
SIMPLIFIED
PROGRAMMING

**as a
farm
management
tool**

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SIMPLIFIED PROGRAMMING as a FARM MANAGEMENT TOOL

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INTRODUCTION

The difference between an above average farmer and a less successful one usually involves more than mere luck. Usually the difference can be traced to careful planning, resulting in more efficient use of available resources. With a well developed plan a person can have a more profitable operation, even though his resource base remains unchanged. The key to increased profits is not merely using available resources, but using them efficiently. Determination of the most economically efficient use of land, labor, management, and capital is the crux of profitable farm planning.

New farming operations and those which have previously been in production both can benefit from planning. Prices of inputs to enterprises change rapidly, as do prices received for livestock and crops. The relative profitability of one method of production or one enterprise compared to other methods or enterprises may alter with a change in prices. For this reason, planning must be a continual process which periodically reevaluates the use of limited resources on the farm. For optimum effectiveness, farm enterprises should be examined at least once a year to determine their net returns in relation to the total farm operation. A person should not necessarily discontinue an enterprise on the basis of 1 year's data but he should be aware of which enterprises are or are not profitable and the amount of resources each is using. This yearly planning job may sound large and time consuming, but it is quite feasible given good records and a systematic evaluation method.

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BUSINESS RECORDS

Records provide financial and physical information about the farm business. This type information can facilitate decision making and effective planning. Good records do not happen by accident; much work is involved in preparing and maintaining them. However, if daily entries are adequately kept, then most of the summary work can be conveniently done after regular working hours or during other times when outside work is not possible.

Farm records take many forms, but most types simply attempt to list inputs and outputs of the farm operation. The different forms that recording methods can take are as varied as the numerous inputs and outputs. Records are most useful when their form is tailored for a particular farm operation. Some of the most common and serviceable types of records follow:

Input records on:

feed usage	machinery and equipment usage
labor usage	land usage
management requirements	chemical application
purchase of seed or stocker animals	fertilizer application

Output records on:

livestock production
crop production
custom work

General records on:

cash incomes
cash expenses
depreciation schedules
complete inventory lists

Illustrations of two useful types of records are found in examples 1 and 2. Example 1 shows how both labor and machinery time can be accounted for on one record sheet and Example 2 illustrates a simple depreciation schedule that may be used by some farmers. Records can be very flexible. A record's form, simplicity, complexity, attractiveness, or efficiency, however, do not determine its value. The most valuable records are those which contain accurate and up-to-date entries. In the long run the best records are those most easily and conveniently kept.

Records have other uses in addition to aiding management decisions in a farm operation. Tax computation is greatly simplified when good records are available. Records also provide an important basis for farm credit, financing, and receiving aid from government programs.

SYSTEMATIC EVALUATION METHOD

There are several different evaluation methods that can be used with records. Each method describes some measure of efficiency or economy of

Example 1. Labor and Machinery Usage by Field

Field <u>No. 3</u>			Crop <u>Cotton</u>			Acres <u>20</u>			Year <u>1975</u>		
<i>land preparation</i>			<i>planting</i>			<i>cultivation</i>			<i>(custom) harvest</i>		
Date	Hours		Date	Hours		Date	Hours		Date	Hours	
	Man	Tractor		Man	Tractor		Man	Tractor		Man	Tractor
3/7	9	8	4/23	8	7	5/24	9 1/4	7 1/2	10/15	6	2
3/8	5	4 3/4				6/10	4	4	10/16	4 1/2	1
4/3	11	10 1/2				6/11	3	3			
						6/22	8	7 1/4			
Total	25	23 1/4	Total	8	7	Total	24 1/4	21 3/4	Total	10 1/2	3

the farm operation, which then can be compared to a set of standards for that area. One of the most useful types of evaluation for planning purposes is the enterprise budget.

Farmers with adequate records can easily convert the information into an enterprise budget form. Since first-year farmers have no past records to rely on, they must find other budget information. The same is true for established farmers who wish to consider enterprises which they have never attempted before. In either of these situations, good sources of production information are from similar farm operations, local government agricultural offices, and state agricultural schools.

Information for enterprise budgeting should consist of (1) a complete list of input items (both fixed and variable) and input prices, (2) an expected level of production under specified management practices, and (3) an expected average price for the product.

Estimations of price and amount of production should be made as accurately as possible, because these two items alone determine the expected gross returns from the enterprise. Production rates may be based on past average farm yields, local yields under similar circumstances, or statewide prediction of yields adjusted for that area. If the farmer is initiating production practices which differ from his usual methods, the yield could be

Example 2. Machinery and Equipment Depreciation Schedule

Item	Date acquired	Cost	Salvage value	Additional 1st year depreciation	Depreciable balance	Estimated years life	Depreciation method	Depr. rate %
Fertilizer Spreader	3/15/70	450 ⁰⁰	0 ⁰⁰	---	450 ⁰⁰	10	Straight line	10
Disc (6 1/2 ft)	11/4/72	800 ⁰⁰	100 ⁰⁰	---	700 ⁰⁰	12	" "	8.3
Tractor (60 hp)	3/23/74	6,500 ⁰⁰	500 ⁰⁰	1,300 ⁰⁰	4,700 ⁰⁰	15	dbl. Decl. Bal.	13.3
Planter (4-row)	12/2/74	2,000 ⁰⁰	100 ⁰⁰	400 ⁰⁰	1,500 ⁰⁰	10	" " "	20
Cultivator (4-row)	12/2/74	1,000 ⁰⁰	100 ⁰⁰	200 ⁰⁰	700 ⁰⁰	10	" " "	20

expected to be slightly lower until he becomes familiar with the new methods.

Price of agricultural production tends to vary both within and between years, which makes price prediction difficult. Within-year price cycles for crops usually fluctuate from a low during the harvest season to a high immediately before the beginning of harvest. This difference reflects the cost of storage and certain risk factors associated with delayed sale of production. Prices for many types of livestock and livestock products also exhibit patterns of seasonal variation. Within-year seasonal variation from top to bottom price seldom exceeds 10 percent of the yearly average price, so this fluctuation is most important in the decision of when to buy or sell crops and livestock.

Between-year fluctuations are often proportionally larger than seasonal ones, and they can result from a variety of unforeseen circumstances. Examples of such circumstances are exceptionally bad or good growing and harvest seasons, unplanned purchases or purchase cancellations by foreign nations, shortage or surplus of a substitute product, and shifts in government agricultural programs. Certain livestock prices fluctuate over a period of years in semi-predictable cycles.

For short range (1 year) planning and farm organization, consideration of both these types of fluctuations can be minimized. Short range changes in the farm operation can be shifts in emphasis or acreage among already existing enterprises. Only a minimal amount of additional capital expenditure should be needed to accomplish these changes. For short range consideration a farmer can usually get a reasonably accurate price estimate 9 to 12 months ahead of his anticipated sales. Two excellent sources of information of this type are forward contract prices available from buyers, and futures market contract prices for the month of intended sales. As sales time draws closer, these price estimates become more accurate. From the two sources mentioned above the farmer can even "lock in" the price quoted by securing a sales contract if he wishes. In this situation the farmer is ensured of getting no less than the contract price for his product; however, if the market price goes up above the contract price, he still receives the agreed price.

Farm changes requiring substantial capital expenditures should be based on something more substantial than 1 year prices. For long range planning, a price trend should be established. The trend line should reflect the changes in yearly average price of the commodity for the previous 10 years. After taking into consideration adjustments to the commodity price from predicted future circumstances that can cause between-year price fluctuation, the price trend line should be projected for the next 5 years. The prices reflected by this projection should be carefully considered before long range changes in operations are made.

After establishing a predicted yield and price for the enterprise, the farmer has the necessary elements to compute estimated receipts. The remaining portion of the enterprise budget consists of input amounts and costs. These input expenses can be divided into two categories – variable and fixed.

Variable inputs or costs are incurred as a direct result of operating an enterprise. By definition, variable expenses usually change with different levels of production, and they cease when production stops. On the other hand, fixed expenses remain whether production continues or not. Variable costs, sometimes termed operating costs, can include such items as feed, seed, fingerlings, fertilizers, chemicals, interest on operating expenses, and many other possible production inputs. The most commonly occurring types of fixed expenses are depreciation, property taxes, and interest on capital expenditures. Other expenses such as full-time hired labor salaries or insurance premiums on facilities and equipment may or may not be fixed for certain enterprises.

