ESTIMATING A POTENTIAL CROPLAND SUPPLY FUNCTION
FOR THE MISSISSIPPI DELTA REGION

by

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Paper prepared for presentation at
The American Agricultural Economics Association Meeting,
Washington State University,
July 29 - August 1, 1979

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ABSTRACT

A potential cropland supply function for the Mississippi Delta Region is constructed under conditions of alternative product prices, crop rotations, factor costs, management levels, and discount rates with special emphasis on the conversion costs of woodland and pastureland. The research funded by Resources for the Future will help provide a projection of regional resource use in U.S. agriculture and form the basis for projected expanded input use and the resulting environmental pressures of such expansion.

Estimating A Potential Cropland Supply Function for the Mississippi Delta Region

Cropland under cultivation in the Mississippi River Delta region increased from 13.5 million acres in 1964 to 17.4 million acres in 1974, an increase of 3.9 million acres in 10 years (USDA 1975). In Arkansas the increase totaled 440,000 acres for the same time period (USDA 1973). This growth in cropland acreage was most significant in the years of 1966-1970 and 1972-1974. The 1966-1970 time period marked the large scale transition to soybeans as the major crop of the region. The 1972-1974 time period resulted from increased international demand for food and grains due to the combined pressures of population growth in some countries, per capita income growth in others, crop shortages in some production regions of the world, and the release of government acreage control programs.

The land that went into crop production during the 10 year period had previously been unfarmed cropland or noncropland such as woodland and pastureland. Estimates of the potential cropland base for the U.S. as high as double the present base have been developed [Davis]. However little is known about the potential cropland supply function in terms of potential acres and productivity, conversion costs, production costs, environmental effects, and natural resource depletion. This paper is directed towards articulating that part of the agricultural expansion process involving the conversion of noncropland to cropland.

Estimates of the supply of potential cropland within the Mississippi Delta region under conditions of alternative product prices, production costs, interest rates, and management levels are developed. Particular emphasis is placed on estimation of the costs of converting noncropland to cropland including the direct costs of conversion, opportunity costs, and costs of production.

The research which is partially reported here is part of a joint effort between the University of Arkansas and Resources for the Future and parallels similar research being conducted by Orley Amos and John Timmons at Iowa State University. These projects combined with others will provide a national overview and considerable regional detail on future patterns of resource use in U.S. agriculture. These estimates will allow projection of expanded input use and the resulting environmental pressures of such expansion.

Previous studies by the U.S.D.A. Soil Conservation Service have attempted to identify potential cropland using basic information obtained in the 1967 Conservation Needs Inventory and the judgement of the S.C.S. interviewers to determine whether a tract of land had high, medium, or low potential for conversion to cropland [USDA, 1967]. The 1975 "Potential Cropland Study" lacked economic analysis in the determination of the land's potential for cropland as no attention was paid to either prices received for potential crops or input costs [Dideriksen].

Bob Davis of the Economic Research Service has incorporated economic analysis in examining the potential for converting woodland and pasture to cropland in the Lower Mississippi Valley and Southeast. Davis explicitly considered conversion and production cost and estimated the break even price necessary to convert noncropland to cropland under assumed yield conditions. The Davis study was based entirely on land capability classes and subclasses. However, capability classes and subclasses are not sufficiently homogenious within Arkansas to allow for their use. For the purposes of this study, Soil Conservation Service mapping units will be aggregated on the basis of soil textures to form productivity classes which will be relatively homogenious with respect to both costs and benefits.

There are four specific objectives of this study:

1. . To estimate the amount (acreage) of potential cropland that could be converted from land not presently in crop production,

2. to estimate the costs of conversion or upgrading in terms of direct costs, opportunity costs of other land uses, and maintenance costs once these acres are converted or upgraded,

3. to estimate the economic returns from these acres under projected factor and product prices,

4. to develope a set of data and a model using the above estimates from a seven county sample area in eastern Arkansas (Chicot, Desha, Arkansas, Phillips, Crittenden, Mississippi, and Clay counties) to be expanded to the entire southern Mississippi Delta region consisting of portions of Arkansas, Louisiana, Mississippi, Tennessee, Missouri and Kentucky.

