# Economic Analysis of Alternative Control Methods for Soybean Cyst Nematode in Southern Illinois

R. P. REIS, Assistant Professor, Escola Superior de Agricultura de Lavras, Minas Gerais, Brazil; G. R. NOEL, Research Plant Pathologist, USDA, and Assistant Professor of Nematology, University of Illinois, Urbana 61801; and E. R. SWANSON, Professor, Department of Agricultural Economics, University of Illinois

**ABSTRACT**

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The choice of soybean (*Glycine max*) cyst nematode (*Heterodera glycines*) (SCN) control methods based on the economic criterion of maximum net returns is illustrated. A linear programming model characterized a typical farm situation in southern Illinois that involved 25 alternative cropping systems and included three soybean varieties, two resistant to SCN and one susceptible to SCN, and the use of nematicide and fertilizer. Continuous corn (*Zea mays*) was also considered as an alternative. The economically optimal SCN control method was influenced by the corn/soybean price ratio and available funds. The base solution for the optimal cropping system with average 1976–1979 corn and soybean prices and $20,000 available funds required 65 ha of corn rotated with soybeans susceptible to SCN treated with nematicide and fertilizer and 39 ha of continuous soybeans resistant to SCN with no fertility treatment. The economically optimal methods for control of SCN depend, among other things, on crop prices and available funds.

Additional key words: aldicarb, crop rotation, soil fertility

Soybeans (*Glycine max* (L.) Merr.) severely infected with the soybean cyst nematode (SCN) (*Heterodera glycines* Ichinohe) become stunted and chlorotic and may be killed. The most striking damage usually occurs in soybeans on soils with low silt and clay content; however, severe losses have been observed on soils with high silt and clay content, typical of much of the soybean acreage in Illinois (2).

By 1982, 61 of the 102 counties in Illinois were infested with SCN. The loss of total production resulting from SCN was estimated at 15% in the southern part of Illinois and 5% statewide. The large number of infested hectares and the yield loss caused by SCN make this pest an important economic problem.

This paper illustrates the economic logic of choosing soybean varieties, crop sequence, use of a nematicide, and fertilization as various control methods (R. P. Reis, *unpublished*). These choices are made within the context of the total farm business rather than considering only the costs and returns from the soybean enterprise. There is no single experimental data base in which researchers have considered all of these control methods and the potential interactions among them. Consequently, it was necessary to synthesize, from various sources, a set of soybean yield data reflecting the yield consequences of the various control measures. This is precisely the task faced by the soybean producer who seeks a control strategy in the absence of a comprehensive set of data on the influence of control methods on soybean yields.

Additional uncertainty was introduced into the analysis because of the lack of information on the levels of SCN infestation associated with the various experimental results. Again, this is characteristic of the environment in which the soybean producer chooses an SCN control strategy. Although the optimization methods (1,4,10) used in this report did not explicitly take these sources of uncertainty into account, some analysis was done to show the sensitivity of the choice of control method to selected changes in the basic data. Methods for dealing with uncertainty in crop production are described elsewhere (1,9).

## MATERIALS AND METHODS

**The farm situation.** A hypothetical farm situation was constructed to provide the setting for the analysis of choice of SCN control methods. This average-size southern Illinois farm had 104 ha (256 acres) suitable for corn and/or soybean production. The farmer had $20,000 available for cash expenses. The farmer and a school-age son provided the primary source of labor, with additional labor hired at average seasonal rates in May, September, and October (6). The labor requirements, both direct and indirect, and costs were based on the Illinois Farm Management Manual (5). Adequate power and machinery were available to accommodate the alternative cropping systems and SCN control methods considered.

**SCN control methods and crop yields.** The range of control methods considered in this economic analysis was limited by the available experimental base. The yield-response data (Table 1) for continuous soybeans were based on a 3-yr experiment conducted in McCracken

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County, KY (8), a production area quite similar to southern Illinois. This experiment included the cultivar Essex, susceptible to SCN, and two cultivars resistant to SCN, Forrest and Bedford. All of these varieties are in maturity group V. Forrest is resistant to races 1 and 3 of SCN, and Bedford is resistant to races 1, 3, and 4.

