% of the gross income, according to K-State Research and Extension publications.

Table 2. Annual crop yields and returns from agroforestry alley-cropping study.

Crop Type	Yield		Wholesale	Net Return
			---------- $/per acre	----------
Horticultural	(lbs/acre)			
Tomatoes (3 yrs)	23,021		4,601	2,530
Melons (3 yrs)	18,634		1,845	1,295
Pumpkins (3 yrs)	24,540		3,975	2,185
Sweet corn (1 yr)	6,641		1,448	795
Grain		(bu)		
Soybeans (3 yrs)	2,239	(37.7)	155	15
Grain sorghum (2 yrs)	2,598	(46.4)	96	10
Wheat (estimated)	2,250	(37.5)	116	10
Forage		(tons)		
Alfalfa (estimated)	6,000	(4.0)	270	150
Bromegrass (5 yrs)	3,993	(2.0)	131	25
Fescue 31 (3 yrs)	3,839	(1.9)	126	45

Note: Area in tree rows (25%) is included in these per-acre rate evaluations, and cost for tree establishment is excluded.

Forage crops. Smooth bromegrass was planted at recommended rates in the fall of 1994 and harvested in mid-June each year. Average yield of the replicated plots was 2.0 tons/a. The gross annual income from the harvested acres was \$131/a, calculated at an average price of \$66/ton. Production costs are high, 90% of gross returns. Kentucky 31 fescue was planted adjacent to the research plots and showed yields slightly less than those of bromegrass, with an average yield of 1.9 tons/a. In comparison, alfalfa was estimated at 4 tons/a and a gross return of \$270.