Due to the restricted length of this paper, all results will not be reported.

Overview of Model

The model consists of two parts: 1) the estimation of a cost-productivity ratio based upon the various costs involved in the conversion process and the productivity of the converted land, and 2) the estimation of the quantity of potential noncropland available for conversion. The two parts of the model are linked by a matrix of land types, correlating the cost-productivity ratio of a particular land type with the quantity of that noncropland type available. By examination of alternative output prices and production costs, yields, rates and potential cropping patterns, projections and estimations of the quantity of economically potential cropland can be made.

Cost-Productivity Submodel

The cost-productivity submodel is composed of two subsections: 1) cost subsection and 2) productivity subsection. The subsection determines <u>all</u> private costs incurred due to the conversion of the noncropland to cropland. The productivity subsection determines the productivity of the converted land in terms of gross revenue. The two subsections will be combined into a cost-productivity ratio; i.e., the ratio of costs to gross revenue. The ratio will give an indication of the economic feasibility of converting the noncropland to cropland. A ratio less than one, in which gross revenues are greater than costs, would be feasible, and a ratio greater than one, in which gross revenues are less than costs, would be infeasible.

The total costs associated with the conversion of noncropland to cropland and the subsequent operating costs incurred in the production of crops on the converted land can be separated into two categories: 1) private costs which are borne by the farmer undertaking the conversion process, and 2) external costs which are borne by the public. External costs presently associated with agricultural production in the Delta region include detrimental impacts due to pesticide runoff, increasing salinity from irrigation, erosion and air pollution form agricultural waste disposal. While external costs and benefits will undoubtedly result from the conversion process it is questionable whether insitiutional forces will be revised sufficiently for these costs and benefits to be reflected to the farmer. In the absence of such revisions the presence of these externalities would have no impact on the conversion decision.

Private costs borne by the farmer are subdeivded into five components: 1) direct costs of converting noncropland to cropland, illustrated by the costs of clearing away trees, bushes, or other vegetation, construction of drainage ditches, and leveling or otherwise restructuring the terrain; 2) opportunity costs of foregone production from the previous use of the land; and 3) costs of producing crops after the land is converted.

Potential Noncropland Quantity Submodel

The Potential Noncropland Quantity Submodel specifies the number of acres of noncropland presently existing in each land productivity class and each land use forming a land type matrix. Symbolically, the potential noncropland quantity for land use i and land productivity class j will be expressed as A_{ij} and represents one cell of the land type matrix.

A data set is presently being developed by S.C.S. in cooperation with the Economic Research Service which is superior to 1967 Conservation Needs Inventory in terms of both timeliness and detail. The data bank identified as RID is being developed for each county within Arkansas. The RID system has identified the land use for each square kilometer by actual field survey and has soil mapping units by 1/4 square kilometers. Information may be retrieved by mapping units and aggregated into productivity classes based on the characteristics believed most significant by the researchers.

Seven counties which had been completely mapped were selected as representative of the Delta Region. Field surveys were conducted in each of these counties to gather data concerning costs of conversion, opportunity costs and production costs. Farmers, commercial land clearers and commercial land levelers from throughout the Delta provided the basic data for the cost estimates as well as estimates of the response period of yields and costs following the conversion process.

The conversion process is examined under the alternative price, cost, and management situations described below.

1) Rotational crop production is assumed. The rotations are (a) rice-soybeans-soybeans, (b) rice-soybeans/wheat (double crop)-soybeans,

(c) soybeans-soybeans/wheat (double crop), (d) cotton-soybeans, (3) grain sorghum-soybeans, (f) corn-soybeans. It is recognized that all rotations are not feasible on every soil group.

