Title: Crop Rotations and Dynamic Analysis of Southeastern Peanut Farms

Authors:
Archie Flanders, Postdoctoral Associate
313-A Conner Hall
Department of Agricultural and Applied Economics
University of Georgia
Athens, GA 30602; 706-542-0751; aflanders@agecon.uga.edu

Stanley M. Fletcher, Professor
1109 Experiment Street
Department of Agricultural and Applied Economics
University of Georgia
Griffin, GA 30223-1797; 770-228-7231 x127; sfletch@griffin.uga.edu

C. Robert Taylor, Alfa Eminent Scholar and Professor
Alabama Crop Improvement Association Building
South Donahue Drive
Department of Agricultural Economics and Rural Sociology
Auburn University
Auburn, AL 36849; 334-844-1957; rtaylor@acesag.auburn.edu

Nathan B. Smith, Assistant Professor
P.O. Box 1209
Rural Development Center
Department of Agricultural and Applied Economics
University of Georgia
Tifton, GA 31793; 229-386-3512; nathans@arches.uga.edu

Allen McCorvey, Research Coordinator
National Center for Peanut Competitiveness
Rural Development Center
Department of Agricultural and Applied Economics
University of Georgia
Tifton, GA 31793; 229-386-7291; allen@tifton.uga.edu

Selected Paper prepared for presentation at the Southern Agricultural Economics Association Annual Meeting, Little Rock, Arkansas, February 5-9, 2005

Crop Rotations and Dynamic Analysis of Southeastern Peanut Farms

Abstract

Agricultural policy objectives provide green payment incentives for farmers to initiate practices with environmental benefits. Velvet beans planted as a cover crop offer an alternative for southeastern peanut farmers to control nematodes without chemicals, while increasing soil fertility. Commodity programs provide government payments that are essential to rural economies of the southeast.

Key Words: peanut farms, government payments, green payments, farm income support, dynamic programming, stochastic analysis

JEL Classifications: **Q12, Q18, Q28**

Crop Rotations and Dynamic Analysis of Southeastern Peanut Farms

Agricultural policy in the U.S. has long been characterized as supporting farm income and meeting environmental objectives. With expanded emphasis on environmental concerns and a continued need for income enhancement, the term "green payments" refers to programs that have simultaneous objectives directed toward farm income and the environment. At a time when international trade agreements limit the scope of traditional income support programs, green payments offer a means of income enhancement that is associated with resource stewardship, without correlation to production or price levels.

The *1996 Farm Act* established the Environmental Quality Incentives Program *(EQIP)* which maintains land in agricultural production while having flexibility in meeting natural resource objectives. Provisions in the *2002 Farm Act* expand *EQIP*, and the program provides technical assistance, cost sharing, and incentive payments for conservation and environmental goals. Prior to the most recent farm bill, most conservation expenditures were directed toward land retirement. Current policy directs that approximately 66% of conservation funds for environmental objectives be on working agricultural lands (USDA, ERS 2003a).

EQIP covers up to 75% of cost sharing for implementation of conservation practices. In addition to cost sharing, incentive payments are available to producers at a rate necessary to encourage adoption of desirable land management practices. Evaluation of contract offers submitted by farmers is based on cost effectiveness, effectiveness in meeting national priorities, and realization of optimizing environmental benefits. There are no annual payment limitations, but an individual or entity cannot receive more than $450,000 over the years 2002-2007 (USDA, ERS 2003b).

Southeastern Peanut Production and Nematodes

Peanut farms in the southeast are multiple crop entities with the majority of crop acreage planted in crops other than peanuts. Peanuts and other field crops in a coordinated production system have agronomic limitations that make continuous cropping detrimental to yields. Aggregate data from the National Agricultural Statistics Service (USDA, NASS 2004a) indicates that cotton is the primary rotation crop with peanuts.

