MINIMUM RESOURCE REQUIREMENTS AND OPTIMUM ENTERPRISE COMBINATIONS TO ATTAIN $7,000 NET FARM INCOME IN TWO AREAS OF KENTUCKY

(A Study of the Competitiveness of Beef Enterprises)

By
Alfred B. Kelly and Fred E. Justus

RESEARCH REPORT 27: September 1976

University of Kentucky :: College of Agriculture
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ACKNOWLEDGMENT

This report is based in part on research developed from regional research project S-67, "Evaluation of the Beef Production Industry in the South." This project is a cooperative effort of State Agricultural Experiment Stations in 12 Southern states, the Farm Production Economics Division of the Economic Research Service, and the Tennessee Valley Authority.

The overall objectives of the regional project were (1) to determine various resource characteristics and combinations employed in beef production in the South, evaluate selected operator attributes and appraise adjustment trends that have occurred, (2) to evaluate the micro and macro economic effects of selected aspects of alternative beef production systems, and (3) to estimate for selected alternative systems of beef production the relative effects on firm survival and/or growth of constraints such as forage production risks, price risks, institutional restrictions and changes in value of assets.

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Alfred B. Kelly and Fred E. Justus*

A fundamental premise upon which the science of economics is constructed is that individuals and/or groups behave in an economically rational manner in utilizing scarce resources created by nature and man in attempting to satisfy their unlimited desires for goods and services. An individual decision-maker trying to act in an economically rational manner must operate within a framework of constraints which has technological, institutional (including legal), knowledge and personal dimensions. To accomplish the theoretical goal, individuals try either to maximize some output function (i.e., income, utility, goods, etc.) or to minimize the use of some inputs (i.e., land, labor, capital), while being constantly given new and changing information in a world of uncertain outcomes.

Farm management specialists in their research (and teaching and extension) efforts usually translate this premise to mean maximizing profit from the farm business. On the farm business planning level the goal typically is to determine the kinds and sizes of crop and livestock enterprises, and the amount of labor and capital needed to maximize profit for a given size farm. In application, constraints differ, alternatives permitted in the analysis differ, and even the definition of profit varies somewhat to fit individual circumstances, but the predominant goal is profit maximization.

Farm management specialists, however, are frequently asked questions for which a minimization goal is more relevant. In farm business planning, this goal is particularly relevant for persons who for some reason have identified a certain income level from the business as being "acceptable." Examples of questions for which minimization analysis is appropriate are: (1) How much land and capital do I need to make a "decent" living for my family from farming?, (2) What kind of farm business and what combination of enterprises will provide a designated net income at least cost?, and (3) How much land and how large a beef cow herd must I have to make a given level of net incomes?

Researchers working on Southern Regional Project S-67, officially entitled "Evaluation of the Beef Production Industry in the South," recognized the importance of minimization-type questions to beef cattle producers. Thus, as part of the regional analysis each state was committed to analyze a core of 10 situations in each delineated geographic area using a minimization linear programming model. Descriptions of these situations and analysis results for two Kentucky areas are a major part of this report.

In any research some conceptual questions are critical to the quality of the endeavor and the usefulness of results. For minimization analyses perhaps the most critical decision to be made is in regard to the minimization criteria; i.e., what factor or factors of production should be minimized? It is possible to delineate a number of minimization criteria for analyses on the farm organization planning level. This leads to two questions: (1) Will different minimization criteria yield appreciably different results?, and (2) If analysis results are different, which criterion should be used? The S-67 committee decided that for the core programming all researchers should minimize average capital investment. In Kentucky this effort was expanded for the two key situations in each area. Optimum farm organizations to achieve the designated net income were obtained using four additional minimization criteria, to

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determine if and how the selection of minimization criteria affects results to minimization linear programming analysis. Results are presented as a second major part of this report.

PURPOSE AND OBJECTIVES

The overall purpose of the S-67 research efforts was to evaluate the competitiveness of different beef enterprises and beef-feed systems on farms with representative resource (including the human resource) situations in delineated areas of the South. Linear programming was the analytical tool used.

While a considerable amount of profit maximizing programming was done, it was conceptualized that for some beef producers and potential beef producers in the South the relevant decision goal is determining the optimum enterprise combination and the minimum amount of resources needed to obtain a specified level of net income. It was recognized that the amount of resources needed and the optimum kind of enterprise combination could vary with the kinds of enterprises permitted in the analysis (i.e., considered by the farmer as possible alternatives). Moreover, it was recognized that the amount of resources needed, at least, would vary with the amount of equity a farmer has in the capital resources employed in the farm business.

A core of 10 situations was identified for minimization linear programming analysis. Two different competitive situations were delineated: (1) beef enterprises permitted to compete against all other feasible enterprises in that area, and (2) competition limited to alternative beef and feed supply enterprises (and enterprises such as burley tobacco, which for institutional reasons would be produced on nearly all farms). For each of these competitive situations it was assumed that the operator had 0, 25, 50, 75 and 100% equity in the total farm capital.

In Kentucky, minimization programming was carried out for two areas, designated: (1) the Bluegrass Area (S-67 Area 15), and (2) the Pennyroyal-Ohio Valley Area (S-67 Area 17). The specific objectives of the research presented in this report are:

1. To determine the minimum resources needed and the optimal farm organization to attain $7,000 return to operator's labor, equity and management from farm businesses in two areas of the state.
2. To determine the effects that different decision criteria which may be employed by farm managers would have on the minimum resources needed and the optimal farm organizations to achieve $7,000 returns to operator's labor, equity and management. The decision criteria analyzed were: (1) total annual variable cost, (2) total cost, (3) average investment, (4) acres of openland, and (5) total hours of labor use.

For both objectives, the two competitive situations described above were analyzed. In Objective 1, solutions were obtained for all five equity levels, but in Objective 2 the analysis was limited to the basic 0 equity level (i.e., all costs of capital were charged).

STUDY AREAS

Characteristics of the two study areas shown in Figure 1 are as follows:

Bluegrass Area (S-67 Area 15)—This area corresponds roughly to what geologists and soil scientists refer to as the Inner Bluegrass Area. It contains 12 counties. The topography is gently rolling to steep, with burley tobacco and roughage-consuming livestock being the main farm enterprises. Burley tobacco allotments are large compared with those in other parts of the state. As the fertile land is conducive to high roughage yields, beef cattle production has increased considerably in the past decade. A substantial number of cattle are fed to stocker or slaughter weights.