2) Three sets of crop prices are examined with all prices expressed in constant 1978 dollars.

a) average prices received over the period 1975-1978

b) 1985 projected prices for baseline conditions

c) 1985 projected prices for high demand conditions

1985 prices are derived from the U.S.D.A. Grain-Oilseeds and Livestock Model (GOL). Baseline conditions assume "world grain trade prices in real terms are likely to average closer to the low levels of 1969/70-1971/72 base period than the high levels of the 1972/73-1974/75 period" and high demand conditions assume "real grain prices...would be substantially higher than in the base 1969/70-1971/72 period but still below the levels of 1972/73-1974/75 [Crosson, p. 2]."

Only soybean meal, and feed grain and wheat prices were projected in the GOL model. Thus soybean prices were estimated as a function of soybean meal prices and corn and grain sorghum as a function of feed grains. Projected rice prices were derived from projections developed for the world rice model [Mullins] and cotton prices were adapted from projections published in Data Resources. [p. 33-35]

3) The potential cropland acreage is; when properly cleared, drained, and leveled; assumed to be as productive as existing cropland of the same soil group following a specified period of adjustment. Extensive field research provided the estimates of adjustment time for both the yield and production cost on converted land. Most crops are extremely

responsive to virgin soil and increased yield can be observed for periods varying from 4 years to 15 years depending on crop, soil type and previous land use.

4) Two sets of crop yields are examined. The high yield set represents that level of management practiced by the top 10 percent of managers and reported on the S.C.S. Form V's. The average yield represents the average crop yield as reported by the S.R.S. for the specific sample area. Thus, cost-benefit ratios were developed for 1,872 potential conditions representing 3 alternative price levels, 2 alternative yield levels, and two alternative cost levels while considering the conversion of either woodland or pastureland. Six soil productivity groups were evaluated in all situations with the number of potential crop rotations dependent upon the productivity, texture, and slope characteristics of each soil group. In each case a twenty year planning horizon was assumed and evaluated under three alternative discount rates; 8, 10, and 12 percent.

The cost/benefit ratios for each rotation were then compared to determine that rotation providing the highest rate of return. The results of the analysis under conditions of 1985 base line prices, high yield management, normal production costs and a discount rate of 10 percent are shown in Table 1. In all cases of woodland conversion the cotton-soybean rotation had the most desirable cost/benefit ratio. No soil group lacks the potential for economically feasible conversion of woodland to cropland.

Cotton experts estimate that cotton yield on virgin cropland converted from woodland will double normal yields for a period of 5 years and then decrease gradually not reaching normal cotton yield until the fifteenth year. This yield response factor is significantly greater than the yield response factor for other crops and is sustained for a period three times that for other crops. This being the case, cotton is a superior new ground crop.

The cost-benefit analysis assumes the farmer owns the machinery complement necessary to farm the converted cropland. Based on these assumptions, normal fixed and variable costs are allocated on a per acre basis to the new cropland in the analysis. In the likely event the farmers have withdrawn from cotton production and do not have the highly specialized machinery complement necessary for cotton farming, the cost-benefit ratio for this rotation would be grossly under estimated. If this is the case, farmers could readily shift to the second best alternative and for most soil groups have at least two potential rotations with cost-benefit ratios less than one.

Analysis of conversion of pastureland to cropland under the above stated assumptions produced the results shown in Table 1, Column B. The cotton-soybean rotation maintains it's first place ranking in 4 of the 6 soil groups. However, the cost-benefit ratio for each is increased due to a decrease in the length of the yield response time for pastureland (five years) relative to woodland (15 years). However, the cost-benefit ratio for other potential rotations improved reflecting the decreased conversion costs of pastureland compared to woodland.

Varying the discount rate, product price, and production costs each had their expected impact on the cost-benefit ratio but none were great enough to create an unfavorable conversion decision. Thus under conditions of high yield management the conversion of all remaining woodland and pastureland in private ownership within the Mississippi Delta Region which is not frequently flooded or too steep is economically feasible given the range of conditions assumed. This region is composed of 2.6 million acres.