Peanut root-knot nematodes *(Meloidogyne arenaria)* are identifiable as a factor in diminishing southeastern peanut yields (Davis et al; Hagan; Kinlock). Two other types of nematodes, southern root-knot *(Meloigogyne incognita)* and reniform *(Rotylenchulus reniformis)* negatively affect cotton yields (Davis et al; Kinloch and Rich), further diminishing profitability of peanut farms. Nematodes are difficult to eradicate once established in a field, and an effective management strategy is to control nematode levels below thresholds of yield impact. Numerous nematode types affect a wide range of agricultural and ornamental crops (Hagan, Gazaway, and Sikora), and an integrated approach to nematode management includes nematicides, crop rotation, and resistant varieties (Kirkpatrick and Plunkett; Lawrence and McLean). Nematicides are effective in population control, but are costly to apply and are additive to the chemical inputs for which farmers have no viable alternatives. Resistant varieties of peanuts and cotton are not presently available for southeastern production.

A report from the University of Georgia (UGA) states that nematode management using crop rotation involves the practice of incorporating nematode suppressive crops in an agricultural production system. Nematodes must have living plant tissue for feed in order to survive and reproduce. Crops that provide the necessary plant tissue are referred to as host plants. Inclusion of non-host plants reduces nematode populations through starvation and limiting reproductive capabilities. Duration of survival without a suitable host for nematodes varies with the type of nematode, but most nematode populations can be reduced below threshold levels for yield reduction in one or two years (UGA 2001). Serving as a host for a nematode refers to a plant providing feed and results in the crop having a negative yield impact from the nematode.

Proper implementation of crop rotation for nematode management requires understanding which crops are non-hosts for each nematode type so that these crops are planted preceding a host crop. For example, peanut root-knot nematodes have no yield effect on cotton and cotton is not a host for this nematode. Likewise, neither southern root-knot nematodes nor reniform nematodes affect peanut yields by serving as a host (Davis et al). Thus, a nematode management strategy is to plant one crop in the year preceding production of the other.

Some varieties of corn are hosts for both types of root-knot nematodes, but corn is not listed as a good host for peanut root-knot nematodes (UGA 2001). Although some peanut root-knot nematodes are usually found in corn, this crop is generally effective in reducing peanut root-knot populations below levels resulting from continuous cropping of peanuts (Kinloch), and corn is commonly included in peanut rotations. Although cotton and corn are hosts for southern root-knot nematodes, corn is not a host for reniform nematodes which affect cotton. Some insecticides applied to corn have nematicidal properties that may control nematodes as a secondary effect of insect control in corn. Minimizing nutrient and moisture stress in corn improves the plant's ability to withstand nematodes and limit yield loss. Corn is a relatively low profit crop in the southeast (UGA 2001), and planting corn in rotations with peanuts and cotton may indicate a farmer strategy of accepting corn yield losses in order to benefit higher valued peanut and cotton production.

Peanuts, cotton, and corn utilize non-host characteristics for nematode management. Other plants produce nematicidal (killing) and nematistatic (suppressive) organic compounds. These toxic compounds are released from the roots of living plants or as foliage are incorporated into the soil as green manure (Hagan, Gazaway, and Sikora). Velvet bean *(Mucuna deeringiana)* is a tropical legume that reduces peanut root-knot and southern root-knot nematodes through root exudates or after incorporation into the soil as green manure (Auburn; Hagan; Hagan, Gazaway, and Sikora). Velvet beans were widely grown in the southeastern U.S. up until the mid 1900's. They were utilized for returning nitrogen to the soil at a time when nitrogen was expensive. Velvet beans were used in erosion control, building organic matter, and feeding cattle. As substitutes for the crop emerged, the labor intensive nature of harvesting velvet beans led to diminished acreage. Currently, few velvet beans are planted in the southeast, and the most prominent use is for attracting wildlife.