Pennyroyal-Ohio Valley Area (S-67 Area 17)—This 13-county area includes Pennyroyal Plains counties along the southern border of the state and the Lower Ohio Valley region on the North, joined by a portion of the Western Coal

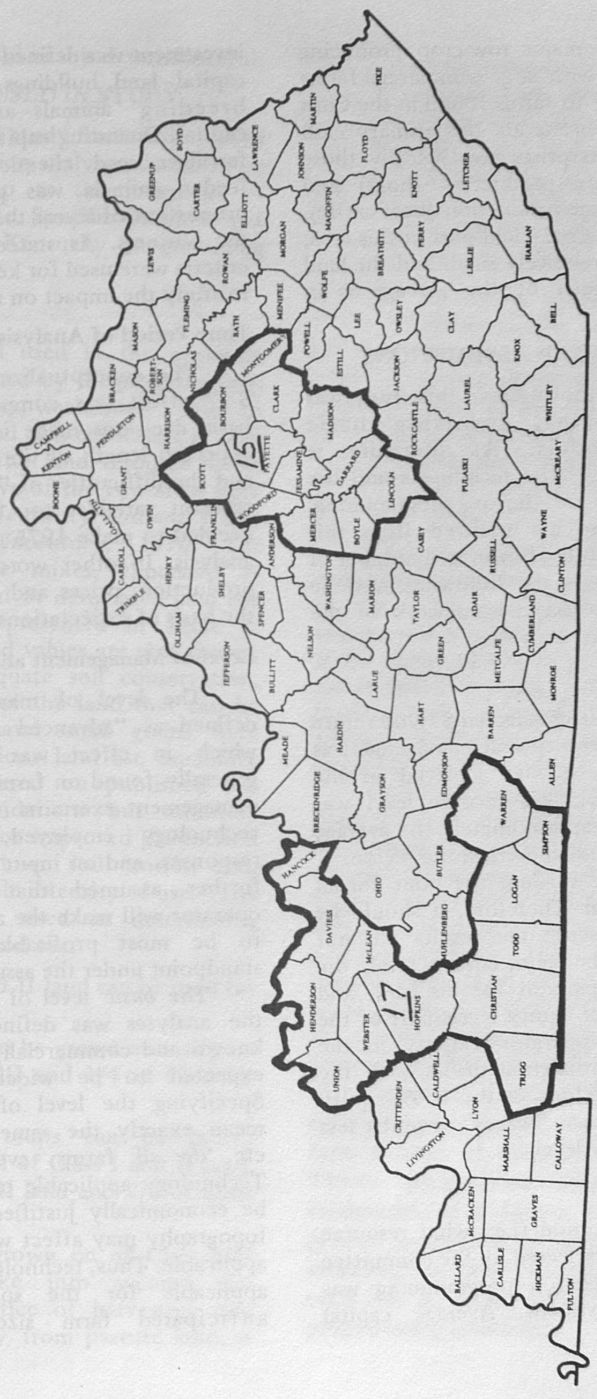

Figure 1.--Areas of Study (Showing S-67 designations).

Fields. This is the major row-crop producing region of the state, with large commercial farms that are very similar to farms found in the Corn Belt. Corn and soybeans are the primary cash crops. Livestock enterprises are typically those associated with corn production (hogs) and supplemental roughage production (beef cattle).

In the Western Coal Field part of this area, however, farms are relatively small and the land is unproductive. Much of the acreage is in pasture.

PROCEDURES AND ASSUMPTIONS

The analytical tool used in this study was linear programming, involving basic minimization models. As literature is voluminous on the specific techniques and the mathematical bases of linear programming, descriptions of these are omitted from this publication. In any study, however, a number of basic decisions such as the following must be made to provide the basic framework of the specific study.

Income Target

The S-67 committee selected $7,000 return to operator's labor, equity and management as the level of income to be achieved in the minimization analysis. This income level was selected to represent approximately the average gross earnings of skilled laborers in the region.

The income goal remains the same for all equity levels analyzed. Therefore, it should be noted that in one sense the results are not commensurate. At the zero equity level, the returns reward the operator for his labor and management. At other equity levels part of the $7,000 rewards the operator's equity in the business, and this proportion grows with the equity assumed. Therefore, at the 100% equity level the operator's own "wages" is much less than at the zero equity level.

Decision Criteria

The decision criterion (i.e., what resource should be minimized) selected by the committee for the core minimization programming was average capital investment. Average capital investment was defined as the sum of investment capital—land, buildings, facilities, machinery and breeding animals—and prorated operating capital. Operating capital used for such things as fertilizer, seed, chemicals, feed and purchased feeder animals was prorated based on the proportion of a year that the capital is tied up in the business. As stated earlier, four additional criteria were used for key situations in Kentucky to study the impact on results.

Time Period of Analysis

The conceptualization of this part of the S-67 effort was completed and many of the basic decisions made in 1969. Because of the expected length of time to complete this study and the difficulties of "predicting" many of the relevant variables too far in the future, it was decided to make 1975 as the target date for the analysis. In other words, technology, physical production, prices and costs were estimated on the basis of expectations for 1975.

Level of Management and Technology

The level of management assumed was defined as "advanced management in 1969," which in effect was that expected to be generally found on farms in 1975. This level of management exerts its influence on the level of technology employed, physical production responses, and on input and output prices. It is further assumed that the individual farm operator will make the adjustments that appear to be most profitable from his individual standpoint under the assumed conditions.

The *basic* level of technology assumed in the analyses was defined as that which was known and commercially available in 1969 and expected to be widely adopted in 1975. Specifying the level of technology does not mean exactly the same practices, equipment, etc. on all farms, even in the same area. Technology applicable on large farms may not be economically justified on small farms., and topography may affect what crop technology is applicable. Thus, technology in this effort is that applicable for the specific area and the anticipated farm size range (preliminary

programming was helpful in this determination).

RESOURCES USED IN STUDY

Within the general study framework agreed upon for the minimization analyses, decisions on resources were left up to the judgment of researchers in each state. Specific decisions and assumptions for the Kentucky programming follow.

Land

Amounts of land used in the optimum solutions were determined by the programming. Quality of land, however, was assumed prior to programming, and served as a constraint in land use and crop yields. The land resource mixes assumed as representative of the two areas were based on data in the *Kentucky Soil and Water Conservation Needs Inventory, 1970.* The assumed land resource mixes, expressed as percentages of openland in designated land use capability classes are presented in Table 1. Assumed associated land values are also shown.