The terms variable and fixed are very relative as they apply to farm expenses. After a variable expense is actually incurred, it becomes fixed; it remains fixed for the duration of the production period. For example, before fingerlings are purchased for a grow-out operation, they are a variable expense. However, after their purchase, that particular expense will remain even if production ceases. Hence, fingerlings have become a fixed expense. The same would be true for inputs such as feed, seed, fertilizer, etc. On the other hand, no input expenses are fixed over the long run. Land, machinery, and other capital items can either be sold or bought if the time span covers several production periods. Therefore, the fixity of inputs is relative to the time frame of the production process. For the purposes of the budgets to follow, expenses are classified for one production period at the beginning of the period.

Inputs can further be divided into cash and non-cash items. Cash costs account for the majority of cost items and involve an actual money outlay, while non-cash costs do not. Depreciation and unpaid family labor are examples of non-cash expenses. Since non-cash costs are easily overlooked while budgeting, it is important to know that there are such costs so that they will not be omitted.

The kind and amounts of inputs are generally dictated by accepted cultural and management practices. The cultural practice usually sets the amount, type, and composition of inputs to use. Records can supply much of the information if this enterprise has been used on the farm in previous years. As with short run prices for production, the prices of most of the input items can be secured up to 1 year in advance. Prices should reflect current local prices in the geographical area of the farm and should also consider general price trends.

By subtracting expected costs from expected receipts, the net returns per unit from the enterprise are calculated. A sample enterprise budget for soybeans is shown in Example 3. This budget contains four major sections: (1) receipts, (2) variable and fixed expenses, (3) net returns above total expenses, and (4) other required inputs not listed in the budget. Each of these sections deserves further explanation.

Receipts and itemized expenses are included for this enterprise, but both need not be present in every enterprise budget. A budget for raising corn fed to swine on the same farm, for instance, would show only expenses. The enterprise would produce an amount of corn grain that would be transferred to the swine enterprise, but usually no money transactions would be made. The swine enterprise would be charged with the expenses of growing a certain number of units of corn, and there would be no receipts until the fed swine are sold. Footnotes and other examples that follow the soybean budget give further insight into how each item was calculated.

Example 3. Sample Enterprise Budget Cost and Returns for Producing Soybeans on the L. B. Sims Farm, 1975 (1 acre)

Item	Unit	Price	Number	Total
		per unit	units	amount
		Dollars		Dollars
<i>Receipts</i>				
Soybeans	bu.	5.00 <u>a/</u>	26.0 <u>b/</u>	\$130.00
<i>Variable expenses</i>				
Seed	bu.	8.00	1.0	8.00
Fertilizer (0-24-24)	100 lb.	7.00	2.0 <u>c/</u>	14.00
Lime (custom applied)	ton	15.00	.33 <u>d/</u>	5.00
Herbicide	spraying	4.00	2.0 <u>e/</u>	8.00
Insecticide	spraying	4.00 <u>f/</u>	2.0	8.00
Tractor operating exp.	hr.	1.92 <u>g/</u>	3.1	5.95
Equipment operating exp.	hr.	1.02 <u>h/</u>	2.5	2.55
Custom harvest	acre	14.50 <u>i/</u>	1.0	14.50
Interest on operating exp. (\$66 @ 9 percent for 6 months) <u>j/</u>				2.97
Total variable expenses				\$ 68.97
<i>Fixed expenses</i>				
Machinery exp. (depreciation, insurance) <u>k/</u>				8.78
Land exp. (taxes) <u>l/</u>				2.25
<i>Total variable and fixed expenses</i>				\$ 80.00
<i>Nets returns above variable and fixed expenses</i>				
(return to land, labor, management, and capital) <u>m/</u>				\$ 50.00
<i>Other required inputs not previously listed:</i>				
land	– 1 acre			
labor	– 4 hours			
management	– L.B. Sims must be able to follow recommended management practices			
additional capital	– no additional capital required			

- a/ Quoted futures price during January 1976 for November 1976 Soybeans less \$.10 basis.
- b/ Expected yield under specified management practices adjusted for local area.
- c/ Normal soil test recommendations based on medium fertility.
- d/ One ton lime lasts 3 years; therefore it is charged at rate of 1/3 ton/year.
- e/ Pre and post emergence spraying.
- f/ Includes price of aerial application.
- g/ See Example 4, Sample Tractor Costs Calculation.
- h/ Equipment expense will be calculated just as tractor operating cost is in Example 4.
- i/ Per acre price estimate for combining done by local farmers.
- j/ Current interest rate for Production Credit Association loan; borrowed money will be paid back after an average of 6 months.
- k/ Machinery expense includes tractor ownership cost (Example 4). Ownership cost for other equipment would be calculated in the same manner. Interest on capital is not included.
- l/ \$250 per acre @ 30% valuation @ 30 mills tax rate on assessed value.
- m/ No charge has been made for land, operator's labor, management or interest on capital items.

The net returns section can vary substantially among different budgets, and much of this variation is related to the expenses charged in another section of the budget. There are four basic inputs or factors of production that must be considered in addition to the many variable and fixed expenses that are already listed in the soybean budget. The basic factors are land, labor, management, and capital. In the expenses section of the soybean budget, no payment has been made for any of these inputs. Therefore, in this particular budget the net return of \$50.00 is a return to the land on which the soybeans are grown, to the operator's labor, to the operator's management, and to the investment in capital equipment, all of which go into soybean production.

The expenses section of other budgets may contain a land rent charge, a labor charge, management charge, or a charge for interest on capital investment. When these payments are made within the budget, the net returns over expenses are not a return to those inputs already charged off as expenses. For example, if there is payment made for land rent and labor within the budget, then net returns are a return to management and capital only. Knowing how to calculate net returns is useful when computing various incomes of the farm business. Budgets used in planning should have comparable net return figures to facilitate accurate selection of the most profitable enterprise. Further discussion of net returns will come later under the topic of "Analysis of the Farm Operation."

Example 4. Sample Tractor Costs Calculation

60 HP diesel tractor, Alabama, 1974

Initial Cost <u>1/</u>	Dollars	6,833.00	
Estimated useful Life <u>2/</u>	Years	15	
Average investment <u>3/</u>	Dollars	3,758.00	
Estimated annual Use <u>4/</u>	Hours	800	
Costs of ownership (fixed costs)		Per Year	Per Hour
Depreciation <u>5/</u>	Dollars	410.00 <u>a/</u>	.57 <u>b/</u>
Interest on average investment <u>6/</u>	Dollars	357.00	.446
Taxes <u>7/</u>	Dollars	75.16	.094
Insurance <u>8/</u>	Dollars	18.79	.023
Housing <u>9/</u>	Dollars	56.37	.07
Total ownership costs	Dollars	917.32	1,203
Costs of operation (variable costs)			
Fuel <u>10/</u>	Dollars	864.00	1.08
Oil, grease, and filters <u>11/</u>	Dollars	129.60	.162
Repairs and maintenance <u>12/</u>	Dollars	546.40	.68
Total operating costs	Dollars	1,540.00	1.922
Total costs	Dollars	2,457.32	3.125

1/ A 5-year average of list prices from six dealers around Alabama. (1970-1974).

2/ Estimated, based on ASAE, D230, and Mississippi AES and USDA Bulletin 794, July 1972.

3/ $\frac{\text{Original Cost} + \text{Salvage Value}}{2}$ where salvage value = 10% of original cost.

4/ Estimated useful life/wearout life from ASAE, D230.

5a/ $\frac{\text{Original Cost} - \text{Salvage Value}}{\text{Years of Useful Life}}$

5b/ Original cost/wearout life (does not include any salvage value).

6/ Assumed 9.5 percent on average investment.

7/ Estimated 2 percent of average investment (ASAE, D230).

8/ Estimated at .5 percent of average investment (ASAE, D230).

9/ Estimated at 1.5 percent of average investment (ASAE, D230).

10/ Estimated at 2.7 gal./hr. from ASAE, D230., and 40¢/gal. for diesel fuel.

11/ Estimated at 15 percent of fuel cost based on ASAE, D230.

12/ Estimated, based on ASAE, D230.

The budget section on other required inputs is especially useful when other planning techniques are to be used for a farm. This section gives a list of additional input items that are necessary for production but may have been omitted from the main budget. Land, operator's labor, capital, and management are good examples of such inputs; these are listed in the soybean budget because they are not charged in the expenses section. Other possible entries might include crop allotments or marketing restrictions.

Since our example budgets are for a farm already in operation, some investment in buildings and equipment has previously been made. The farmer owns adequate row-crop equipment, so no additional capital investment is needed for the soybean enterprise. For the proposed catfish enterprise shown in Example 5, however, there must be a substantial amount (\$6,475) of new investment before production is possible, as catfish have never been grown on the farm. These new capital expenditures are itemized in Example 5. Depreciation (annual fixed ownership expense) is computed for eligible items.