Crop Rotations and Yields

Several studies demonstrate yield benefits of crop rotations as opposed to continuous cropping of peanuts and cotton. Johnson et al demonstrate on Georgia soils an average 19% cotton yield increase for a peanut-cotton sequence over cotton-cotton. A sequence of cotton-peanut led to an average 10% greater peanut yield than peanut-peanut. Research at Auburn University (AgroEcology Program) indicates improved peanut yields ranging from 11% to 31% resulting from rotating with cotton instead of monoculture peanut production. This study includes plots with velvet beans that indicate peanut yield improvements ranging from 16% to 26% due to planting peanuts after velvet beans rather than consecutive planting of peanuts. Corn in rotation improves peanut yield by 4% over monoculture peanuts. Velvet beans improve cotton yield from 5% to 45% on field plots when compared to continuous cotton production. Comparing peanut production after a year of corn as opposed to a year of velvet beans indicates a 10% increase in peanut yield when the crop follows velvet beans rather than corn. Another study on Alabama soils shows velvet beans in rotation increase peanut yields by 33% and cotton yields by 29% when compared to monoculture production (Taylor and Rodriguez-Kabana).

Previous research on improved yields from crop rotations and the potential of including velvet beans for agronomic benefits suggests a means of managing nematodes on southeastern peanut farms. Yield improvements for peanuts will likewise accrue to other crops composing the cropping system through immediate yield increases, and long-term benefits may be realized in soil fertility due to increased organic matter from soil incorporation of velvet beans. There is presently a public policy emphasis on allocating resources in ways that improve environmental quality, as well as support farm income. Farmer adoption of the optimal rotation programs concurs with public policy objectives. However, implementation of innovative production methods related to crop rotation requires additional costs and foregoing revenue of crops substituted by new crops.

Subsidies that are available to farmers may be necessary to meet additional costs and provide incentive for adoption of cropping systems. The objective of this research is to determine the level of green payments that would encourage southeastern peanut farmers to implement a cropping system that includes velvet beans as a rotation crop. Farmers would receive additional income from increased yields and government subsidies, while public benefits would include less chemical usage and improved soil for future generations.

Data and Empirical Model

Data maintained by the National Center for Peanut Competitiveness at UGA for five representative farms includes variable costs per acre, total farm fixed costs, and acreage allocations for one year, as well as yields for 1991-2003. Projected fixed costs for years after the base year are estimated by FLIPSIM (Richardson and Nixon; Richardson et al). Labor, repairs, and land rent are reported as "lumpy" expenditures and are included as fixed costs. Base acreage and historical yields for each farm are included for calculating government payments. Relevant yields and coverage election are reported for farms with crop insurance so that premiums and indemnities may be calculated.

The National Center for Peanut Competitiveness does not release data for individual representative farms in accordance with confidentiality agreements among panel members. Representative farm yields and variable costs per acre are calculated as weighted averages of 5 representative farms based on total farm acreage and presented in Table 1. Expected commodity prices are derived from FAPRI (2004) projections for each crop. Prices are \$0.193/lbs. for peanuts, \$0.547/lbs. for cotton, \$2.34/bu. for corn, and

\$3.24/bu. for wheat. Annual changes for variable costs are determined by FAPRI (2003) estimates and range from 1.3% to 1.5% per year for each crop.

Decision making by farmers for acreage allocation seeks to maximize returns which are given by:

$$(1) \quad \max R = \sum_{i} RV_i + G_i - C_i \ ,$$

where R is returns maximized, RV is revenue for crop i, G is government payments received, and C is operating costs. Government payments include direct payments (DP), countercyclical payments (CCP), and loan deficiency payments (LDP). Over a multiyear planning horizon farmers attempt to allocate acreage crop acreage based on expected yields and prices, as well as maintain a suitable rotation regime. Optimizing acreage allocations over multiple years allows less than maximum returns in any single year in order that discounted returns are maximized for the entire planning horizon. Dynamic programming methods facilitate solution of discounted optimization problems in agriculture (Taylor) and revising equation (1) leads to expressing the Bellman equation (Miranda and Fackler) as:

$$(2) \quad V_t(A) = \max\{R_t + \delta E[V_{t+1}(R_{t+1})]\},$$

where V_t = the maximum expected present value of returns for the duration of the planning horizon, A = acreage allocation state existing in period t, R_t = immediate returns, δ = a constant discount factor (2%), E = the expectations operator, and $\delta E[V_{t+1}(R_{t+1})$ = discounted expected future returns. Acreage allocations in future periods are actions that lead to maximization of discounted returns, given immediate returns.

Prices and yields are stochastic and farmers make planting decisions under conditions of uncertainty. Specification of the model bases multiyear rotation acreage allocations on price and yield expectations that are regarded as deterministic from the perspective of a farmer's inability to forecast yields and prices throughout the planning horizon. Representative yields are expected values from records for each farm, and prices are from FAPRI (2004) projections. Representative farm acreage indicates that each year farmers practice some degree of continuous cropping rather than rotating all fields each year. Model specification is that each year some acreage of peanuts and cotton may either follow another crop in a rotation program or follow itself in continuous cropping. It is possible for some acreage of a crop to be in rotation while the balance for the crop is in continuous cropping. Crops in continuous cropping suffer a 15% yield decline. Length of the planning horizon is determined by the number of years for either successive annual acreage allocations to be equal or an allocation cycle to repeat. With constant prices and yields, continuing beyond these points would only lead to repetitive allocations of crop acreage and returns.

Optimization Results

Solution of the Bellman equation for each representative farm maximizes returns by optimizing crop acreage. Average total acreage planted is 1868 acres, with an average 201 acres of double cropped wheat for a net average of 1667 farm acres. Among the 1667 acres of cropland, 12% is planted in corn, 34% in peanuts, and 54% is devoted to cotton. All wheat is irrigated, with 92% of corn, 70% of peanuts, and 67% of cotton receiving supplemental water.

Weighted discounted costs, returns, and government payments are reported in Table 3. Net returns are returns plus additional farm income from production not associated with commodity programs, less fixed costs and additional expenses. There are no loan deficiency payments under expected commodity prices, and direct payments and countercyclical payments only change due to discounting under the model specification of unchanging prices and yields. Average annual net returns are $148,768 with a coefficient of variation equal to 9.4%.

Estimating opportunity costs for management and owned land enables calculation of the return to assets (ROA) for southeastern peanut farms (Kay and Edwards). Interest expenses and asset value are included in data for representative farms. Cropland rental rates are $40/ac. (USDA, NASS 2004b), and this rate is applied as the opportunity cost of owned land. Owned land of 506 acres per farm is constant over the planning horizon. Opportunity costs for management are estimated as 5% of total annual operating costs (UGA 2004). Operating costs include variable costs from representative farm budgets, labor costs, as well as repair and maintenance costs for equipment. Estimated opportunity costs for management average $50,276 per year, and the resulting ROA is 5.2%.

Introduction of velvet beans into the rotation system has the potential to improve agronomic properties of the soil, but at a cost of foregone earnings of a displaced crop. Sufficient green payments to provide incentive for farmers to plant an environmentally beneficial crop must equal the difference in production cost between velvet beans and the crop no longer produced, plus its lost revenue.

Communications with seed wholesalers and retailers provide information for velvet bean seed prices and planting rates. A $2/lbs. price for velvet bean seed is an estimate based upon current wholesale prices, as well as expectations of retail prices with expanded velvet bean usage due to increased farmer demand. A planting guide obtained from a retailer recommends a velvet bean seeding rate of between 20 to 40 lbs./ac., and

30 lbs./ac. is assumed as the budgeted rate for this research, leading to a total seed cost of $60/ac. Costs of planting seeds and disking the crop as green manure are estimated to total $5/ac. for a total velvet bean crop budget of $65/ac. Program regulations for farmer harvest of velvet beans are uncertain, and velvet beans are included in the model with no revenue from selling production. Since utilization is only as a summer cover crop with no anticipated harvest, expenses for herbicides are not included in the budget.