In the McCracken County experiments (Table 1), the nematicide aldicarb was applied at the rate of 2.24 kg a.i./ha (2.0 lb a.i./acre or 2.3 oz a.i./1,000 ft of row). Fertility deficiency, especially potash, can seriously limit soybean yields where SCN is a problem (7,8). The McCracken County experiments included the following fertility treatments: 56 kg/ha of $P_2O_5$ and 90 kg/ha of $K_2O$ in the first and third years and 134 kg/ha of $P_2O_5$ and 168 kg/ha of $K_2O$ in the second year.

The McCracken County experiments did not contain crop rotation as an SCN control method; therefore, it was necessary to construct a set of soybean yields for a corn-soybean rotation (the right-hand column of Table 1). An experiment conducted at Brownstown, IL, provided the basis for the adjustment of the soybean yields from the McCracken County experiment to reflect the crop sequence effect (Table 2). The Brownstown experiment considered two cultivars: Union, a cultivar susceptible to SCN, and Franklin, a cultivar resistant to races 1 and 3. Both are in maturity group IV. The influence of crop sequence on the yield of the Union (SCN-susceptible cultivar, Table 2) was used to adjust yield of Essex (SCN-susceptible cultivar, Table 1) to reflect a crop rotation effect. For example, the rotation caused the average Union yield to increase from 1,239 to 1,807 kg/ha, or by 45.8%. This percentage was used to estimate the yield increase due to rotation for the corresponding treatment (no nematicide and no fertility) of the susceptible cultivar, Essex (Table 1). Thus, the 2,156 kg/ha yield for Essex with no nematicide and no fertility treatment represented a 45.8% increase above the 1,479 kg/ha yield under a continuous soybean cropping sequence. Similarly, the percentage increases in the yields of Franklin (SCN resistant) due to crop sequence (Table 2) were used to estimate the increases in yields for the resistant cultivars Forrest and Bedford.

We considered 24 alternative methods of control for SCN (Table 1): three cultivars, nematicide or no nematicide, fertilizer or no fertilizer, and continuous soybeans or a corn-soybean rotation. To analyze all alternatives, we needed estimates of corn yields for the options of continuous corn and for the corn-soybean rotations (3). The 3-yr (1977–1979) average corn/soybean yield ratio (kilograms per hectare) for McCracken County, KY, was 2.76:1. The average of the 24 soybean yields (Table 1) was 2,634 kg/ha. When this yield was multiplied by 2.76, we calculated an estimated corn yield of 7,270 kg/ha. Assuming that this represents an average yield with half of the acreage of corn following corn and the other half following soybeans, the yield was 6,706 kg/ha for continuous corn and 7,834 kg/ha for corn following soybeans. The inclusion of continuous corn increased to 25 the number of alternative cropping systems.

**Costs and prices.** The variable costs per hectare excluding the nematicide and soybean fertilizer were $105.02 for soybeans and $249.57 for corn (5). The additional cost for the nematicide treatment was $64.96/ha, based on quoted dealer prices. The added soybean fertilizer cost was $68.42/ha (5). The corn and soybean prices used in the evaluation of SCN control methods were the 4-yr averages for the period 1976–1979: $89.37/ton ($2.27/bu) for corn and $230.38/ton ($6.27/bu) for soybeans.

**Method of linear programming.** The central concept involved in linear programming is that of an activity, which is a combination of products (eg, corn, soybeans, oats) and inputs (land, capital, labor) in fixed ratios. Thus an activity may be viewed simply as a set of coefficients that describes relationships among the various resources and products (1,4,10).

Twenty-four production activities ($X_1$, $X_2$, $X_3$, . . ., $X_{24}$) involving soybean production were identified (Table 1). The resource requirements per hectare for each of these activities were calculated (Table 3). For example, $X_1$, the corn-soybean rotation with the cultivar Essex and with no nematicide and no fertility treatments, requires $178.00/ha in operating expenses (Table 3: row 1, column 2). This activity also requires 0.44 hr of March labor (row 1, column 3) and produces 1.08 tons of soybeans and 3.92 tons of corn per rotation hectare (row 1, columns 14 and 15). Additional activities include continuous corn production, ($X_{25}$) and labor hiring in May, September, and October ($X_{26}$, $X_{27}$, and $X_{28}$). Soybean marketing is $X_{29}$ and corn marketing is $X_{30}$. Available funds may be invested in off-farm opportunities at 12% ($X_{31}$).