To maintain adequate soil conservation, maximum proportions of the land that can be used for row crops and small grains were established for the various land use capability classes. These were based on published soil conservation recommendations but modified somewhat to account for improved production practices which hold down soil erosion and, thus, increase "acceptable intensity of use." The following guides were used in determining maximum intensity of land use.

1. All Class I and II land can be used for row crops.
2. Row crops can be grown annually on 1/3 of Class III and 1/4 of Class IV land.
3. Small grain crops can be grown annually on all of Class I and II land, 2/3 of Class III land and 2/5 of Class IV land.
4. Hay can be grown on all Class I-IV land. To take into account the common practice of harvesting one cutting of hay from pasture land, it was assumed that 20% of Class VI land can be harvested as red clover-grass hay.
5. Except for the hay harvesting just mentioned, pasture has exclusive use of Class VI land. Pasture can also be grown on all other land, if it competes economically.
6. If no-till production practices are followed, the maximum intensitives change to: (A) row crops can be grown on all of Class I and II, 2/3 of Class III and 1/3 of Class IV land; (B) small grains can be grown on all Class I-II, the remainder of Class III (left after row crops), and 1/3 of Class IV land.

The programming model was set up so that each class of land was a resource in proportion to the percentages shown in Table 1. Crops competed for each class of land independently, to the extent permitted by the land use intensity maximums. Each class of land had a land charge (interest and property tax) based on the assumed land value, that was charged against the crops competing for its use.

Only openland suitable for crops and/or pasture enters the programming directly, but every farm has some land in roads, farmsteads, woods, etc. As the amount (and proportion) of nonproductive land varies greatly from farm to farm, it was decided to assume only a "nominal proportion" of this type land in the representative land mix and charge interest and taxes on this land against the farm business (not the crops). It was assumed that for every 100 acres of openland in the Bluegrass farm 7.5 acres of nonproductive land is also brought into the solution; and in the Pennyroyal-Ohio Valley farm 5 acres of nonproductive land is added. These proportions should be considered minimums. If a farmer buys a farm with a greater proportion of unproductive land than assumed, the capital investment and associated costs will be higher than those obtained in the programming solutions.

TABLE 1

Representative Land Resource Mixes Assumed, and Associated Land Values

Land Use Capability Class	Bluegrass Area		Pennyroyal-Ohio Valley Area	
	% of Openland	Value Per Acre	% of Openland	Value Per Acre
I - II	32.2	$600	45.9	$400
III	20.8	450	24.6	350
IV	14.9	350	13.3	250
VI	32.1	275	16.2	200
TOTAL	100.0	$427	100.0	$335

Tobacco Allotment

The size of the burley tobacco allotment was determined by the programming. The allotment was put in the model as so much tobacco *acreage* per 100 acres of openland brought into the solution. Even though the present burley tobacco price support program is based on poundage rather than acreage, using acreage in the programming simplified the model. Acreage assumptions, however, are directly associated with prevailing poundage levels. It was assumed that for each 100 acres of openland, the burley tobacco allotment would be 2.05 acres in the Bluegrass Area and 1.26 acres in the Pennyroyal-Ohio Valley Area.

In the Pennyroyal-Ohio Valley Area some farmers have small allotments of dark tobacco. As the number of farmers raising dark tobacco and the size of allotments are small, dark tobacco was not considered as an enterprise in this analysis.

Labor

Labor requirements of the various enterprises and the labor constraints in the programming were in terms of hours of direct labor needed and supplied in bimonthly periods. There is sufficient "time flexibility" in the seasonal production jobs to make the bimonthly time period a relevant constraint.

In this programming, a full-time farm operator was assumed. Of the 2,500 hours time the operator supplies to the farm annually, it was assumed that 30% is used for overhead labor and management tasks, including the supervision of hired labor. The remainder of his time is available for direct crop and livestock labor requirements. In this analysis, no other family labor was included.

Full-time hired labor was not included in the assumed labor supply. Hourly seasonal labor could be hired at a wage rate of $1.75 per hour, but maximum bimonthly limits were put on the amounts. The maximum amounts corresponded roughly to that of a full-time hired man, except in periods of peak labor needs for such chores as tobacco housing and stripping. The limits were relaxed in these periods based on the premise that operators would somehow get the labor to get these jobs done. Permitting hourly seasonal hired labor but not permitting full-time hired labor made hired labor strictly a variable input, with use and cost to the business dependent upon need. Bimonthly labor supplies for direct use are shown in Table 2.

Capital

It was assumed in this study that the operator could obtain all the capital needed for investment and operational purposes. Thus, as long as it was profitable to employ capital, there was no maximum constraint. It was assumed that the operator had to pay 6% annual interest on borrowed investment capital and 7% interest on borrowed operating capital. The interest charge on operating capital was prorated, i.e., the charge was only for the proportion of a year that the capital was actually used by an enterprise.

No charge was made against the business for the operator's own capital used in the business (equity). Thus, in the zero equity level analyses interest was charged for all capital; and, on the other hand, in the 100% equity analyses no interest was charged.

ENTERPRISES PERMITTED AND OPERATIONAL ASSUMPTIONS

In the programming, two different competitive situations were delineated. In the first situation, beef enterprises were competing with all other feasible enterprises in the area. In the second situation, competition was limited to burley tobacco and alternative beef and feed supplying enterprises.

Enterprises listed below were considered in the Kentucky analyses. Limitations on these enterprises are also noted.

Crop Enterprises

Cash and Grain Crops

1. Burley tobacco.
2. Corn (conventional minimum tillage).
3. Corn (no-till practices).
4. Wheat.
5. Barley.

TABLE 2

Hours of Labor Available for Direct Crop and Livestock Labor Needs

	Operator's Labor[a]	Hourly Seasonal Hired Labor
Jan. - Feb.	258	332
Mar. - Apr.	305	1000
May - June	305	500
July - Aug.	272	350
Sept. - Oct.	305	500
Nov. - Dec.	305	1200
TOTAL	1750	3882

[a]It was assumed that the operator would take weekly vacations in August and in January - February.

6. Soybeans (Pennyroyal-Ohio Valley Area only).
7. Wheat-soybeans double-cropped (Pennyroyal-Ohio Valley Area only).
8. Barley-soybeans double-cropped (Pennyroyal-Ohio Valley Area only).
9. Corn-soybeans-barley (3 crops in 2 years, Pennyroyal-Ohio Valley Area only).