Velvet beans are included as a potential rotation crop as the model is optimized with green payments sufficient to render returns equal to that of the initial optimization. Corn is excluded from representative farms in the green payment solution. For farms not initially planting corn, velvet beans substitute cotton acreage, since velvet beans precede peanuts in the rotation. Peanut yields increase 10% when following velvet beans instead of corn.

Optimizing acreage with a green payment sufficient to result in returns equal to the initial optimization indicates a green payment of $116/ac. Average velvet bean acreage is 220 acres for an annual total payment of $25,520. Peanut and wheat acreages are unchanged, and average cotton acreage deceases 3%. With corn substituted by velvet beans in the rotation and the decrease in cotton acreage, total irrigation decreases 15%. An assumption of the model farm is that irrigation facilities are fixed to designated fields, and velvet beans as a cover crop may be planted in fields with irrigation facilities that are not activated for their production. Thus, water conservation is an environmental benefit of farmers incorporating velvet beans into rotation programs.

Stochastic Analysis and Government Payments

Optimal acreage allocations under deterministic prices and yields represent decision making when future price and yield changes are not predictable, and decisions are based on expected values. Production with acreage allocations that are intended to satisfy rotation goals is subject to variability in resulting net returns due to stochastic yields and prices. Evaluating the previous acreage allocations with changing yields and prices indicates the likelihood of specific net return levels.

Richardson proposes procedures for applying simulation techniques to economic models with stochastic variables. While it is not possible to obtain perfect solutions to problems with inherently risky outcomes, simulation may provide a reasonable estimate to a true statistical distribution. Deterministic models are generally converted to stochastic models by reformulating one or more of the deterministic exogenous variables as stochastic variables. Stochastic simulation is accomplished by generating random variables that represent uncertain economic variables. Selection of the proper functional form to represent the probability distribution of the economic variables is critical to meaningful simulation.

Semitar (Richardson, Schumann, and Feldman) generates random variables for two or more correlated variables in circumstances where the quantity of data is not sufficient to determine the true underlying statistical distribution. Representative farm yield data is available from 1991 to 2003, and it is hypothesized that reported NASS (2004a) prices are correlated with yields. A distinct collection of randomly generated yields and prices should span a period of 5 years in order to represent all rotation years. To obtain 100 simulations covering 5 years, a series of random number generating processes with the multivariate empirical distribution procedure of *Semitar* produces a total of 500 yields and prices for simulation. Correlated yields and prices are then applied to the optimal acreage allocation of equation (2), achieving 100 unique simulations.

Stochastic analysis results in average net returns of $167,741 per year with a coefficient of variation equal to 8.1%. Figure 1 depicts the cumulative distribution function (CDF) for net returns. A stochastic analysis allows variable levels of total government payments as commodity prices change. Direct payments are constant with a discounted annual average of $75,872. Countercyclical payments change as commodity prices vary and are calculated based on historical bases. Countercyclical payments average $113,125 per year. Loan deficiency payments vary with price and production, as payments are made on the total quantity produced of a qualifying crop. Average annual loan deficiency payments are $12,730. Government payments total $201,727 per year.

Green payment initiatives should be evaluated in context with existing commodity programs and their importance to farm income. Total government payments over the whole farm size of 1868 acres, including double cropped wheat, calculate to $108/ac., and this is similar to the estimated velvet bean green payment of $116/ac. Green payments for the optimized result of 220 velvet bean acres total $25,520. Adding the annual green payment total to the stochastic simulation government payment total leads to $227,247 in payments, or $122/ac. for the whole farm.