A solution to the linear programming problem is found by maximizing the objective function ($\$230\ X_{29} + \$89\ X_{30} + \$1.12\ X_{31}$) subject to the 14 constraints of resource availability and crop production and sale (Table 3). The linear programming matrix (R. P. Reis, *unpublished*) assumes that the cropping system chosen would be followed for a period of time sufficient for crop rotations to influence yields in the manner indicated above, ("SCN control methods and crop yields"). The 25

**Table 1.** Estimated soybean yields with various combinations of treatments with and without crop rotation in McCracken County, KY, 1977–1979

| | Treatment | | Soybean yield (kg/ha) | |
|---|---|---|---|---|
| Cultivar | Nematicide | Fertilizer | Continuous soybeans[a] | Corn-soybean rotation[b] |
| Essex | No | No | 1,479 ($X_{13}$)[c] | 2,152 ($X_1$) |
| Essex | Yes | No | 1,748 ($X_{14}$) | 2,556 ($X_2$) |
| Essex | No | Yes | 2,017 ($X_{15}$) | 3,160 ($X_3$) |
| Essex | Yes | Yes | 2,892 ($X_{16}$) | 4,035 ($X_4$) |
| Forrest | No | No | 2,085 ($X_{17}$) | 2,219 ($X_5$) |
| Forrest | Yes | No | 2,286 ($X_{18}$) | 2,556 ($X_6$) |
| Forrest | No | Yes | 2,690 ($X_{19}$) | 3,160 ($X_7$) |
| Forrest | Yes | Yes | 2,824 ($X_{20}$) | 3,295 ($X_8$) |
| Bedford | No | No | 2,219 ($X_{21}$) | 2,353 ($X_9$) |
| Bedford | Yes | No | 2,286 ($X_{22}$) | 2,556 ($X_{10}$) |
| Bedford | No | Yes | 2,757 ($X_{23}$) | 3,228 ($X_{11}$) |
| Bedford | Yes | Yes | 3,093 ($X_{24}$) | 3,564 ($X_{12}$) |

[a] From Stuckey (8), pp. 162–168.
[b] Estimated by using ratio of soybean yield with a corn-soybean rotation to yield with continuous soybeans as reported in Table 2.
[c] Variables in parentheses correspond to activities in Table 3.

**Table 2.** Estimated soybean yields with various combinations of treatments with and without crop rotation in Brownstown, IL, 1978–1979

| | Treatment | | Soybean yield (kg/ha) | |
|---|---|---|---|---|
| Cultivar | Nematicide | Fertilizer | Continuous soybeans | Corn-soybean rotation[a] |
| Franklin | No | No | 1,500 | 1,601 |
| Franklin | Yes | No | 1,641 | 1,843 |
| Franklin | No | Yes | 1,937 | 2,260 |
| Franklin | Yes | Yes | 2,078 | 2,414 |
| Union | No | No | 807 | 1,177 |
| Union | Yes | No | 1,217 | 1,775 |
| Union | No | Yes | 1,177 | 1,836 |
| Union | Yes | Yes | 1,755 | 2,441 |

[a] From Edwards et al (2), pp. 133–144.

alternative cropping systems were not mutually exclusive; the range of possible solutions considered also included combinations of the 25 systems.

## RESULTS AND DISCUSSION

The base solution assumed that the farmer expected corn and soybean prices to be at their average levels for 1976–1979 and that $20,000 was available for operating expenses. We then present the results of altering the corn and soybean prices to determine whether the optimal combination of SCN control methods depends on corn and soybean prices. Finally, we estimate the influence of the extent of funds available on the choice of SCN control methods.

**Base solution.** The optimal cropping system with average 1976–1979 corn and soybean prices with $20,000 available funds was as follows: corn-soybeans (cultivar Essex) rotation with nematicide and fertilizer treatment, 65 ha; and continuous soybeans (cultivar Bedford) with no nematicide and no fertilizer treatment, 39 ha, for a total of 104 ha. Slightly more than a third of the 104 ha available was in continuous soybeans with an SCN-resistant cultivar, with the balance (65 ha) in an SCN-susceptible cultivar (Essex) with both nematicide and fertilizer treatments. This program required all of the $20,000 available and resulted in an income above variable cost of $52,659. About 1 day of hired labor was required in May and about 2 days in October. The family labor supply was adequate in the other months. Corn production totaled 254 tons and soybean production 217 tons.