When an enterprise has never been produced on a farm, the proposed budget should be as detailed as possible so it can be a management guide. Such a budget has been made for catfish production and additional information is given in the list of "Production Assumptions." In this instance the production assumptions help set an expected management level by establishing the stocking date, fingerling size, stocking rate, feeding rate, and expected date of harvest. Simply putting basic assumptions in writing can often be an important asset when new enterprises are considered for the farm plan.

Each of the previously mentioned sections or additions help make the enterprise budget a practical and effective management tool. Even though enterprise budgets can show the relative profitability and resource use of each undertaking, extra calculations are needed before a farmer can decide how much of different enterprises to include in his farm operation. This is too important to be done haphazardly. A systematic evaluation system is needed, and can be provided by the aid of a computer and linear programming (LP). Most farmers do not have ready and inexpensive access to computers or programmers. Therefore, a method for farm planning called simplified programming (SP), which can be done by the farmer with little expense except time and energy, will be used.

SIMPLIFIED PROGRAMMING

With simplified programming, farm enterprises can be organized to maximize net farm income under certain restrictions existing on the farm. SP accomplishes this by allocating limiting resources to enterprises with the greatest net return for each unit of that resource used.

**Example 5. Sample Enterprise Budget-Cost and Returns for Producing Catfish
on the L. B. Sims Farm, 1975 (5 acres, single cropping)**

Item	Unit	Price per unit	Number units	Total amount
<i>Receipts</i>				
Marketable catfish <u>a/</u>	lb.	\$.45	10,500	\$4,725.00
<i>Variable expenses</i>				
Fingerlings (5-6", 1% mortality)	each	.08	10,605	848.40
Feed (floating, 32% CP)	ton	238.00	9.45	2,220.75
Truck operating expense <u>b/</u>	mi.	.06	600	36.00
Disease control (terramycin 50mg/cc)	cc.	.02	2,500	50.00
Algae-weed control (alagicide)	gal.	12.00	.25	3.00
Parasite control (KMnO ₄)	lb.	.80	10	8.00
Tractor (30 hp) and equipment operating exp <u>c/</u>	hr.	1.20	60	
Additional harvest labor <u>d/</u>	hr.	2.20	12	26.40
Interest on operating expense (\$3,264.55 @ 9 percent for 6 mo.) <u>e/</u>				146.90
Total variable expenses				\$3,411.45
<i>Fixed expenses</i>				
Depreciation and insurance <u>f/</u>				
Pipe, valve, and fittings				60.00
feed blower				30.00
boat				15.00
tractor (30 hp) and rotary mower				28.70
truck (½ ton pickup)				24.50
storage shed				44.55
Land tax (\$200/ac x .3 x .03 x 6ac.)				10.80
Total fixed expenses				\$ 213.55
<i>Total variable and fixed expenses</i>				3,625.00
<i>Net returns above fixed and variable expenses</i> (return to land, labor, management, and capital) <u>g/</u>				\$1,100.00
Other required inputs not previously listed:				
land – 6 acres				
labor – 120 hours				
management – L.B. Sims must be able to follow recommended management practices.				
additional capital – \$6,475				

Additional Investment Items

Item	Purchase price	Salvage value	Expected yr. of use	Annual depreciation	Annual insurance
pipe, valve & fittings	\$1,200.00	\$ 0	20	\$ 60.00	\$ 0
500 lb. feed blower	450.00	0	15	30.00	0
14 ft. aluminum boat	225.00	0	15	15.00	0
storage shed (20' x 30')	600.00	0	15	40.00	4.55
pond construction <u>h/</u>	4,000.00	4,000.00	—	—	0
Totals	\$6,475.00			\$145.00	\$4.55

- a/ See Production Assumptions for details.
- b/ Pickup truck is used for hauling feed and other jobs associated with the catfish unit.
- c/ Tractor is used each day for feeding, for periodical pond bank mowing, and for maintenance of pond during the off season.
- d/ The processor provides harvest equipment and labor to operate this equipment. However, labor in addition to available family labor is needed to help harvest the fish.
- e/ Current interest rate for Production Credit Association loans. This amount will be borrowed on an average of 6 months before repayment. Feed is purchased every 3 months. Other supplies purchased as needed.
- f/ See list of Additional Investment Items for detailed expenses.
- g/ No charge has been made for land, operator's labor, management or interest on capital items.
- h/ Includes all earth moving and land forming. This cost is not depreciated but is accounted for by the increased value of the land where the pond is built.

Production Assumptions

Stock 5–6” fingerlings during first of April at the rate of 2,100 per acre.

Feeding rate is 3% of body weight.

Feed conversion rate is 1.8 pounds feed per pound of gain.

Because of moderate stocking rate and continuous flowing of small stream through the pond, no auxiliary aeration will be needed.

Pond is drained and harvested at the end of October—one harvest per pond.

Processor who purchases the fish will provide harvest equipment and some labor during harvest.

In many ways simplified programming and computer linear programming are similar, but they do have important differences. As its name implies, SP should be limited to organizing relatively simple farm situations in which a maximum of 7 or 8 possible enterprises are considered. Unlike computer LP, the SP technique becomes hopelessly tangled and complicated when too many enterprises are considered at one time. SP is ideally suited to many farm operations, however, and may have additional applications in complex operations when a decision must be made dealing with a certain segment of the farm.

One of the main advantages of simplified programming is that it can be done by the farmer at his convenience. This prevents the cost of outside computer assistance so the only cost to the farmer is his time and effort.

Once the technique is learned, SP is not very time consuming and a lot of the work can be done during idle time, when other jobs are not feasible.

A basic assumption in linear programming is that the unit of an enterprise is completely divisible. As a result, optimum LP farm plans can be created that are not practically feasible. For instance, the catfish enterprise budget presented in Example 5 is based on a 5-acre size unit. The 5-acre size is selected because it has a specific marketing advantage over other size units. One unit will produce 10,500 pounds of fish a growing season. The catfish are harvested and transported live to a processing plant in Greensboro some 100 miles away. A special livehaul truck is necessary to move the fish and keep them alive. The hauling trucks used by this processing plant have a full load at 10,000 pounds each of fish, but will hold up to a maximum of 12,000 pounds during cooler weather.

Because of the distance of the haul, the processing plant is not willing to harvest and transport less than a full 10,000 pound load. Consequently, if a LP solution called for 1.6 units of catfish, this would be 8 acres or 16,800 pounds of production, exceeding the maximum limits of one truck but not filling two trucks. Therefore, to sell the extra 3 acres the farmer would have to locate another producer who wanted to harvest 3,000 to 5,000 pounds of fish to fill the load. However, finding a local producer with this amount of fish ready to harvest may not always be possible, and this creates problems in selling the extra .6 unit of fish.

This could be the situation with a LP solution. However, since simplified programming is done by hand, the problem of divided units can be solved as it occurs. If a SP solution calls for impractical split units of an enterprise, it can simply be included in the farm plan at the next lowest whole unit. Using the previous catfish example, the enterprise would be included in the SP farm plan at the one unit level rather than 1.6 units as indicated. By correcting the farm plan at this point, the resources used by the extra .6 unit of catfish are put back into the resource pool and are available for the remaining possible enterprises. SP can handle other similar types of restrictions just as easily.

The simplified programming procedure is best presented by using examples. For illustrative purposes the hypothetical farm of Mr. L.B. Sims will be reorganized using SP. One of the first steps in SP or any other type of planning is to inventory all available resources of the farm. Mr. Sims' long range plans and aspirations are also important in planning.

After inventorying resources and goals, enterprises must be selected which are to be considered in the new plan. A budget should be prepared for each enterprise showing the extent resources will be used and what the expected net returns will be. The choice of enterprises and net returns levels of the budgets should reflect reasonable management and production capabilities of the farm and farmer.

The following sections contain a thorough listing of the L.B. Sims farm resources, a description of the tables and procedures of SP, and an evaluation of the new farm plan.

Planning Information – L. B. Sims Farm

The L. B. Sims farm is located in south Butler County, Alabama. The farm consists of 125 acres, five of which are occupied by a homesite having a dwelling, garden plot, service roads, and various utility buildings, leaving 120 acres for agricultural purposes. Of this area, 100 acres is Class I and II sandy loam, open land that is quite suitable for row crops. The remaining 20 acres contain 5 acres of pine timber and 15 acres of permanent pasture, with a small year round stream flowing through this portion of the farm. This section is clay loam type soil of the Class III category, making it highly suitable for livestock grazing or other non-cultivation uses.

L.B. Sims, who is 43 years old, has a wife (age 40), two sons (ages 16 and 14) and a daughter (age 13). Mr. Sims has farmed for 20 years, the last 18 of which have been on this farm. In addition to farming, for the past 12 years Mr. Sims has driven a school bus for the county school system. This job occupies an hour and a half each morning and afternoon when school is in session. This time period is usually weekdays from September through May, excluding school holidays. Mr. Sims is paid \$250 a month or \$2,250 annually for driving the bus.