Benefits to farm income are an aspect in evaluating public expenditures in agriculture. With total payments of $201,727 per farm, a demonstrable public benefit is a component of justifying commodity programs. Peanut farms include diverse crop production that impacts economic activity throughout rural economies. Resources presently devoted to agriculture, including large tracts of land, have limited alternative uses within rural areas. A method of analyzing the importance of commodity programs to rural economies is to determine impacts to farms that would result without programs for income support.

With data for Figure 1 modified to exclude government payments, Figure 2 shows net returns for peanut farms that receive only revenue derived from market prices. Intersection of $0 and the probability axis is at 0.86, indicating a high likelihood of farms not having the ability to meet current financial obligations without income support from government payments. Figure 2 contains annual averages of net returns over 5 years, and net return levels should be regarded as persistent shortfalls that would have widespread impacts on the numerous economic activities that are associated with agricultural production.

Summary

Agricultural policy objectives provide green payment incentives for farmers to initiate practices with environmental benefits. Velvet beans planted as a cover crop offer an alternative for southeastern peanut farmers to control nematodes without chemicals, while increasing soil fertility. A green payment of $116/ac. would not greatly increase current per acre government payments. Existing programs provide government payments that are essential to rural economies of the southeast.

References

Auburn University, AgroEcology Program, release of April 20, 1999, Auburn, AL.

——. “Romancing the Velvet Bean-Old Flame of Southern Farmers May Make a Comeback.” Alabama Agricultural Experiment Station Office of Communications, March 24, 1997. Internet site: http://www.ag.auburn.edu/aaes/webpress/1997/velvetbean.htm. (Accessed November, 2004).

Davis, R.F., P. Bertrand, J.D. Gray, R.E. Baird, G.B. Padgett, E.A. Brown, and F.E. Hendrix. “Guide for Interpreting Nematodes.” The University of Georgia College of Agricultural and Environmental Sciences, Circular 834, Reprinted November, 2001.

FAPRI. “Agricultural Outlook 2004.” Food and Agriculture Policy Research Institute, University of Missouri-Columbia, January, 2004.

——. “Agricultural Outlook 2003.” Food and Agriculture Policy Research Institute, University of Missouri-Columbia, January, 2003.

Hagan, A. “Nematode Pests of Peanut.” Auburn University, ANR-393, Revised July, 1994.

Hagan, A.K., W.S. Gazaway, E.J. Sikora. “Nematode Suppressive Crops.” Alabama Cooperative Extension System, Circular ANR-856, April, 1994.

Johnson, A.W., N.A. Minton, T.B. Brenneman, J.W. Todd, G.A. Herzog, G.J. Gascho, S.H. Baker, and K. Bondari. “Peanut-Cotton-Rye Rotations and Soil Chemical Treatment for Managing Nematodes and Thrips.” *Journal of Nematology,* 30(June 1998): 211-25.

Kay, R.D. and W.M. Edwards. *Farm Management,* 4th edition, WCB/McGraw-Hill, New York, 1999, pp. 97-100.

Kinlock, R.A., "Peanut Nematode Management." University of Florida, Institute of Food and Agricultural Sciences, ENY-002, Revised December, 2001.

Kinlock, R.A. and J.R. Rich, "Cotton Nematode Management." University of Florida, Institute of Food and Agricultural Sciences, ENY-004, Revised December, 2001.

Kirkpatrick, T.L., and D. Plunkett. "Root–Knot Nematodes *(Meloidogyne Incognita)*." *Proceedings of the 2002 Beltwide Cotton Conferences,* January 8-12, 2002, Atlanta, GA.

Lawrence, G.W., and K.S. McLean. "The Reniform Nematode." *Proceedings of the 2002 Beltwide Cotton Conferences,* January 8-12, 2002, Atlanta, GA.

Miranda, M.J., and P.L. Fackler. Applied Computational Economics and Finance, The MIT Press, Cambridge, MA, 2002.