Although a simple cost-returns analysis, which did not consider the available funds, indicated the rotation with nematicide and fertilizer to be more profitable, the $20,000 limitation caused the choice of the indicated combination. The cash requirements for cultivar Bedford with no nematicide and no fertility treatment were $105.02/ha. In contrast, the cash requirements for a rotation hectare (half in corn and half in Essex soybeans) with both nematicide and fertility treatments was $244.63/ha. Although the net returns per hectare were higher for the latter system, the limit on available funds prevented all of the 104 ha from being put in a corn-soybean (cultivar Essex) rotation with nematicide and fertility treatments.

It was of interest to see how competitive the nonoptimal SCN control methods were in relation to the two methods chosen. Close competitors included corn-soybeans (cultivar Bedford) with no nematicide but with the fertility treatment. If 1 ha of this crop system had been forced into the optimal solution, net returns would have been reduced by only $20.26. This amount applies within a limited range of substitution of one crop system for those in the optimal set. Another close competitor was continuous soybeans (cultivar Bedford) with no nematicide, but with fertility treatment. Forcing 1 ha of this into the solution would reduce net returns by $26.44. Requiring 1 ha of soybean (cultivar Essex) with nematicide but no fertility treatments would reduce net returns by $248.09 below the net returns from the optimal combination of 65 ha of rotation with the cultivar Essex, nematicide, and fertilizer and 39 ha of continuous soybeans with cultivar Bedford but no nematicide or fertilizer.

**Sensitivity to price changes.** The base solution assumed average prices for the 4-yr period 1976–1979. To test the sensitivity of the results to price changes, we obtained four additional solutions using the prices for each of the years 1976-1979.

The solutions for prices representing 1977–1979 are identical to the base solution. However, the corn/soybean price ratio was substantially higher in 1976 than in the other 3 yr, thus causing a different SCN control method to be chosen. The optimal methods for the 1976 prices were as follows: corn-soybeans (cultivar Bedford) with no

**Table 3.** Resources available, resource requirements, and crop production for 104-ha farm in southern Illinois with alternative controls for soybean cyst nematode