Labor for the farm is supplied by Mr. Sims and his two sons. Mr. Sims works full time at farming during the summer and uses available time for farming when county schools are in session. He estimates that his sons supply 40 hours of labor per month during fall, winter, and spring. During the summer months the younger son helps on the farm, while the older son works full-time at the local Farmers' Cooperative Store. Mrs. Sims has a full-time job in a nearby town, and it is assumed that she and her daughter do the household work but contribute no labor to the agricultural enterprises. Ample seasonal farm labor is supplied locally at the rate of \$2.00 per hour.

Originally Mr. Sims borrowed money from the Federal Land Bank to buy his home and farm. Repayment of the loan occurred over a 15-year period. The final payment was made in October, 1973, and now Mr. Sims is sole owner of the farm. Mr. Sims presently owns the following list of equipment, all of which is debt free: one 30 hp tractor, one 60 hp tractor, tillage implements, planters, cultivators, wagons, and a pickup truck. None of this equipment is new, but all is in good repair.

Mr. Sims has no major outstanding personal debts, and credit references are available. He and his wife have accumulated \$10,000 in a savings account

at a local bank. They have decided to make \$5,000 of the amount available for reinvestment in the farm operation. Their savings were to be used for the children's education or emergency situations, but they feel they can build the account back up before the eldest son is ready for college. Mr. Sims has further indicated that he is willing to borrow up to \$25,000 more capital if needed for the reorganized operation. Therefore, for planning purposes there will be a total of \$30,000 available for additional investment in new farm enterprises.

Mr. Sims is presently using his 100 acres of row crop land for corn, cotton, and tobacco production — 50 acres corn, 45 acres cotton, and 5 acres tobacco. The 20 acres of timber and permanent pasture is fenced and cross-fenced and supports a small cow-calf herd consisting of 13 cows, 10 calves, and 1 herd bull. He has all equipment necessary for land preparation, planting, and cultivating his row crops. Cotton and corn crops are harvested by a neighbor farmer who has a custom harvest business. Tobacco is hand harvested by local labor and cured on the farm in tobacco barns.

Possible Changes in the Farm Operation

Mr. Sims has become dissatisfied with some of the enterprises he now has on the farm and wants to reorganize. He finds it increasingly difficult to maintain an acceptable farm income from his crops and livestock. Recent large fluctuations in cotton prices have caught him by surprise each year. In addition to unsteady prices, production costs have risen steeply; and for these reasons Mr. Sims wishes to discontinue cotton production. Expenses for the cow-calf herd have also risen significantly and calf prices have been weak in recent years. As a result the cow-calf herd has not covered variable expenses for the past 2 years, and Mr. Sims has decided to sell the herd.

In contrast, tobacco and corn have been good cash crops for the farm in the past, and Mr. Sims would like to consider these in the new plan for the farm. However, he wants to make better use of available labor. To accomplish this, he will consider marketing the corn crop through a 20-sow unit producing market hogs. This enterprise will require approximately .5 man-year of labor and should return a larger net profit than received from selling the corn as grain. There are three livestock markets within 50 miles of the farm where the hogs can be sold.

Because of its soil building properties, less expensive fertilizer requirements, and easily accessible market, soybeans will be considered as a replacement row crop for cotton. From observation of other farms in the area, soybeans are well adapted to growing here. There is a grain elevator located 15 miles north of the farm which will buy all beans produced at a competitive price.

Several farmers within a 5-mile radius of the Sims farm went into commercial catfish production during the past 2 years. Total acreage in the area has reached 75 acres, and an agreement has been reached with a processing plant in Hale County, Alabama, to harvest, transport, and purchase the fish. This is made possible by the relative concentration of catfish production in this area of the county. The arrangement has worked out smoothly during the past two harvest seasons. Mr. Sims recognizes a profit potential in this enterprise as well as a possible source of recreation for his family, and would like to consider it in the farm plan. The year-round stream would supply water, and there are pond sites available along the stream.

The final enterprise to be considered in the farm plan is broiler production. This enterprise consists of growing 3-day old chicks to a live weight of 2.5–3.5 pounds per bird. The chicks, feed, medication, and a management service are provided by the processor. The grower is under contract to the processor to grow the birds to a marketable weight. The producers are paid on the amount of gain and the efficiency of gain that is shown by their birds. The producer is responsible for providing a growing house and equipment, water, heat, and cooling for the birds. The size unit considered for the farm is a house with 10,000 square feet. This is both a labor and capital intensive enterprise. It should compete for many of the same resources as hogs and catfish production.

With this information about Mr. Sims, his family, and his farm, a new farm plan can be developed. The following section contains a working description of the process used for the Sims farm.

Preparing Tables Used in Simplified Programming

To be useful in simplified programming, all the information gathered on resources, budgets, etc, must be put in tabular form. In SP three main working tables (I, II, and III) are prepared. From these three tables, decisions are made on which enterprises to include and how much of each enterprise to produce. The final table (table IV) is called “the farm plan” and it records the decisions of what and how much to produce. Also included in table IV is a record of resources remaining after each enterprise is added and cumulative net income. In the following text, tables identified as “Work Tables” specifically refer to the Sims farm example, while any other reference to tables I-IV apply to simplified programming tables in general.

Table I is a list of limiting resources available for farm production and how much of each resource is used by one unit of the various enterprises considered. The main limiting resources are usually land, labor, and capital, with various sub-listings under each category. Management is definitely a

limiting resource on many farms. Since management is hard to quantify, however, it is seldom included in this table. Other restraints such as crop allotments or personal preference items are often included. Also shown in table I is the amount of net returns expected from one unit of each enterprise.

In Work Table I of the example there are 120 acres of land available, of which 100 acres are suitable for row crops and 20 acres are more suitable for pasture-type uses. There are 2,300 hours of total labor available for farm work during the year. This labor is listed as it occurs among the four equal time periods. There is a tobacco allotment of 4 acres, and investment capital is limited to \$30,000.

The first enterprise in Work Table I is 1 acre of tobacco. Because of the necessary use of "sled rows" in harvesting tobacco, 1.25 acres of row-crop land are required to produce 1 acre of actual tobacco. However, no pasture land is required for tobacco production, so this row remains blank in the tobacco column. One acre of tobacco requires 20 hours of labor from January-March, 30 hours from April-June, 60 hours from July-September, and 15 hours from October-December. One acre of tobacco uses 1 acre of allotment and has net returns of \$500. No additional investment capital is needed to produce tobacco. In slight contrast to tobacco is the fourth enterprise — catfish production. The production unit is a 5-acre pond, for

Work Table I. Resource Situation and Enterprise Requirements per Unit of Enterprise

Resource	Amount available	Tobacco 1 acre	Soybeans 1 acre	Corn fed to swine 20 sows	Catfish 5 acres	Broilers 10,000 ft. ² house
Land	<i>Acres</i>					
Pasture land	20	—	—	8.0	6.0	.5
Row-crop land	100	1.25	1.0	70.0	—	—
Labor	<i>Hours</i>					
January—March	550	20	1	330	20	300
April—June	600	30	2	345	40	350
July—September	600	60	—	260	20	325
October—December	550	15	1	330	40	150
Tobacco allotment	<i>Acres</i>					
	4	1				
Investment capital	<i>Dollars</i>					
	30,000	—	—	14,000	6,475	25,000
Net returns		\$500	\$50	\$4,700	\$1,100	\$ 2,000

which 6 acres of pasture land are required. However, it is not possible for these 6 acres to be row-crop land since there are no pondsites on the row-crop land, so this column is left blank. Labor figures are similar in amount to tobacco. The higher amounts of labor required for periods 2 and 4 reflect stocking and harvesting labor. In this enterprise \$6,475 of additional investment capital are required for each 5-acre pond. Each unit is expected to yield \$1,100 in net returns.

It is most desirable to have the resource availability figures, the resource requirement figures, and the net income amount as correct as possible in table I, since tables II and III are computed directly from this table.

Table II shows the maximum number of units of each enterprise that could be produced from available resources if each resource were the only limiting production factor. This table shows what resource most limits each enterprise, and also gives the maximum net income that could be expected if the whole farm's resource were devoted to that one enterprise. This figure is calculated by multiplying the maximum number of units allowed by the most limiting factor times the net returns expected for one unit.