Mechanically Harvested Forage Crops

1. Corn silage (no-till).
2. Corn silage-barley silage double-cropped.
3. Alfalfa-grass hay.
4. Red clover-grass hay.
5. Annual lespedeza hay.

Pasture alternatives

1. Improved grass pasture (regular nitrogen applications).
2. Grass-legume pasture.

Combination (pasture-mechanically harvested) alternatives

1. Improved grass hay-pasture (regular nitrogen applications) – primarily a pasture crop, with surplus spring growth harvested as hay.
2. Grass-legume hay-pasture – primarily a pasture crop, with surplus spring growth harvested as hay.

Decisions regarding crop enterprises for inclusion in the study, production practices and crop yields were made in consultation with crop specialists in the University of Kentucky Agronomy Department. Because anticipated crop acreages were too small to justify the ownership of specialized harvesting equipment, custom harvesting of grain and silage crops was assumed. Expected crop yields are shown in Table 3.

Livestock Enterprises

The following livestock enterprises were included as alternatives in the analyses. As considerable variation is possible in production practices, timing and physical efficiency of livestock enterprises, a brief description of each enterprise is also presented. Decisions about enterprises to be included, as well as physical production relationships, were made in consultation with specialists in the University of Kentucky Department of Animal Sciences.[1]

Beef Cow Herd Enterprises

1. Beef Cow Herd, Feeder Calves Sold – Calves are born in the spring (March-early April) and sold about December 1st. Sale weight averages 500 pounds. Calving rate is 92%, with 5% death loss. Calves are creep fed for 150 days. No specialized buildings are required for this enterprise. Cattle can use tobacco barns during severe weather.
2. Beef Cow Herd, Calves Sold as 650 pound Feeders – Calves are born in spring (March-early April), weaned in the fall and kept on the farm instead of being sold. They are carried over the winter on hay, grazed for 60 days in the spring, and sold in June as 650 pound yearling feeders. Creep feeding of nonweaned calves is limited.
3. Beef Cow Herd, Calves Fed to Salughter Weight – In this enterprise calves are born in spring, weaned in fall, wintered on hay, grazed for 60 days, and then fed grain and supplement on pasture until finished. Slaughter cattle are sold at 1,045 pounds in November.

Cattle Feeding Enterprises

1. Winter Feeding Steer Calves on Silage – High Good steer calves weighing 400 pounds are purchased in early December. These calves are placed in a semi-confinement feeding area to be fed corn silage and supplement. Their daily ration for the total feeding period averages 35 pounds of corn

[1] The ideas and judgements of a number of specialists were utilized in enterprise selection and production relationships estimations. Special note should be made of the contributions of the following persons: T. H. Taylor and W. C. Templeton of the Agronomy Department; S. H. Phillips, Assistant Extension Director; and N. W. Bradley, G. L. M. Chappell and Nelson Gay of the Department of Animal Sciences.

TABLE 3

Crop Yields Assumed, By Area of State and Land Use Capability Class

Crop	Unit	BLUEGRASS Land Class I-II	III	IV	VI	PENNYROYAL-OHIO VALLEY Land Class I-II	III	IV	VI
Burley Tobacco	lb.	2900	--	--	--	2700	--	--	--
Corn (Convent.)	bu.	95	92	92	--	105	100	100	--
Corn (No-till)	bu.	105	105	105	--	115	115	115	--
Wheat	bu.	50	48	43	--	50	48	43	--
Barley	bu.	66	64	60	--	67	64	62	
Soybeans	bu.	--	--	--	--	35	32	32	--
Soybeans (Barley D.C.)	bu.	--	--	--	--	25	24	24	--
Soybeans (Wheat D.C.)	bu.	--	--	--	--	23	22	22	--
Corn Silage	tons	18	18	--	--	19	19	--	--
Corn Silage (double crop)	tons	17	17	--	--	17	17	--	--
Barley Silage (double crop)	tons	8	6	--	--	10	9	--	--
Alfalfa-grass hay	tons	5.0	5.0	4.5	--	5.0	5.0	4.5	--
Red Clover - grass hay	tons	3.0	3.0	2.75	2.5	3.0	3.0	2.75	2.5
Lespedeza hay	tons	1.5	1.5	1.25	--	1.5	1.5	1.25	--
Grass (Nitrogen) pasture	lbs. TDN[a]	3150	3150	2800	2520	3150	3150	2800	2520
Grass-legume pasture	lbs. TDN	2940	2940	2640	2225	2940	2940	2640	2225
Grass (Nit.) pasture -hay[b]	lbs. TDN	--	3250	2850	--	--	3340	2945	--
Grass-legume pasture-hay[b]	lbs. TDN	--	3040	2710	--	--	3130	2800	--

[a]Net pounds available for consumption.

[b]Pounds of TDN include TDN in harvested hay.

silage and 1.3 pounds of supplement. They have an average daily rate of gain of 1.6 pounds. The feeding period is 150 days long, and they are sold as 625-pound Choice feeders during May. Silage is assumed to be stored in a bunker silo.

2. Feeding Steer Calves on Silage (Two Lots Sequence) – This enterprise is the same as Number 1, except that two lots per year are involved. This double use of facilities and equipment spreads fixed costs. One lot of 400 pound steer calves is purchased in December and sold in May; the second lot is purchased July 1st, to be sold in late November.

3. Wintering Steer Calves on Hay – High Good steer calves weighing 400 pounds are purchased in early December and placed in a semi-confinement feeding area to be fed good quality hay and supplement. The steers have an average daily rate gain of 1.0 pounds. They are fed for 150 days, then sold as 550 pound Low Choice feeders during May.

4. Winter-Spring Steer Calf Feeding (Hay) – High Good steer calves weighing 400 pounds are purchased in early December. They are fed good quality hay through April and then put on pasture for 60 days. Their average daily rate of gain is 1.10 pounds per day. They are sold July 1st as 610 pound Choice feeders.

5. Winter-Spring Steer Calf Feeding (Silage) – High Good steer calves weighing 400 pounds are purchased in early December. They are fed corn silage through April in drylot, and then grazed for 60 days. Their average daily winter ration is 35 pounds of silage and 1.3 pounds of supplement. The daily weight gain is 1.5 pounds. The selling date of the Choice feeders is July 1st, at 720 pounds. Use of a bunker silo is involved, thus holding down capital investment.