| Activity[a] | Available funds, $20,000 | Available family labor (hr) Mar. 180 | Apr. 151 | May 151 | June 359 | July 359 | Aug. 359 | Sept. 151 | Oct. 151 | Nov. 151 | Dec. 180 | Land, 104 ha | Production and sale (tons) Soybean | Corn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Resource requirements per hectare | | | | | | | | | | | | | |
| $X_1$ | 178 | 0.44 | 0.86 | 1.41 | 1.53 | 0.67 | 0.44 | 0.67 | 1.53 | 0.67 | 0.22 | 1 | 1.08 | 3.92 |
| $X_2$ | 210 | 0.44 | 0.86 | 1.51 | 1.53 | 0.67 | 0.44 | 0.67 | 1.53 | 0.67 | 0.22 | 1 | 1.28 | 3.92 |
| $X_3$ | 211 | 0.44 | 0.86 | 1.73 | 1.53 | 0.67 | 0.44 | 0.67 | 1.53 | 0.67 | 0.22 | 1 | 1.58 | 3.92 |
| $X_4$ | 245 | 0.44 | 0.86 | 1.83 | 1.53 | 0.67 | 0.44 | 0.67 | 1.53 | 0.67 | 0.22 | 1 | 2.02 | 3.92 |
| $X_5$ | 178 | 0.44 | 0.86 | 1.41 | 1.53 | 0.67 | 0.44 | 0.67 | 1.53 | 0.67 | 0.22 | 1 | 1.11 | 3.92 |
| $X_6$ | 210 | 0.44 | 0.86 | 1.51 | 1.53 | 0.67 | 0.44 | 0.67 | 1.53 | 0.67 | 0.22 | 1 | 1.28 | 3.92 |
| $X_7$ | 211 | 0.44 | 0.86 | 1.73 | 1.53 | 0.67 | 0.44 | 0.67 | 1.53 | 0.67 | 0.22 | 1 | 1.58 | 3.92 |
| $X_8$ | 245 | 0.44 | 0.86 | 1.83 | 1.53 | 0.67 | 0.44 | 0.67 | 1.53 | 0.67 | 0.22 | 1 | 1.65 | 3.92 |
| $X_9$ | 178 | 0.44 | 0.86 | 1.41 | 1.53 | 0.67 | 0.44 | 0.67 | 1.53 | 0.67 | 0.22 | 1 | 1.18 | 3.92 |
| $X_{10}$ | 210 | 0.44 | 0.86 | 1.51 | 1.53 | 0.67 | 0.44 | 0.67 | 1.53 | 0.67 | 0.22 | 1 | 1.28 | 3.92 |
| $X_{11}$ | 211 | 0.44 | 0.86 | 1.73 | 1.53 | 0.67 | 0.44 | 0.67 | 1.53 | 0.67 | 0.22 | 1 | 1.61 | 3.92 |
| $X_{12}$ | 245 | 0.44 | 0.86 | 1.83 | 1.53 | 0.67 | 0.44 | 0.67 | 1.53 | 0.67 | 0.22 | 1 | 1.78 | 3.92 |
| $X_{13}$ | 105 | 0.44 | 0.86 | 1.09 | 1.73 | 0.86 | 0.44 | 0.86 | 1.73 | 0 | 0 | 1 | 1.48 | 0 |
| $X_{14}$ | 169 | 0.44 | 0.86 | 1.28 | 1.73 | 0.86 | 0.44 | 0.86 | 1.73 | 0 | 0 | 1 | 1.75 | 0 |
| $X_{15}$ | 173 | 0.44 | 0.86 | 1.73 | 1.73 | 0.86 | 0.44 | 0.86 | 1.73 | 0 | 0 | 1 | 2.02 | 0 |
| $X_{16}$ | 238 | 0.44 | 0.86 | 1.93 | 1.73 | 0.86 | 0.44 | 0.86 | 1.73 | 0 | 0 | 1 | 2.89 | 0 |
| $X_{17}$ | 105 | 0.44 | 0.86 | 1.09 | 1.73 | 0.86 | 0.44 | 0.86 | 1.73 | 0 | 0 | 1 | 2.09 | 0 |
| $X_{18}$ | 169 | 0.44 | 0.86 | 1.28 | 1.73 | 0.86 | 0.44 | 0.86 | 1.73 | 0 | 0 | 1 | 2.29 | 0 |
| $X_{19}$ | 173 | 0.44 | 0.86 | 1.73 | 1.73 | 0.86 | 0.44 | 0.86 | 1.73 | 0 | 0 | 1 | 2.69 | 0 |
| $X_{20}$ | 238 | 0.44 | 0.86 | 1.93 | 1.73 | 0.86 | 0.44 | 0.86 | 1.73 | 0 | 0 | 1 | 2.82 | 0 |
| $X_{21}$ | 105 | 0.44 | 0.86 | 1.09 | 1.73 | 0.86 | 0.44 | 0.86 | 1.73 | 0 | 0 | 1 | 2.22 | 0 |
| $X_{22}$ | 169 | 0.44 | 0.86 | 1.28 | 1.73 | 0.86 | 0.44 | 0.86 | 1.73 | 0 | 0 | 1 | 2.29 | 0 |
| $X_{23}$ | 173 | 0.44 | 0.86 | 1.73 | 1.73 | 0.86 | 0.44 | 0.86 | 1.73 | 0 | 0 | 1 | 2.76 | 0 |
| $X_{24}$ | 238 | 0.44 | 0.86 | 1.93 | 1.73 | 0.86 | 0.44 | 0.86 | 1.73 | 0 | 0 | 1 | 3.09 | 0 |
| $X_{25}$ | 250 | 0.44 | 0.86 | 1.73 | 1.31 | 0.44 | 0.44 | 0.44 | 1.31 | 1.31 | 0.44 | 1 | 0 | 6.71 |
| $X_{26}$ | 3.08 | 0 | 0 | −1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $X_{27}$ | 2.83 | 0 | 0 | 0 | 0 | 0 | 0 | −1 | 0 | 0 | 0 | 0 | 0 | 0 |
| $X_{28}$ | 3.33 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | −1 | 0 | 0 | 0 | 0 | 0 |
| $X_{29}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | −1 | 0 |
| $X_{30}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | −1 |
| $X_{31}$ | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