In Work Table II a., if all the row-crop land went into tobacco, 80 units could be produced; 100 acres divided by 1.25 equals 80 units. For labor, 550 hours are available in Period 1, and tobacco requires 20 hours in the same period — 550 divided by 20 equals a maximum of 28 units if Period 1 labor

Work Table IIa. Maximum Amount of Each Enterprise from Total Resources Available

Resource	Amount available	Tobacco 1 acre	Soybeans 1 acre	Corn fed to swine 20 sows	Catfish 5 acres	Broilers 10,000 ft. 2 house
Land	<i>Acres</i>					
Pasture land	20	—	—	2.5	3.3	40
Row-crop land	100	80	100	1.4	—	—
Labor						
January—March	550	28	550	1.7	28	1.8
April—June	600	20	300	1.7	15	1.7
July—September	600	10	—	2.3	30	1.8
October—December	550	37	550	1.7	13.8	3.7
Tobacco allotment	<i>Acres</i>					
	4	4	—	—	—	—
Investment capital	<i>Dollars</i>					
	30,000	—	—	2.1	4.6	1.2
Maximum net income		\$2,000	\$5,000	\$6,580	\$3,630	\$2,400

were the only resource used. The other periods of labor are calculated in the same manner. Four acres of tobacco allotment are available and each unit of tobacco requires 1 acre of allotment — 4 acres allotment divided by 1 acre per unit equals 4 units maximum amount. Investment capital is not a limiting resource for tobacco. A quick glance over the tobacco column of Work Table II a. shows that tobacco allotment is the most limiting resource and it limits production to 4 units. Multiplying the maximum of 4 units times \$500 net profit per unit gives us a maximum net income of \$2,000. This means if all the resources on the farm were devoted to growing tobacco, 4 units would be grown and \$2,000 would be the entire net income for the farm. Maximum net incomes for the other enterprises are calculated similarly. With broilers, however, \$25,000 of investment capital is required for each unit. By dividing the total capital available of \$30,000 by the \$25,000 required per unit, there is a maximum of 1.2 units of broilers. Thus, investment capital becomes the limiting factor for broiler production.

Table IIb. and IIc. are calculated by the same method used for table IIa; however, tables IIb. and IIc. do use a revised resources available base with the same specified resource requirements per unit of enterprise. Tables IIb. and IIc. are calculated after a new enterprise is brought into the farm plan and certain resources are “used up” by that enterprise.

Table III indicates net returns per unit of resource used; like table II, it is derived from table I. Table III is prepared by dividing the amount of each resource used per unit of enterprise into the net income for one unit of that enterprise. All figures in table III reflect dollar amounts of returns even though they are not marked as such.

In Work Table III of the example problem each 1.25 acres of row-crop land used yields income of \$500, giving a net return to row-crop land of \$400 per unit of tobacco ($\$500 \text{ net returns per unit} \div 1.25 \text{ acres row-crop land per unit} = \$400 \text{ net returns per acre of row-crop land}$). For January — March labor a return of \$25 per unit of tobacco is realized ($\$500 \text{ net returns per unit} \div 20 \text{ hours labor per unit} = \$25 \text{ net returns per hour of January — March labor}$). Other enterprises are calculated by the same method. Catfish return \$.17 per dollar of investment capital used ($\$1,100 \text{ net returns per unit} \div \$6,475 \text{ capital investment per unit} = \$.17 \text{ net returns per dollar of investment capital}$).

Now that tables I, II, and III are fully prepared, table IV or “The Farm Plan” can now be constructed.

The objective of the following process is to select the combination of enterprises that will maximize net income from the bundle of resources available to the farm. To accomplish income maximization, each resource

Work Table III. Net Returns Per Unit of Resource Used

Resource	Tobacco 1 acre	Soybeans 1 acre	Corn fed to swine 20 sows	Catfish 5 acres	Broilers 10,000 ft. ² house
Land					
Pasture land	—	—	588	183	4,000
Row-crop land	400	50	67	—	—
Labor					
January–March	25	50	14	55	7
April–June	17	25	14	28	6
July–September	8	—	18	55	6
October–December	33	50	14	28	13
Tobacco allotment	500	—	—	—	—
Investment capital	—	—	.34	.17	.08

that is depleted should be used on the enterprise that yields the greatest net return per unit of the exhausted resource.

Available resources are listed horizontally across the top of the table. These are initially taken from table I. After listing available resources across the top of table IV, the enterprise that yields the highest maximum net income is selected from table II. Then check for the most limiting resource of that enterprise — also shown in table II. From table III, see if any other enterprise has greater returns to that resource than the enterprise chosen. If there is, choose the one with the highest return per unit of that resource used and find its most limiting resource from table II. Again check in table III to see if any other enterprise has greater returns. If so, go through the above process again. If not, include the selected enterprise in the farm plan at the highest level possible.

After including the first enterprise in the farm plan, resources used by that enterprise must be subtracted from total resources available to create a new resource base. It is from this new resource base that table IIb is created. The same process described in the above paragraph is used to select the next enterprise. The only difference is that table IIb is used instead of IIa. An additional table II is prepared after each new enterprise is added in the farm plan. Enterprises are added until there are not enough resources remaining to support any of the remaining enterprises.

Returning to Work Table IIa. of the example problem, swine have the highest maximum net income; and the most limiting factor on swine production is row-crop land. However, checking returns to row-crop land in Work Table III, tobacco has much higher returns to row-crop land than swine.

Work Table IIb. Maximum Amount of Each Enterprise from Total Resources Available

Resource	Amount available	Soybeans 1 acre	Corn fed to swine 20 sows	Catfish 5 acres	Broilers 10,000 ft. ² house
Land	<i>Acres</i>				
Pasture land	20	—	2.5	3.3	40
Row-crop land	95	95	1.36	—	—
Labor	<i>Hours</i>				
January—March	470	470	1.42	24	1.6
April—June	480	240	1.39	12	1.4
July—September	360	—	1.38	18	1.1
October—December	490	490	1.48	12	3.3
Investment capital	<i>Dollars</i>				
	30,000	—	2.1	4.6	1.2
Maximum net income		\$4,750	\$6,392	\$3,630	\$2,200

Again from Work Table IIa., tobacco allotment is tobacco's most limiting resource and Work Table III shows no other enterprise using tobacco allotment. Therefore, tobacco is included in the farm plan at its highest possible level - 4 acres. Resources used by 4 acres of tobacco are recorded in Work Table IV along with the net income. The remaining or "unused" portion of resources are calculated, and accumulated net income at this point is \$2,000.

Work Table IIb. is computed from the set of "unused" resources. From Work Table IIb. the enterprise with the highest maximum net income is still swine and its limiting resource remains row-crop land. From Work Table III, no enterprise returns greater to row-crop land than swine, so swine are included in the farm plan. Here an arbitrary restriction takes affect. From Work Table IIb., the maximum amount of swine allowed by row-crop land is 1.36 units. However, the 20-sow unit was designed to work efficiently as a whole unit. Part of this efficiency is lost if the unit is divided, so all enterprises are restricted to come into the farm plan in one or more multiples of whole units. Therefore, 1 unit of swine is added to the farm plan rather than 1.36 units.

Resources used by 1 unit of swine are subtracted from the total amount of resources unused by tobacco. Accumulated net income becomes \$6,700.

From the resources unused by either tobacco or hogs, Work Table IIc. is computed. At this point please note that the broiler enterprise is no longer

Work Table IIc. Maximum Amount of Each Enterprise from Total Resources Available

Resource	Amount available	Soybeans 1 acre	Catfish 5 acres
Land	<i>Acres</i>		
Pasture land	12	—	2
Row-crop land	25	25	—
Labor	<i>Hours</i>		
January–March	140	140	7
April–June	135	68	3
July–September	100	—	5
October–December	160	160	4
Investment capital	<i>Dollars</i>		
	16,000	—	2.5
Maximum net income		\$1,250	\$2,200

considered in table II. The inclusion of swine into the farm plan used up \$14,000 of the total \$30,000 investment capital available. The \$16,000 remaining capital would only finance .64 units of broilers. Consequently, the decision to include only whole units or multiples of whole units of enterprises is implemented, and growing broilers is no longer a feasible alternative.

Work Table II c. shows catfish having the greatest maximum net income of the two feasible enterprises remaining. Pasture land is its most limiting resource, and soybeans do not provide a return to pasture land. Therefore, two units of catfish production are added to the farm plan.

After the addition of catfish, small amounts of land, labor, and capital remain unused and available for soybean production. The most limiting resource for soybeans is row-crop land, so soybeans are included at the maximum amount of 25 acres. This is the final enterprise to be added to the farm plan—all land has been used up and no enterprise that requires zero acres of land has been considered. Work Table IV now shows the complete farm plan for the Sims farm.

Now the farm plan is complete with recommended enterprises and amounts of each to include in the farm operation. The plan also shows what amount of resources are used and how much net income to expect. All the tables (I-IV) used in the Sims example are grouped in the Appendix so that you can work back through the exercise to check your understanding of the SP process.