6. Winter Feeding Heavier Steer Calves on Silage – Choice steer calves weighing 500 pounds are purchased in early December. These steer calves are placed in a semi-confinement feeding area for the entire 150 day period they are on the farm. The ration fed is 35 pounds corn silage and 1.5 pounds of supplement per day. This gives an average daily rate of gain of 1.5 pounds. Choice 725 pounds feeder steers are sold in early May. An Upright silo is assumed.

7. Feeding Heavier Steer Calves on Silage (Two Lots Sequence) – This enterprise is the same as Number 6, except two lots are fed each year. Double use is therefore made of facilities and equipment. One lot of 500 pound steer calves is purchased in December and sold in May. The other lot is purchased July 1st and sold in late November.

8. Winter Feeding Heavier Steer Calves on Silage II – This enterprise is identical to Number 6, except that bunker silos are used to permit lower fixed costs of operation.

9. Winter Feeding Heavier Steer Calves on Hay – High Good steer calves are purchased at 500 pounds about December 1st. They are placed on a quality hay ration for 150 days, while being kept in a semi-confinement feeding area. The average daily rate of gain is 0.93 pounds. They are sold as Choice 650 pound feeders in May.

10. Finishing Steers on Pasture – Low Choice 625 pound yearling steers are purchased about May 1st. They are grazed for 60 days, then self-fed a shelled corn and supplement ration on pasture for the remainder of the feeding period. The average daily gain is 2.3 pounds. These steers are sold as

Choice slaughter cattle in November, weighing 1,045 pounds.

Ewe Flock Enterprises

1. Ewe Flock (High TDN Ration) – Ewes lamb in late winter (January 15th to March 1st). Lambs are weaned at 8 weeks of age, fed a high TDN ration, and sold in June at an average weight of 100 pounds. Ewes make maximum use of grazed forage. This enterprise is limited in the programming to the Bluegrass Area.

2. Ewe Flock (High Quality Pasture Program) – Ewes lamb in late winter, lambs are weaned at 8 weeks of age and grazed on high quality pasture until marketed. Lambs are sold at the same average weight as those fed the high TDN ration but will reach the market 10 days later. This enterprise is also limited to the Bluegrass Area.

Swine Enterprises

1. Swine Herd-hogs Fed to Slaughter Weight – This sow herd activity involves a two-litter production system (farrowing in February and August), with slaughter hogs sold at 220 pounds, 6 months later. This is a confinement operation.

2. Swine Herd-hogs Fed to Slaughter Weight – Same basic enterprise as Number 1, except that multiple farrowing is involved (February, May, August, and November). This alternative makes greater use of farrowing facilities and, thus, lowers per unit investment and fixed costs. However, a higher level of operational management is required.

3. Swine Herd-feeder Pigs Produced – This enterprise involves a semi-confinement system of production (pigs are completely confined). A two-litter system is employed, with farrowing in March and September. Pigs are sold at about 60 days of age, weighing an average of 40 pounds.

4. Swine Herd-feeder Pigs Produced – This alternative is the same as Number 3, except that four farrowings are made each year. The result is lower investment and fixed costs per unit.

5. Finishing Purchased Feeder Pigs – This enterprise involves purchasing 40 pound feeder pigs about December 1st and feeding them to 220 pounds (120 days on the farm). They are fed in confinement, with a feed conversion ratio of 3.8 to 1. This enterprise utilizes available farm labor in the winter months when other labor needs are low.

6. Finishing Purchased Feeder Pigs – This enterprise involves purchasing 40 pound feeder pigs three times a year (about December 1st, April 1st, and August 1st). Sale of 220 pound slaughter hogs would be 120 days later than these dates. This activity involves year-round use of labor, thus, it competes with crops. It also means multiple use of confinement feeding facilities.

Limitations on Livestock, and Enterprises Omitted

Considering the level of existing management and technology in relation to the needs of large-scale livestock enterprises, limits were placed on the size of certain livestock enterprises. Available feed supply and anticipated size of farm needed to achieve $7,000 net returns also were factors in the size limitation decisions. The following maximum numbers were set.

1. Swine herd was limited to 40 sows. These could produce all feeder pigs, all slaughter hogs, or any combination determined by the programming.

2. The maximum number of purchased feeder pigs was 600. This restriction is independent of the sow herd restriction.

3. The maximum number of purchased feeder cattle that could enter the solution was 1,000. The maximum is for the total of all purchased feeder cattle enterprises which enter the solution.

Dairy cattle and poultry enterprises were excluded from the analyses. These enterprise require specialized investments and marketing outlets. They also require operator interests and work regimentation not generally found in the two areas.

PRICES AND OTHER ASSUMPTIONS

Perhaps the most critical variable in determining the usefulness of programming results is the assumed price relationships – the assumed level of output prices, the relationships between output prices, and the relationships between input and output prices. A special S-67 subcommittee was established to study agricultural price trends, cycles and relationships, and recommend a set of prices and price guides. Their recommendations, based on price expectations for 1975 (6 years in future from the time this analysis was conceptualized), were approved as the standards for use by all states.[2] Variations from specific approved prices would be made by individual states if actual regional differences exist. Commodity prices used in the Kentucky analyses are shown in Table 4. Other price assumptions are as follows.

1. Prices of operational inputs were left up to the individual states. These were to reflect expected prices in 1975. Prices for the major resource items, labor and capital (presented earlier), were established by the committee.

2. While it was left up to individual states to decide which cost items were included in enterprise budgets, it was recommended that general overhead costs, where possible, be charged in appropriate enterprise budgets.

Physical Production Assumptions

1. Sale of grain was permitted in situations where beef enterprises competed with all other feasible enterprises, but excluded in the models where competition was limited to alternative beef and feed supplying enterprises. Purchase of grain for livestock feed was not permitted in any situation.

2. Hay and other forages could be neither sold nor purchased in this minimization effort.

3. TDN was approved as the standard for livestock feed requirements. Individual states could use additional nutrient constraints. The official reference used as a guide by individual states in making feed requirement estimates was the National Academy of Science, National Research Council Standards publications.

4. Pasture forage supplies and requirements were estimated for monthly periods. Having monthly pasture constraints in the models, as opposed to a much simpler annual constraint, more closely approximates the seasonal pasture production variation problems actually faced by livestock farmers. Moreover, among the beef enterprises analyzed some had different seasonal pasture requirements; thus, it was possible to more accurately evaluate the competitiveness of various "beef-feed systems."