[a] Defined as a set of coefficients that describe relationships among varous resources (land, capital, labor) and products (corn and soybeans). See Table 1 for an explanation of activities $X_1$–$X_{24}$. Activity $X_{25}$ = continuous corn production; $X_{26}$–$X_{28}$ = labor hiring in May, September, and October; $X_{29}$ = soybean marketing (at $230/ton); $X_{30}$ = corn marketing (at $89/ton); and $X_{31}$ = available funds invested in off-farm opportunities at 12%. Values for $X_1$–$X_{25}$ are given on a per-hectare basis; for $X_{26}$–$X_{28}$, per hour; for $X_{29}$ and $X_{30}$, per ton; and for $X_{31}$, on a dollar basis. The objective function that is maximized is $230 $X_{29}$ + $89 $X_{30}$ + $1.12 $X_{31}$.

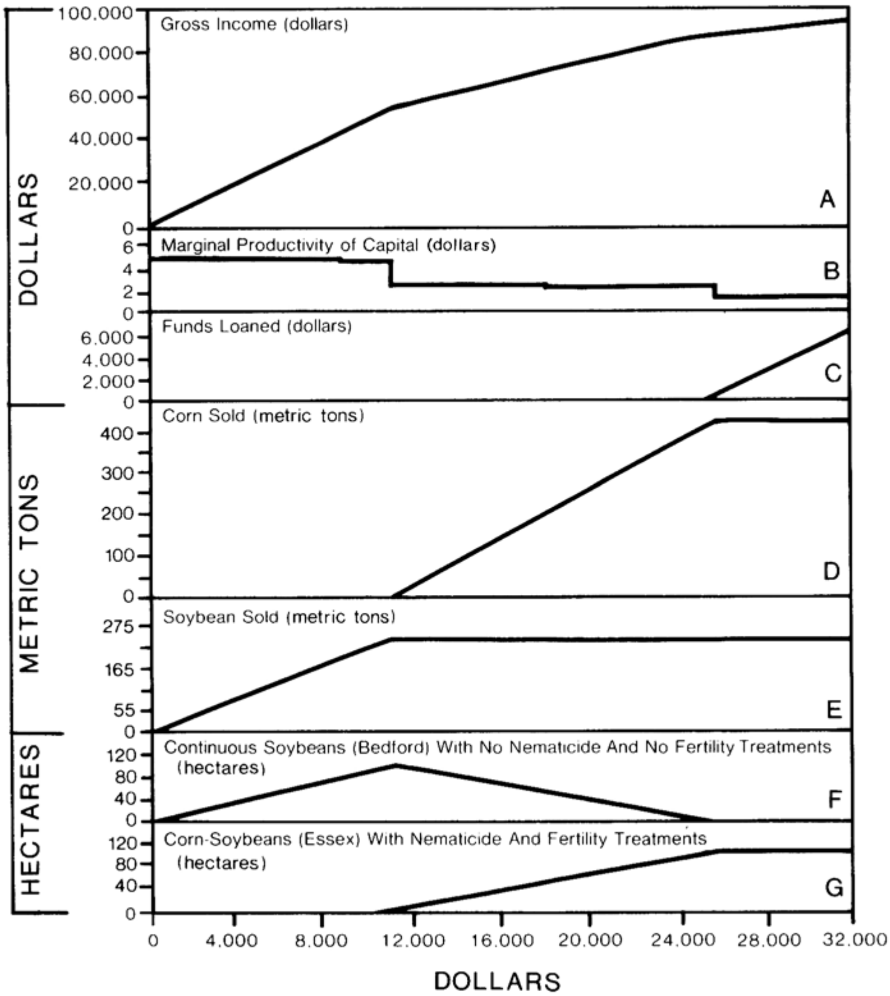


**Fig. 1.** Influence of available funds on **(A)** gross income, **(B)** marginal productivity of capital, **(C)** funds loaned, **(D)** corn sold, **(E)** soybeans sold, **(F)** hectares of continuous soybeans, and **(G)** corn-soybean rotation.

nematicide but with fertilizer treatments, 85 ha; and continuous soybeans (cultivar Bedford) with no nematicide and no fertilizer treatment, 19 ha, for a total of 104 ha.