At this point it is advisable to remember that this plan is both theoretical and tentative. It shows a recommended course of action, not an absolute one.

Work Table IV. The Farm Plan

Resources	LAND		J-M	LABOR			Tobacco allotment	Investment capital	Accumulated net income
	Pasture	row crop		A-J	J-S	O-D			
	<i>Acres</i>			<i>Hours</i>			<i>Acres</i>	<i>Dol.</i>	<i>Dol.</i>
Total available	20	100	550	600	600	550	4	30,000	\$ 0
4 acres tobacco	—	5	80	120	240	60	4	—	2,000
Unused	20	95	470	480	360	490	0	30,000	\$ 2,000
1 unit swine	8	70	330	345	260	330	—	14,000	4,700
Unused	12	25	140	135	100	160	0	16,000	\$ 6,700
10 acres catfish	12		40	80	40	80	—	12,950	2,200
Unused	0	25	100	55	60	80	0	3,050	\$ 8,900
25 acres soybeans	—	25	25	50	—	25	—	0	1,250
Final unused	0	0	75	5	60	55	0	3,050	\$10,150

The more realistic and accurate the enterprise budgets are, the less theoretical the plan is. However, there are always certain risk and input factors which cannot be considered in simplified programming. Therefore, the farmer should ask himself some basic questions before becoming fully committed to the new plan. Is he really willing to work the specified number of hours and maintain the prescribed management levels? Remember that it may be difficult to change old work and leisure patterns. Are the expected net returns of some enterprise such as swine worth the additional investment risk? If the answer to these questions is “no”, then perhaps the number of available labor hours should be reduced or less capital extensive enterprises should be considered. Then the farm plan can be reworked according to the new restrictions.

Simplified programming is a tool to be used in farm management. However, it is no substitute for common sense. After the plan is completed, again study all elements that went into this plan. Reevaluate the enterprise budgets and the resources available in table I. An error in either one of these two areas can likely become magnified in the final plan. If the plan does not seem acceptable and workable, then try to adjust the plan rather than forcing the farm or farmer to fit it.

There are other ways to evaluate farm plans that are more systematic and less subjective than those described above. These evaluation methods are described in the analysis section.

Problem Areas in Simplified Programming

All farm plans are not as easily formulated using simplified programming as the one for Mr. Sims. Some unique problems occur in SP that were purposely eliminated from the text example so that complications in learning the SP process would be minimized. However, since these problems do sometimes arise, methods for their solution should be discussed.

“Looping” or “cycling,” as one problem is called, occurs between tables II and III as enterprises are selected for inclusion in the farm plan. Remember that enterprise selection in simplified programming is based on allocating a limiting resource (shown in table II) to the enterprise where it earns the highest net returns (shown in table III). The selection procedure works smoothly until an enterprise does not have the highest net returns to its most limiting resource. This situation can develop into a looping complication.

The problem of looping is best explained by use of a practical example involving two enterprises and three resources. Only tables II and III are needed for the illustration, and they are placed side by side in Example 6A to facilitate explanations. The enterprises considered are cotton and peanuts; the resources used are land and two periods of labor, available in the specified quantities.

Example 6A. Looping Problems In Simplified Programming

Table II. Maximum Amount of Each Enterprise From Total Resources Available

Table III. Net Returns Per Unit of Resource Used

Resource	Amount available	Skip-row cotton 1 acre	Peanuts 1 acre	Skip-row cotton 1 acre	Peanuts 1 acre
Land	<i>Acres</i>				
Row-crop land	15	10	15	100	200
Labor	<i>Hours</i>				
Period 1	40	20	13.3	75	67
Period 2	80	11.4	16	21	40
Net income per unit		\$ 150	\$ 200		
Maximum net income		\$1,500	\$2,660		

The reason for the term “looping” will become more evident during the example exercise. Using Example 6A, the SP process is begun by selecting the enterprise from table II with the highest maximum net income and find its most limiting resource. In this case the peanuts enterprise shows the highest maximum net returns of \$2,660 and its limiting resource is period 1 labor, which will allow a maximum of 13.3 units. (The circled figures and arrows in Example 6A and 6B outline points of decision-making and direction of movement in the SP process). Table III shows that cotton, not peanuts, returns higher to period 1 labor; table II shows that land is the limiting resource factor for cotton production. Once more from table III, check if cotton has the highest net returns to land. Again, however, the selected enterprise does not have the highest returns to its limiting resource – cotton returns \$100 per acre of land used, while peanuts return \$200 per acre. Therefore, go back to table II and the peanut enterprise, which is most limited by period 1 labor at 13.3 units.

Now the SP procedure has returned to the beginning. The selection process has achieved a complete cycle, or loop. If programming is continued from this point, the results will always be the same and end in a loop.

The occurrence of a loop is bothersome, but it must be dealt with before the plan can be completed. Even though the loop situation is annoying, its mere existence has implications that should not be overlooked while devising the farm plan.

When looping occurs, it means that no one of the enterprises involved in the loop commands the use of its limiting resource by having the highest

returns to that resource. A looping situation further implies that a farm plan yielding the highest total net returns should include a combination of enterprises in the loop rather than one single enterprise. Even though an enterprise combination is not always practically feasible, this point should be remembered when choosing between enterprises to include in the plan.

Terminating a loop is not difficult. A loop can be stopped quite effectively and quickly by simply choosing the looping enterprise with the highest maximum net income and including it in the farm plan at its maximum level. Then the limiting resource is completely used up, and the planning is finished. In Example 6A if peanuts were selected, 13.3 acres would produce \$2,660 income.

However, since a combination of the two enterprises would yield a higher net return, profit may be sacrificed by choosing only one enterprise. There is a mathematical formula that is used by the computer in linear programming for selecting enterprises in a loop. When attempted by hand, however, reaching a solution to the formula is complicated and time consuming. Similar solutions can be reached more easily by educated "trial and error" guesses. For instance in the peanut-cotton exercise peanuts are by far the most profitable of the two enterprises, so obviously most of the available resources should be devoted to peanut production. However, peanuts are a relatively high user of Period 1 labor. Therefore, when peanuts are brought in at the maximum level they cannot fully use available land or period 2 labor – 1.7 acres and 13.5 hours remain unused if only peanuts are included.

To obtain a more profitable combination of enterprises, begin to substitute cotton for peanuts. Substitution is done in whole units of cotton to simplify the procedure. It is apparent that there is enough land and Period 2 labor already available for one unit of cotton, but the lack of Period 1 labor makes that substitution impractical. The next amount of cotton to try is 2 units. To substitute 2 units of cotton requires 3 acres of land. Twelve acres now remain available for peanuts; and with this amount of peanuts, 4 hours of Period 1 labor become available for cotton production. Four hours of Period 1 labor just meet the requirement of 2 units of cotton, and Period 2 labor will cover 2 acres of cotton and 12 acres of peanuts with 6 hours remaining. Like Period 1 labor, land is completely used up. The 12 units of peanuts generate \$2,400 net returns and 2 units of cotton add \$300. Total net returns for the combination becomes \$2,700, more than the \$2,660 received if only peanuts are grown.

Of course other combinations which include more cotton are possible, but any of these combinations will have a net return less than \$2,700. The diminishing returns are due to the fact that from this point on every time one unit of cotton is substituted for 1.5 units of peanuts, net returns decrease \$150 – 3 units of cotton yield \$450 and 10.5 units of peanuts yield \$2,100 for a total combination income of \$2,550.

The farmer now has some financial data on which to base his planning decisions. He must decide whether or not the extra trouble involved in managing two crops instead of one is worth a \$40 increase in net returns. Chances are in this case that the extra \$40 is not worth the added worry, but at least the farmer has been exposed to more than one possible course of action before he makes his final decision.

Another alternative solution should be mentioned before leaving Example 6A. This solution alternative is not specifically related to the problem of looping, but is quite applicable in this particular instance. Assume that the farmer decided not to grow the 2 units of cotton, and he will put all his resources into peanut production. Under the present assumptions he can grow 13.3 acres of peanuts for which he can expect \$2,660 net returns. However, if the amount of Period 1 labor was raised by only 5 hours to 45 hours total, then the full 15 acres of peanuts could be produced. Fifteen acres of peanuts should bring in returns of \$3,000 – a \$340 increase over the 13.3 level. The 5-hour increase in labor could result either from hiring it done or from additional work time put in by the farmer. Again, regardless of what the farmer decides to do about the labor increase, he should be aware of the possible \$340 additional returns.