Budget Review

All enterprise budgets developed for this programming were reviewed by a budget review subcommittee. The budget review subcommittee

[2] Price estimates were made, using historical data (with emphasis on recent years) and taking into account trends and changing relationships. Some account was also taken of inflation, which was expected to affect input prices.

The actual volatility of farm output prices during 1973-1975 and the rate of inflation for input prices were beyond the range of experience or expectation of agricultural economists when these prices were established. Some of the assumed prices, therefore, are presently out of line. But considering the competitive position of agriculture, and since most of the relationships are fundamentally sound given a reasonable time-span, the results of this minimization analysis are still germane.

TABLE 4

Commodity Prices Assumed in Minimization Programming

Product	Unit	Price
Crops[a]		
Corn - buy	bu.	1.35
- sell	bu.	1.22
Wheat	bu.	1.30
Barley	bu.	.90
Soybeans	bu.	2.75
Burley Tobacco	lb.	.75
Livestock		
Swine:		
Barrows and gilts (220#)	cwt.	21.00
Sows	cwt.	17.00
Feeder Pigs (40-50 lbs)	cwt.	37.00
Sheep:		
Lambs	cwt.	27.50
Ewes	cwt.	9.00
Beef Cattle:[b]		
Feeder Calves (400#)	cwt.	32.50
Feeder Calves (500#)	cwt.	33.00
Feeders (625-725#)	cwt.	31.75
Slaughter Cattle (1045#)	cwt.	30.00
Cull Cows	cwt.	22.00

[a]Grain prices are for a period 30-45 days after harvesting and include no storage costs.

[b]Some prices assumed for individual beef enterprises vary slightly from the prices shown, accounting for different grades of feeders and different times of purchase and sale.

TABLE 5

Farm Plans that Achieve $7,000 Return to Operator's Equity, Labor and Management at Lowest Total Capital Investment for Different Equity Levels: Farms in the Bluegrass Area of Kentucky, All Enterprises Permitted to Compete

Item	Unit	Equity Level 0	25	50	75	100
Crop Enterprises						
Burley Tobacco	ac.	2.04	1.78	1.61	1.47	1.35
Corn (No till)	ac.	42.6	37.3	33.6	30.7	28.3
Wheat	ac.	6.8	5.9	5.4	4.9	4.5
Barley	ac.	5.7	5.0	4.5	4.1	3.8
Alfalfa Hay	ac.	3.4	2.3	1.8	1.3	1.0
Pasture	ac.	--	--	--	--	--
Livestock Lots	ac.	5.3	5.2	5.0	4.9	4.7
Idle Land	ac.	31.3	27.4	24.7	22.5	20.7
Total Land	ac.	97.1	84.9	76.6	69.9	64.4
Livestock Enterprises						
Hogs-Feeder Pigs Produced	sows	11	21	24	26	29
Hogs-Farrow to Finish	sows	25	19	16	14	11
Beef Cows	hd.	--	--	--	--	--
Purchased Cattle (Feeding System C)*	hd.	17	12	9	7	5
Other Activities						
Corn Sold**	bu.	0	0	0	0	0
Seasonal Hired Labor	hrs.	448	350	260	187	136
Financial Summary						
Operating Capital (prorated)	$	6,031	4,605	4,140	3,771	3,456
Investment Capital (nonland)	$	31,869	29,558	27,052	25,039	23,459
Land Investment	$	41,494	36,252	32,755	29,870	27,520
Total Capital Investment	$	79,394	70,415	63,947	58,680	54,433
Gross Farm Income	$	27,531	23,804	21,640	19,878	18,448
Total Cost	$	20,531	16,804	14,640	12,878	11,448
Operator's Equity, Labor and Mgt. Returns	$	7,000	7,000	7,000	7,000	7,000

* This enterprise involves purchasing 400# calves Dec. 1, wintering on hay, selling May 1 as 550# feeders.

** Corn purchase was not permitted, but corn could be sold in this situation.

was comprised of three farm management specialists (members of the committee) and eminent agronomy and animal science specialists (one from each discipline) from the region. Consistency of budget coefficients (from state to state), rather than sameness, was the objective of this effort. The primary job of the review committee was to locate areas of apparent inconsistency in budgets of different states and make recommendations for additional consideration.

RESULTS OF ANALYSIS

The remainder of this report is devoted to the results of the minimization linear programming. Presented first are the results using average capital investment as the decision criterion. These optimum solutions are for the situations programmed as the commitment to the regional project. The results are, therefore, direct contributions to that effort.

Minimum Resources to Achieve $7,000 Income

The direct commitment involved 10 situations in each area — two different competitive situations, programmed at five different equity levels. Optimum solutions at the zero equity level may be considered the "primary" or "basic" solutions, as all farm inputs are charged except operator's labor and management. The $7,000 net income rewards operator's labor and management. Presentation of results in the text takes the general format of discussing first the "primary" solution (for a given competitive situation), and then discussing the changes that occur in the optimum solution as the operator's equity is increased.

Bluegrass Area

All Enterprises Permitted in Analysis – The farm organizations in the Bluegrass Area that achieve $7,000 return to operator's labor, equity and management at lowest average investment when all feasible enterprises are permitted to compete are presented in Table 5. Resources needed and the enterprises which comprise the optimum farm organization are shown for all five equity levels.

When all feasible enterprises are permitted to compete, at the zero equity level it takes 97.1 acres of openland, 448 hours of hired labor, and a average capital investment of $79,394 to achieve a $7,000 return to operator's labor and management. The optimum farm organization contains two major and one minor cash income producing enterprises. Burley tobacco (2.04 acres) and a swine herd of 36 sows are the major income producing enterprises. The optimum organization calls for the pigs from 11 sows to be sold as feeder pigs; the remainder are fed on the farm and sold as slaughter hogs. The farm organization also includes 17 feeder calves, to be purchased at 400 pounds about December 1st, wintered on hay, and sold May 1st as 550 pound feeders. This enterprise requires a relatively small capital investment and utilizes the operator's labor during the slack winter months.

The land use, except for burley tobacco, reflects the feed requirements of the livestock – particularly the hogs. The maximum amount of corn that could be produced (42.6 acres), considering the soil conservation needs of the land resource mix, is grown. Small acreages of wheat and barley are grown for feed, on Class III and IV land restricted from row crop use. The alfalfa hay produced is utilized by the feeder calves.