Thus, the higher corn price, relative to soybeans, increased the acreage in the corn-soybean rotation from 65 to 85 ha. It also caused a shift in soybean cultivar in the rotation from Essex to Bedford and an elimination of the nematicide treatment. The higher value of the corn relative to soybeans not only caused an increase in hectares of corn but also a decrease in the cash expenditure per hectare on the corn-soybean rotation. The corn-soybean (cultivar Essex) rotation with nematicide and fertility treatments required an outlay of $244.63 per rotation hectare, whereas the corn-soybean (cultivar Bedford) rotation with no nematicide but with a fertility treatment required $211.27 per rotation hectare.

**Influence of available funds.** Most soybean producers do not operate with unlimited cash available for the conduct of their farming operation. Therefore, we studied the influence of the amount of available funds on selected aspects of the farm business (Fig. 1). The horizontal axis indicates that the available funds range from zero to $32,000.

The seven panels (Fig. 1) each show a different feature of the influence of the level of available funds. The top panel (A), gross income, indicates that with increases in available funds, gross income increases at a decreasing rate. This results primarily from the fixed land base of 104 ha. The second panel (B), marginal productivity of capital, represents the slope or rate of increase of the gross income in the top panel. Initial investments have a high marginal product, returning $4–5 for each dollar spent. With added expenditures, marginal productivity declines. Net income continues to increase as long as the marginal productivity of cash is greater than zero. In the third panel (C), funds loaned, we see that when the available funds exceed $25,500, the farmer ceases to invest in his farming operation and loans money out at 12% interest per annum. The fixed land base cannot profitably absorb cash expenditures beyond $25,500.

The general impact of the level of available funds on corn and soybean production can be seen in panels D and E, corn sold and soybeans sold. Because of its higher cash operating costs, corn does not enter the solution until the available funds reach $11,000.

Panels F and G contain the information relevant to the control of SCN. At low levels of available funds, a system of continuous soybeans with a resistant cultivar, Bedford, is followed. Nematicides and fertilizer are not used. With approximately $11,000 available, the entire 104 ha is planted to this system. As the available funds increase beyond $11,000, the corn-soybean (cultivar Essex) rotation with both a nematicide and fertilizer becomes increasingly important. By the time the available funds reach $25,500, this rotation has completely replaced the continuous soybean system.

**LITERATURE CITED**


1. Anderson, J. R., Dillon, J. L., and Hardaker, J. B. 1977. Agricultural Decision Analysis. Iowa State University Press, Ames. 344 pp.
2. Edwards, D. I., Jacobsen, B. J., Noel, G. R., Shurtleff, M. C., and Malek, R. B. 1982. The soybean cyst nematode problem. Pages 133-144 in: Proc. Ill. Custom Spray Operators Training School, 34th. Univ. Ill. Coop. Ext. Serv.
3. Hawkins, D. E., Slife, F. W., and Swanson, E. R. 1977. Economic analysis of herbicide use in various crop sequences. Ill. Agric. Econ. 17:8-13.
4. Heady, E. O., and Candler, W. 1958. Linear Programming Methods. Iowa State University Press, Ames. 597 pp.
5. Hinton, R. A. 1980. Farm management manual. Ill. Coop. Ext. Serv. AE-4473.
6. Illinois Department of Agriculture. 1976, 1977, 1978, and 1979. Illinois Agricultural Statistics. Annual Summary. Ill. Coop. Crop Rep. Serv. Bull. 77-1, 78-1, 79-1, and 80-1.
7. Shannon, J. G., Baldwin, C. H., Jr., Colliver, G. W., and Hartwig, E. E. 1977. Potash fertilization helps fight soybean cyst nematode. Better Crops with Plant Food 61:12-15.
8. Stuckey, R. 1981. Soybean cyst nematode: A serious threat to soybean production in the United States. Pages 162-168 in: Proc. Ill. Custom Spray Operators Training School 33rd. Ill. Coop. Ext. Serv.
9. Swanson, E. R., and Tyner, E. H. 1965. Influence of moisture regime on optimum nitrogen level and plant population for corn: A game theoretic technique. Agron. J. 58:361-364.
10. Swanson, E. R., Tyner, E. H., and Peterson, G. A. 1958. Economic interpretation of agronomic data by the linear programming technique. Proc. Soil Sci. Soc. Am. 22:132-136.