The amount of labor a farmer is willing to put in his farm can be an arbitrary figure. If labor is the limiting factor of the final enterprise to come into a farm plan, then the possibility of increasing available labor should always be considered. The same holds true for any other resource that may have arbitrary upper limits such as additional investment capital. When the farmer is presented an option that could substantially increase his income, he may wish to reconsider and increase those resource limits that he can change.

Example 6B illustrates how looping can occur even when one enterprise has an obvious income advantage over the the alternative enterprise. Maximum net income for swine is more than twice as much as the maximum

Example 6B. Looping Problems In Simplified Programming

Table II. Maximum Amount of Each Enterprise From Total Resources Available

Table III. Net Returns Per Unit of Resource Used

Resource	Amount available	Table II		Table III	
		Swine	Beef	Swine	Beef
Land	<i>Acres</i>				
Pasture land	30	3	1.5	1.5	110
Row-crop land	100	2	2.5	50	55
Labor	<i>Hours</i>				
Period 1	500	3	1	15	4.4
Period 2	600	2.5	1.5	10.4	5.5
Maximum net income		\$5,000	\$2,200		

for beef, yet a loop develops because beef has greater returns to row-crop land than swine does. There are sufficient resources available to support a maximum of 2 units of swine or 1 unit of beef – swine is limited by row-crop land and beef is limited by Period 1 labor. Often a livestock unit loses part of its efficiency and profitability when it is broken down to less than a full unit. Assuming these livestock enterprises have indivisible units, the logical choice is the 2 units of swine, which will provide \$5,000 net income.

Using the computer and linear programming, a different solution can be reached that will slightly increase net income. Since linear programming assumes all enterprise units to be completely divisible, LP solves the loop by dividing the resources between the two enterprises. The LP final plan contains 1.63755 units of swine and 0.45306 unit of beef with a total income of \$5,090.61. This \$90 increase could quite possibly be lost in the actual farm operation due to the odd size of units, so the SP solution is still probably the most practical one.

There are certainly other problems that the SP user will come up against occasionally, but most can be solved by careful, logical decision making on the part of the user. When problems do occur, there are usually underlying implications that should be considered. If these implications are remembered and certain broad outlines for decision making are followed, then the results should be a workable, profit maximizing farm plan.

ANALYSIS OF THE FARM OPERATION

There are numerous types of efficiency ratios and incomes that can be used for analyzing a farm operation. Farm analysis can also have different purposes such as helping to decide whether or not a new farm plan should be accepted.

A primary concern of most farmers when adding new enterprises is the increase in liability resulting from additional investment. As indicated in Work Table IV, THE FARM PLAN, Mr. Jones needs a total of \$26,950 in new investment to finance the swine and catfish operations. Therefore, the analysis will show where the new investment capital comes from and where it is used.

** Sources of additional investment required under the new plan:

- personal savings withdrawal	\$ 5,000
- sale of cattle	2,400
- sale of cleared timber	550
- borrowed capital @ 9 percent interest	19,000
Total	\$26,950

** Uses of additional investment
required under the new plan:

- 1 unit swine	\$14,000
- 2 units catfish	12,950
Total	\$26,950

The above information shows that \$5,000 available from savings will be used in the new farm plan. Likewise, sale of the cattle herd and timber cleared from the site of the swine unit will bring in another \$2,950. Thus, \$19,000 remains outstanding and must be procured to meet the investment requirement. This amount can be borrowed from local lending agencies for a 7-year period at a true annual interest rate of 9 percent.

It is now simple to slightly expand the additional investment information and make a list of total farm investment.

** Total farm investment:

- land; row-crop (100 a. @ \$250/a.)	\$25,000
pasture (20 a. @ \$200/a.)	4,000
- used equipment and sheds (excluding residence)	11,000
- swine unit	14,000
- catfish units	12,950
Total	\$66,950

A useful area of analysis can be developed around the net returns figure of the farm plan. The starting point for calculating various incomes is often the "net farm income," which may be derived by simply subtracting the value of unpaid family labor (excluding the operator's labor) from the figure in the example called "net returns." Unpaid family labor consists of 400 hours and it is valued at \$2.00 per hour — the amount that would have to be paid to hire the labor done. The computed net farm income of \$9,350 represents a return to the inputs of the operator's labor, land, capital, and management.

net returns	\$10,150
unpaid family labor (400 hr. @ \$2/hr)	-800
Net farm income	\$ 9,350

Each of the inputs can be assigned a value so they can be charged off the net farm income. There is no set method to calculate the value of inputs.

Some of the possible methods will be discussed as they relate to the L.B. Sims farm example.

Often labor and management are hard to separate if the operator makes his own management decisions, as most farmers do. The operator's physical labor can be charged at the amount required to hire someone else to do this labor. However, it is difficult to determine how many hours of a particular day are spent in manual labor as opposed to time spent managing. If no accurate management charge can be determined, then management is usually treated as a residual charge. This means that after the other three major inputs have been charged off net farm income, any amount that remains is considered to cover the cost of management. This amount can sometimes be negative, which means that there are no returns left to pay for management even if there were a charge.

<i>Input</i>	<i>Value</i>	<i>Method of calculation</i>
labor	\$3,410	– cost of replacing operator's labor (1,705 hr. @ \$2/hr.)
land	1,800	– rental value of the land (120 ac. @ \$15/ac.)
capital	1,710	– actual interest paid on borrowed capital (\$19,000 @ 9 percent annual interest)
	1,421	– forgone interest income on capital investment (excluding land) (\$18,950 @ 7.5 percent annual interest)
management	not calculated	– usually treated as a residual if no accurate management charge can be determined

Land and capital can either be charged at their actual expense to the farmer or, if no cash outlay is made, they can be charged off as an opportunity cost. A cash cost for land or capital might be in the form of rental or lease payments. Another common form of cash outlay is interest payments. Interest payments are made to the lender in return for use of money to purchase land or capital items.

In the example, however, Mr. Sims owns his farm debt free so there is no actual cash expense for land. Therefore, an opportunity cost will be charged for land. An opportunity cost does not involve an actual cash outlay. It does reflect income foregone or lost because a resource was not put to other uses. There are two main alternative uses a farmer can make of land other than working the land himself: (1) he can sell the land and purchase an interest bearing note with the sales proceeds; or (2) he can rent the land to someone else to farm. Either alternative presents the opportunity to earn a steady income from the land resources. Like many other farmers, Mr. Sims considers the farm his home and is reluctant to sell. In this situation renting is a more

feasible alternative than selling the farm; thus, the local land rental price of \$15 per acre is assigned as the land charge.

A capital charge for the Sims farm is calculated using actual cash expenditures and opportunity costs. As previously shown, the farm plan calls for an additional \$26,950 of capital investment, \$19,000 of which must be borrowed. A 7-year repayment schedule has been set up for this loan, Example 7. Example 7 illustrates that the interest due on the loan the first year is \$1,710, the actual cash cost for \$19,000 worth of capital borrowed in year 1. During years 2–7 the yearly cash interest will decrease as the loan principal is paid off. Correspondingly, the opportunity costs on capital should increase as the amount of debt free capital increases.

As with land, capital items can also have associated opportunity costs. An opportunity cost for capital represents potential income that could be received if the capital items were sold and the returns invested. Thus, the opportunity cost for capital items is calculated on their fair market value. In the example problem, money withdrawn from the bank and money from the sale of timber and cattle accounts for \$7,950 of the new investment. There are also \$11,000 worth of capital items that are carried over from the old farm plan. An opportunity cost should be charged for the sum of these two (\$18,950). A 5-year bank certificate could be purchased that would yield 7.5 percent interest, and the note would be guaranteed against default. Therefore, for the opportunity cost on capital, we will use 7.5 percent of \$18,950. The total capital charge consists of actual interest payments and opportunity costs, and it amounts to \$3,131.

Now that a charge has been calculated for each of the basic inputs except management, several types of net returns can be computed. One that should be of interest to a farmer is net returns to labor and management. This figure will show what portion of the net income is attributable to the farmer's time spent laboring and managing. Net return to labor and management is

**Example 7. Sample Loan Repayment Schedule Repayment Plan
for a \$19,000 Loan Borrowed for a Period
of 7 Years at a True Annual Interest Rate of 9%**

Year	Remaining principal balance	Yearly payments		
		Interest	Principal	Total
1	\$19,000	\$1,710	\$ 2,065	\$ 3,775
2	16,935	1,524	2,251	3,775
3	14,684	1,322	2,453	3,775
4	12,231	1,100	2,675	3,775
5	9,556	860	2,915	3,775
6	6,641	598	3,177	3,775
7	3,464	311	3,464	3,775
8	0			
Total		\$7,425	\$19,000	\$26,425

calculated by subtracting land and capital charges from net farm income. To compute this on a per-hour basis, divide the net returns by the total hours worked.