The most controversial aspect of the land use program is that 31.3 acres of the rolling land on this farm is left idle. This amounts to nearly 1/3 of the total openland on the farm. While this amount of idle land would appear to be unrealistic to practical agriculturalists, the program determined that to utilize it would require greater capital investment to achieve the income target than is needed in the optimum solution. In other words, it may be profitable to use the land, but to reach the given income target under stated assumptions to do so would increase capital investment. It should be noted that the investment associated with the idle land is included in total capital investment, and land charges for idle land (interest, taxes, clipping, etc.) are charged against the farm business.

Increasing the operator's equity in total

TABLE 6

Farm Plans that Achieve $7,000 Return to Operator's Equity, Labor and Management at Lowest Total Capital Investment for Different Equity Levels: Farms in the Bluegrass Area of Kentucky, only Tobacco, Beef-Feed Enterprises Considered

Item	Unit	Equity Level 0	25	50	75	100
Crop Enterprises						
Burley Tobacco	ac.	5.39	3.95	3.12	2.63	2.26
Corn (no till)	ac.	18.7	13.7	10.9	9.2	6.2
Corn Silage	ac.	94.0	68.8	54.4	45.9	41.1
Alfalfa Hay	ac.	--	--	--	--	--
Grass-Nitrogen Pasture	ac.	45.9	33.7	26.7	22.5	15.3
Grass-Legume Pasture	ac.	--	--	--	--	--
Livestock Lots	ac.	10.1	7.2	5.7	4.8	4.9
Idle Land	ac.	82.7	60.6	47.9	40.4	34.7
Total Land	ac.	256.8	188.0	148.7	125.4	107.7
Livestock Enterprises						
Beef Cows	hd.	--	--	--	--	--
Purchased Cattle (Finish to Slaughter)*	hd.	58	42	33	28	19
Purchased Cattle (Feeding System A)**	hd.	606	444	351	296	269
Purchased Cattle (Feeding System B)**	hd.	28	21	16	14	9
Purchased Cattle (Feeding System C)**	hd.	--	--	--	--	19
Other Activities						
Corn Sold***	bu.	0	0	0	0	0
Seasonal Hired Labor	hrs.	2,234	1,249	691	413	290
Financial Summary						
Operating Capital (prorated)	$	57,830	39,564	31,101	26,333	23,707
Investment Capital (nonland)	$	72,776	56,102	44,498	37,456	33,112
Land Investment	$	109,738	80,338	63,544	53,587	45,987
Total Capital Investment	$	240,344	176,004	139,143	117,376	102,800
Gross Farm Income	$	152,743	103,265	88,428	74,595	67,889
Total Costs	$	145,743	96,265	81,428	67,595	60,889
Operator's Equity, Labor and Mgt. Returns	$	7,000	7,000	7,000	7,000	7,000

* This enterprise involves purchasing 625# feeders, grazing for 60 days, then self-feeding grain on pasture to 1045# slaughter weight (Nov. 1).

** System A - 400# feeders, half purchased December 1 and rest July 1, fed silage for 150 days, sold as 625# feeders.

System B - 400# feeders, purchased December 1, wintered on silage, grazed 60 days, sold July 1 at 720#.

System C - 400# feeders, purchased December 1, wintered on hay, sold May 1 as 550# feeders.

*** Corn Purchase or sale was not permitted in this analysis of tobacco, beef and feed alternatives.

farm capital to 25, 50, 75 and 100% brings about very little change in the optimum farm organization. As increases in equity bring about decreases in interest charge, the amounts of land, labor and capital resources needed decline consistently. At 100% equity, only 64.4 acres of land and $54,433 of capital investment are needed to achieve the $7,000 net return. The same crop and livestock enterprises are in every optimum farm organizations. All enterprises decrease in size with increasing equity, except for the swine enterprise. The swine enterprise increases to 40 sows (the maximum permitted), and as the equity level increases there is a shift toward an increasing proportion of the pigs being sold as feeder pigs. The shift is associated with the lower feed grain requirements of this enterprise (which reduces the amount of land needed for grain production).

Competition Limited to Burley Tobacco, Beef and Feed Enterprises – Table 6 shows the resources needed and the optimum organizations of enterprises to achieve $7,000 return to operator's labor, equity and management in the Bluegrass Area if the only enterprises considered are burley tobacco, beef and feed producing alternatives. Excluding swine alternatives and the possibility of selling grain (even though this didn't enter previous solutions) results in considerably more resources and a much larger volume of business needed to achieve the desired net income level.

At the zero equity level (i.e., interest charged on all capital) it takes 256.8 acres of land, a capital investment exceeding $240,000, and 2,234 hours of hired labor (the equivalent of about a full-time hired man) to achieve a $7,000 net income. Also, to do so involves a gross farm income of more than $152,000. This large amount of cash that must be managed annually is primarily due to the large number of purchased feeder cattle in the optimum plan. An important characteristic of feeder enterprises is that gross income includes the resale of the purchased weight of these animals, and the margin between the sale and purchase prices is a major determinant of enterprise profits.

The optimum farm organization includes 5.39 acres of burley tobacco, the maximum acreage for the amount of land in the farm, and three different cattle feeding enterprises. The largest cattle feeding enterprise involves 606 calves purchased at 400 pounds, fed on a silage ration for 150 days in semi-confinement, and sold as 625 pound feeders. Half are purchased around December 1st and the remainder July 1st, thus making double use of facilities and equipment. Another small cattle feeding enterprise (28 feeders) involves the purchasing of 400 pound calves and feeding silage. These calves are purchased December 1st, wintered on silage, and then pastured for 60 days before selling as 720 pound feeders. The third enterprise involves fattening out 58 heavier feeders to slaughter weight (1,045 pounds). These 625 pound feeders are purchased May 1st, pastured for 60 days, and then self-fed a grain ration on pasture until around November 1st. While shown as a separate enterprise using purchased 625 pound feeders, the timing is such that these could be 58 feeders kept from the winter feeding lot of the first enterprise described above.

The beef enterprises in the optimum organization have feed requirements associated with intensive use of Class I-II and III land – specifically, maximum production of corn silage and corn for grain. The pasture used by the cattle enterprises is grass pasture grown on Class III and IV land, and receiving heavy nitrogen applications. All Class VI land is left idle. Summarizing, the optimum land use for this situation is intensive use (with high per acre costs) of productive land and leaving the remaining land idle.