Examination of conditions for average yield management produced less favorable cost/benefit ratios. Table 1 Columns C and D show the results under a situation of average yield, 1985 baseline crop prices, a 10 percent discount rate and normal production costs for conversion of woodland and pastureland respectively. While the cost/benefit ratios for the cotton-soybean rotation are still favorable they may be approaching that range where product price and cost uncertainty would deter a farmer from the conversion activity. In the absence of the cotton machinery complement, conversion of woodland in soil groups 1, 2, and 4 and pastureland in soil group 2 would not be economically feasible. This would reduce convertable acres to 1.9 million acres.

Pairing the best cost/benefit ratios for each soil productivity group and land use and ranking them in ascending order produces a new cropland supply function. Expanding the information from the seven county sample produces estimates for the entire Mississippi Delta Region. The potential cropland supply function under conditions of 1985 baseline prices, normal production cost and high yield management are shown in Figure 1.

Results such as those presented here should aid in the formulation of policy needed to both meet expanded world demand for crops and form a base for estimating the externalities of agricultural expansion.

Figure 1.

POTENTIAL CROPLAND SUPPLY FUNCTIONS
1985 BASELINE CROP PRICES,
HIGH YIELD, NORMAL PRODUCTION COSTS

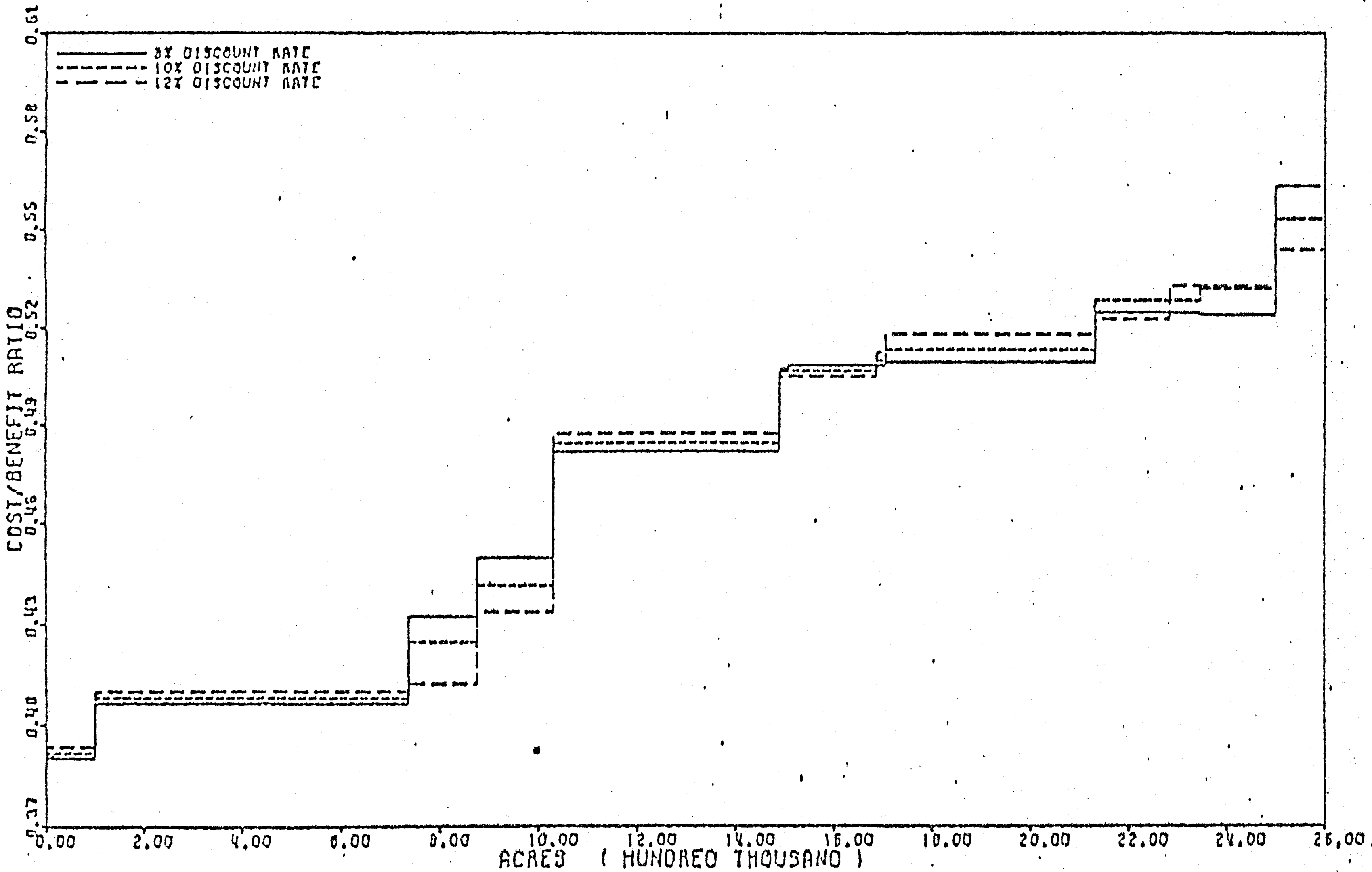

Table 1. Cost/Benefit Ratios, Alternative Soil Productivity Groups Crop Rotations, Yield Levels, for Woodland and Pastureland at 10 Percent Discount Rate