Richardson, J.W. Simulation for Risk Management, Department of Agricultural Economics, Texas A&M University, College Station, TX, 2004.

Richardson, J.W. and Clair J. Nixon. "The Farm Level Income and Policy Simulation Model: FLIPSIM." Department Technical Report, DTR No. 81-2, Department of Agricultural Economics, Texas A&M University, 1981.

Richardson, J.W., K.D. Schumann, and P.A. Feldman. *Semitar,* version 2006.07.01, Department of Agricultural Economics, Texas A&M University, College Station, TX, 2004.

Richardson, J.W., P.T. Zimmel, D.P. Anderson, C.A. Moehring, and M.A. Moreno. "Technical Description of FLIP: FLIPSIM Operating Environment, Version

1.00." Texas Agricultural Experiment Station, Texas Agricultural Extension Service, Texas A&M University, Department of Agricultural Economics, Agricultural and Food Policy Center Research Report 93-13, October, 1993.

Taylor, C.R., Editor. Application of Dynamic Programming to Agricultural Decision Problems, Westview Press, Boulder, Co, 1993.

Taylor, C.R., and R. Rodriguez-Kabana. "History of the Alabama Velvet Bean and its Potential for the Future." *Farming Systems Research Forum,* Auburn University College of Agriculture, Number 2, January, 1998.

U.S. Department of Agriculture, Economic Research Service (USDA, ERS). "Emphasis Shifts in U.S. Agri-Environmental Policy." *Amber Waves,* November, 2003, Washington, DC.

——. "The 2002 Farm Bill: Provisions and Economic Implications." June 4, 2003. Internet site: http://www.ers.usda.gov/features/farmbill (Accessed January, 2005).

U.S. Department of Agriculture, National Agricultural Statistics Service (USDA, NASS). "Historical Data." Internet site: http://www.usda.gov/nass/pubs/histdata.htm (Accessed December, 2004).

——. "Land Values and Cash Rents 2004 Summary." August, 2004, Washington, DC.

University of Georgia (UGA). "Crop Enterprise Cost Analysis 2004." Department of Agricultural and Applied Economics, The University of Georgia, March, 2004.

——. "Plant Susceptibility to Major Nematodes in Georgia." The University of Georgia College of Agriculture and Environmental Sciences, Bulletin 994, Reprinted December, 2001.

Table 1. Yields and Operating Costs per Acre for Southeastern Peanut Farms

	Yield[1]	$/acre
Irrigated Peanuts	4,072	$367
NonIrrigated Peanuts	2,655	$230
Irrigated Cotton	974	$356
NonIrrigated Cotton	620	$194
Irrigated Corn	174	$278
Irrigated Wheat	72	$146

[1] Units per acre: peanuts and cotton = lbs.; corn and wheat = bu.

Table 2. Discounted Costs, Returns, and Government Payments for Each Year in Optimal Rotation

Year	Variable Costs	Returns	DP	CCP	Fixed Costs	Other Returns	Net Returns
				-dollars-			
1	572,806	411,375	78,906	140,584	544,879	73,977	159,963
2	558,500	364,943	77,359	137,827	485,901	72,523	166,751
3	554,135	350,296	75,842	135,125	490,108	71,098	142,253
4	552,589	334,058	74,355	132,475	477,676	69,700	132,912
5	547,246	320,933	72,897	129,878	450,076	68,329	141,961