Net farm income	\$9,350
Less charges for land and capital	4,931
Net returns to labor and management	\$4,419 ÷ 1,705 hr. = \$2.59 per hour

Net returns to capital is also often computed. In this case net returns will be to capital and management. By deducting the labor and land charges from net farm income, a return to capital and management remains. Dividing the

Net farm income	\$9,350
Less charges for labor and land	5,210
Net returns to capital and management	\$4,140 ÷ \$37,950 = 11 percent return

returns by the amount of total capital invested gives the percent return to capital and management. Sometimes land is included as part of capital. When that occurs, the calculation yields a percent return to land, capital and management. In the example that return is 9 percent.

Net farm income	\$9,350
Less charges for labor	3,410
Net returns to land, capital and management	\$5,940 ÷ \$66,950 = 9 percent return

So far the various net returns have dealt with many non-cash, approximated costs that are useful for determining efficiency of capital or payments to operator’s labor, but do not indicate how much of the farm income will be available for discretionary use by the Sims family. An income figure which takes into consideration only cash payments will more accurately represent this idea of net spendable income. However, the amount of income and self employment tax that must be paid cannot be calculated. Therefore, the amount computed is correctly termed “spendable farm income before taxes.”

Calculations for spendable income begin with the original net returns amount of \$10,150. Unlike calculating net farm income, unpaid family labor should not be deducted from this amount for two reasons: (1) it is a non-cash expense, and (2) even if cash payments are made, it is a “within family” type expense. Only cash payments associated with the farm business that have not previously been taken out will be subtracted from the \$10,150 net returns. In the Sims farm plan there is only one payment that fits this description. Example 7 showed that \$3,775 must be paid yearly to retire the

loan for borrowed capital in 7 years. This leaves a remainder of \$6,375 to pay taxes and be spent by the family.

Net returns	\$10,150
Less loan expense	3,775
Spendable farm income (before taxes)	\$ 6,375

Two other points about spendable farm income should be discussed. First, there was one non-cash expense already deducted in each enterprise budget — depreciation. Depreciation expense accounts for the wearing out or obsolescence of capital equipment over the years of useful life of that equipment. Theoretically, the depreciation is set aside each year in a special account and is to be used to replace capital equipment when needed. In reality, however, few farmers maintain this special account, and the theoretical depreciation funds are available to be spent by the family. These funds remain available until the capital equipment must be replaced. At this time the purchase price comes directly from the family income or savings account. Therefore, the personal family account often has use of the depreciation fund until it is used. In the Sims example depreciation accounts for perhaps \$2,000 in non-cash expenses.

The second point that should be brought to mind is that the labor situation for the farm was built around the outside jobs of Mr. Sims and his oldest son; Mr. Sims is to drive the school bus from September through May and his son is to work at a co-op during the summer. The flexibility in farming which allows them to keep these jobs might be lost if Mr. Sims had some other occupation. Mr. Sims receives \$2,250 for his school job and his son receives \$750 for his summer work. Thus, their two part-time jobs bring in an additional \$3,000 that can be spent by the family.

This discussion borders on the subject of labor efficiency. There are methods to compute labor efficiency by listing labor inputs and the resulting outputs. Rather than go through similar calculations, it is sufficient to note there were 2,300 hours of labor available and 2,105 hours were used under the new farm plan. Therefore, more than 90 percent of the available labor is used, which indicates better than average labor usage.

Sufficient analysis information should now be available so that Mr. Sims can decide whether or not to implement the new farm plan. He can see what his labor and management are worth, how much his capital outlay is returning, and how much income will be available for his family to spend. If one or more of these and other possible check points is less than satisfactory to Mr. Sims, then he should perhaps take steps to change the plan to better fit his desires.

After the analysis is completed, Mr. Sims should once again look over the basic assumptions of the farm plan to see if they still seem valid. Does a 26

bushel per acre yield and a \$5.00 per bushel price still seem reasonable for soybeans next year? Will the present row-crop equipment actually be sufficient for the crops planned? Does Mr. Sims have the managerial capability to handle three new enterprises begun in the same year? Is he willing to assume the extra risk involved? All these questions are valid and quite pertinent. Many questions such as the above have no absolute answers, but they do merit consideration before the new plan is finally implemented.

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APPENDIX

**Work Table I. Resource Situation and Enterprise Requirements
Per Unit of Enterprise**

Resource	Amount available	Tobacco 1 acre	Soybeans 1 acre	Corn fed to swine 20 sows	Catfish 5 acres	Broilers 10,000 ft. ² house
Land	<i>Acres</i>					
Pasture land	20	—	—	8.0	6.0	.5
Row-crop land	100	1.25	1.0	70.0	—	—
Labor	<i>Hours</i>					
January–March	550	20	1	330	20	300
April–June	600	30	2	345	40	350
July–September	600	60	—	260	20	325
October–December	550	15	1	330	40	150
Tobacco allotment	<i>Acres</i>					
	4	1				
Investment capital	<i>Dollars</i>					
	30,000	—	—	14,000	6,475	25,000
Net returns		\$500	\$50	\$4,700	\$1,100	\$2,000

Work Table IIa. Maximum Amount of Each Enterprise from Total Resources Available

Resource	Amount available	Tobacco 1 acre	Soybeans 1 acre	Corn fed to swine 20 sows	Catfish 5 acres	Broilers 10,000 ft. ² house
Land	<i>Acres</i>					
Pasture land	20	—	—	2.5	3.3	40
Row-crop land	100	80	100	1.4	—	—
Labor						
January—March	550	28	550	1.7	28	1.8
April—June	600	20	300	1.7	15	1.7
July—September	600	10	—	2.3	30	1.8
October—December	550	37	550	1.7	13.8	3.7
Tobacco allotment	<i>Acres</i>					
	4	4	—	—	—	—
Investment capital	<i>Dollars</i>					
	30,000	—	—	2.1	4.6	1.2
Maximum net income		\$2,000	\$5,000	\$6,580	\$3,630	\$2,400

Work Table IIb. Maximum Amount of Each Enterprise from Total Resources Available

Resource	Amount available	Soybeans 1 acre	Corn fed to swine 20 sows	Catfish 5 acres	Broilers 10,000 ft. ² house
Land	<i>Acres</i>				
Pasture land	20	—	2.5	3.3	40
Row-crop land	95	95	1.36	—	—
Labor	<i>Hours</i>				
January—March	470	470	1.42	24	1.6
April—June	480	240	1.39	12	1.4
July—September	360	—	1.38	18	1.1
October—December	490	490	1.48	12	3.3
Investment capital	<i>Dollars</i>				
	30,000	—	2.1	4.6	1.2
Maximum net income		\$4,750	\$6,392	\$3,630	\$2,200

Work Table IIc. Maximum Amount of Each Enterprise from Total Resources Available

Resource	Amount available	Soybeans 1 acre	Catfish 5 acres
Land	<i>Acres</i>		
Pasture land	12	—	2
Row-crop land	25	25	—
Labor	<i>Hours</i>		
January—March	140	140	7
April—June	135	68	3
July—September	100	—	5
October—December	160	160	4
Investment capital	<i>Dollars</i>		
	16,000	—	2.5
Maximum net income		\$1,250	\$2,200

Work Table III. Net Returns Per Unit of Resource Used

Resource	Tobacco 1 acre	Soybeans 1 acre	Corn fed to swine 20 sows	Catfish 5 acres	Broilers 10,000 ft. ² house
Land					
Pasture land	—	—	588	183	4,000
Row-crop land	400	50	67	—	—
Labor					
January—March	25	50	14	55	7
April—June	17	25	14	28	6
July—September	8	—	18	55	6
October—December	33	50	14	28	13
Tobacco allotment	500	—	—	—	—
Investment capital	—	—	.34	.17	.08

Work Table IV. The Farm Plan

Resources	LAND		J-M	LABOR			Tobacco allotment	Investment capital	Accumulated net income
	Pasture	row crop		A-J	J-S	O-D			
	<i>Acres</i>			<i>Hours</i>			<i>Acres</i>	<i>Dol.</i>	<i>Dol.</i>
Total available	20	100	550	600	600	550	4	30,000	\$ 0
4 acres tobacco	—	5	80	120	240	60	4	—	2,000
Unused	20	95	470	480	360	490	0	30,000	\$ 2,000
1 unit swine	8	70	330	345	260	330	—	14,000	4,700
Unused	12	25	140	135	100	160	0	16,000	\$ 6,700
10 acres catfish	12		40	80	40	80	—	12,950	2,200
Unused	0	25	100	55	60	80	0	3,050	\$ 8,900
25 acres soybeans	—	25	25	50	—	25	—	0	1,250
Final unused	0	0	75	5	60	55	0	3,050	\$10,150

[40]