Soil Group	Crop Rotation	A	B	C	D
1	Cotton-soybeans	.5133	.5323	.7697	.7990
	Rice-soybeans-soybeans	.7053	.6032	.9607	.8154
	Rice-soybeans/wheat-soybeans	.7103	.6051	.9745	.8354
	Soybeans-soybeans/wheat	.7304	.6123	1.1418	.9572
	Corn-soybeans	.8248	.6696	1.1738	.9528
	Grain soyhum-soybeans	.9618	.7866	1.2955	1.0590
2	Cotton-soybeans	.5285	.5502	.7919	.8253
	Soybeans-soybeans/wheat	.8215	.6865	1.2906	1.0787
	Corn-soybeans	.9188	.7460	1.3263	1.0766
	Grain sorghum-soybeans	1.0667	.8724	1.4359	1.1737
3	Cotton-soybeans	.4845	.5234	.7265	.7855
	Rice-soybeans-soybeans	.5750	.5797	.8640	.7895
	Rice-soybeans/wheat-soybeans	.6224	.5721	.8662	.7955
	Soybeans-soybeans/wheat	.6342	.5068	.8922	.7864
	Grain sorghum-soybeans	.8070	.7066	1.1030	.9647
4	Cotton-soybeans	.5097	.5538	.7619	.8280
	Soybeans-soybeans/wheat	.6750	.5950	1.0349	.9121
	Grain sorghum-soybeans	.9319	.8159	1.2531	1.0958
5	Cotton-soybeans	.4080	.4418	.6081	.6582
	Soybeans-soybeans/wheat	.5389	.4684	.8110	.7049
	Corn-soybeans	.6165	.5279	.8728	.7471
	Grain sorghum-soybeans	.7178	.6202	.9587	.8278
6	Cotton-soybeans	.3915	.4249	.5830	.6325
	Soybeans-soybeans/wheat	.5389	.4648	.8110	.7049
	Corn-soybeans	.6165	.5279	.8728	.7471
	Grain sorghum-soybeans	.7178	.6202	.9587	.8278

A = Conversion of woodland to cropland, 1985 baseline crop prices, high yields

B = Conversion of pastureland to cropland, 1985 baseline crop prices, high yields

C = Conversion of woodland to cropland, 1985 baseline crop prices, average yields

D = Conversion of pastureland to cropland, 1985 baseline crop prices, average yields

All analysis at 10% discount rate.

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