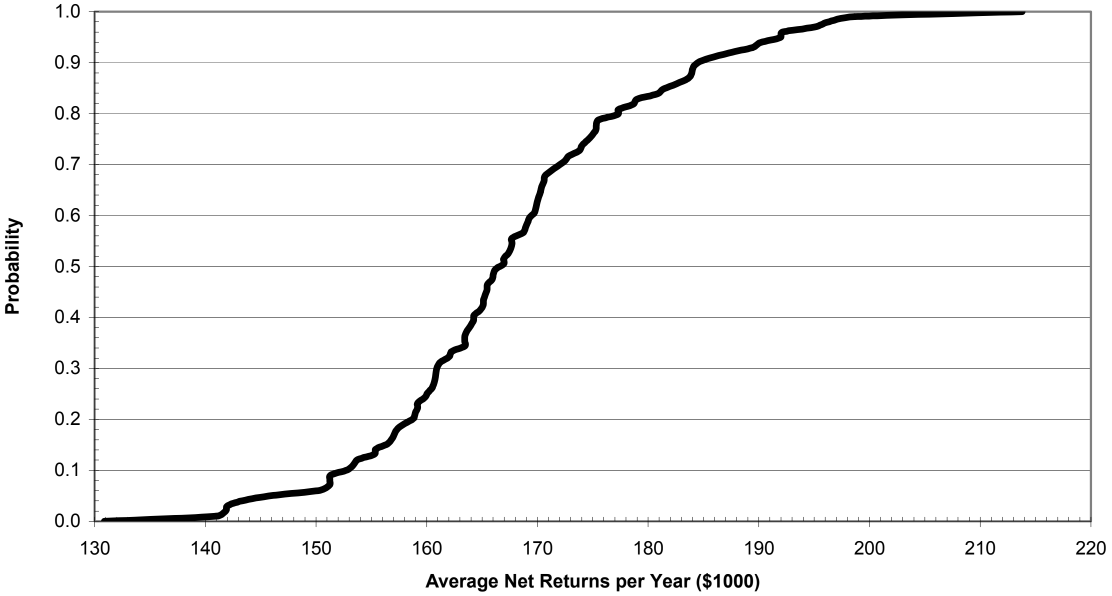

Figure 1. CDF of 5-Year Average Net Returns

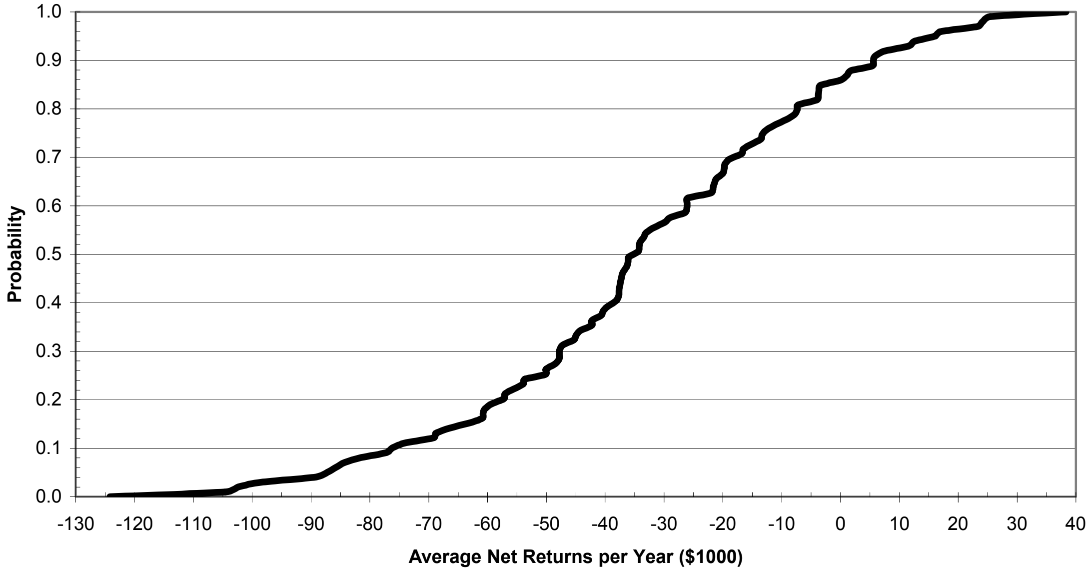

Figure 2. CDF of 5-Year Average Net Returns without Government Payments