Increasing the operator's equity in total farm capital to 25, 50, 75 and 100% brings about very little change in the optimum combination of enterprises. Except that the enterprises get progressively smaller, the only changes occur at the 100% equity level. At this level a small enterprise (19 head) involving the wintering of 400 pound calves on hay enters the livestock program. To supply the hay required, a small acreage of alfalfa hay is grown.

It is of interest to note that, while there is a

TABLE 7

Farm Plans that Achieve $7,000 Return to Operator's Equity, Labor and Management at Lowest Total Capital Investment for Different Equity Levels: Farms in The Pennyroyal-Ohio Valley Area of Kentucky, All Enterprises Permitted to Compete

Item	Unit	Equity Level 0	25	50	75	100
Crop Enterprises						
Burley Tobacco	ac.	.72	.68	.64	.63	.60
Corn (No till)	ac.	36.8	34.7	32.8	32.2	30.4
Wheat	ac.	4.9	4.7	4.4	4.3	4.1
Barley	ac.	3.0	2.7	2.3	2.8	2.4
Livestock Lots	ac.	5.0	4.8	4.7	4.2	4.2
Idle Land	ac.	9.8	9.2	8.7	8.5	8.1
Total Land	ac.	60.3	56.7	53.7	52.6	49.8
Livestock Enterprises						
Hogs-Feeder Pigs Produced	sows	20	21	24	15	18
Hogs-Farrow to Finish	sows	20	19	16	19	16
Other Activities						
Corn Sold*	bu.	0	0	0	0	0
Seasonal Hired Labor	hrs.	72	53	42	5	0
Financial Summary						
Operating Capital (prorated)	$	3,878	3,652	3,491	3,250	3,131
Investment Capital (nonland)	$	15,035	14,453	13,956	13,042	12,717
Land Investment	$	20,200	18,995	17,990	17,621	16,683
Total Capital Investment	$	39,113	37,100	35,437	33,913	32,531
Gross Farm Income	$	19,949	18,980	18,192	17,246	16,630
Total Costs	$	12,949	11,980	11,192	10,246	9,630
Operator's Equity, Labor and Mgt. Returns	$	7,000	7,000	7,000	7,000	7,000

* Corn Purchase was not permitted, but corn could be sold in this situation.

large number of beef cows on farms in the Bluegrass Area, beef cows do not come in any of the optimum enterprise organizations in this minimization analysis.

While operator's equity level did not appreciably affect the optimum farm organization it greatly affected the amount of resources needed to attain $7,000 net income. At the 100% equity level only 107.7 acres of openland is needed – about 40% of the amount needed at the zero equity level. Similarly, only $102,800 capital investment is required (less than 43% of that required at the zero equity level). Moreover, only 290 hours of seasonal hired labor is needed, compared with 2,334 in the primary zero equity solution.

Pennyroyal-Ohio Valley Area

All Enterprises Permitted in Analysis – The farm organizations in the Pennyroyal-Ohio Valley Area that yield $7,000 return to operator's labor, equity and management at lowest average investment when all feasible enterprises are permitted to compete, are presented in Table 7. Optimum solutions for all five equity levels are shown.

Land in the Pennyroyal-Ohio Valley Area can be used more intensively (see Table 1) than in the Bluegrass Area; moreover crop yields are slightly higher and land values are lower. Consequently, fewer resources are needed to provide a $7,000 net return. At the zero equity level to achieve that income target, it takes 60.3 acres of land, a capital investment of $39,113, and only a few days of hired labor.

To achieve $7,000 net returns with this small amount of land necessitates an intensive farm business. The swine herd provides that intensity. The optimum farm organization includes a 40-sow swine herd (the maximum number permitted in the analysis), with half of the pigs produced sold as feeder pigs and the rest fattened to slaughter weight.

Burley tobacco is the only other cash income producing enterprise. The optimum organization contains 0.72 acre of burley tobacco, the total allotment available for the amount of land in the solution. As indicated earlier, allotments are considerably smaller in the Pennyroyal-Ohio Valley Area than in the Bluegrass Area. The remainder of the land in crops is devoted to producing grain for the swine herd. No-till corn for grain is the primary feed crop. All class VI land is left idle.

Because of the small amount of land involved and the intensity of the business in the zero equity level solution, increasing the operator's equity in total capital employed did not greatly reduce the resources needed to achieve the target net income. At the 100% equity level, only 49.8 acres of land and $32,531 capital are needed. These are less than the amounts needed at the zero equity level, but the reductions are considerably smaller than for the comparable analysis in the Bluegrass Area.

The same enterprises are in the optimum organizations at all equity levels. Hogs are the primary enterprise. There is a slight tendency at the higher equity levels to market a greater percentage of the pigs as feeder pigs.

Competition Limited to Burley Tobacco, Beef and Feed Enterprises – The minimum resources needed and the optimum enterprise combinations to achieve $7,000 return to operator's labor, equity and management when the only enterprises considered are burley tobacco, beef and feed producing alternatives are shown in Table 8. As in other tables, results are presented for all five levels of operator's equity in the farm capital.

At the zero equity level if enterprise alternatives are limited to tobacco, beef and feed, it takes 145.4 acres of land, about $117,000 capital, and 1,057 hours of seasonal hired labor to achieve $7,000 net returns. Thus, the acreage of land needed is nearly 2½ times the amount needed, the capital nearly triple the amount needed, when swine and other nonbeef enterprises are permitted in the farm organization. On the other hand, the lower land values, greater potential intensity of land use and slightly higher yields permit achieving the income target with much less land and capital than in the Bluegrass Area.

The livestock part of the optimum

TABLE 8

Farm Plans that Achieve $7,000 Return to Operator's Equity, Labor and Management at Lowest Total Capital Investment for Different Equity Levels: Farms in The Pennyroyal-Ohio Valley Area of Kentucky, only Tobacco, Beef and Beef-Feed Enterprises Considered

Item	Unit	Equity Level 0	25	50	75	100
Crop Enterprises						
Burley Tobacco	ac.	1.74	1.40	1.24	1.13	1.33
Corn (No till)	ac.	17.6	13.1	12.5	12.0	25.0
Corn Silage	ac.	66.8	57.7	47.7	41.2	13.0
Grass-Nitrogen Pasture	ac.	17.4	13.2	12.5	12.1	25.3
Grass-Legume Pasture	ac.	34.6	25.8	24.4	23.3	44.9
Livestock Lots	ac.	7.3	6.2	5.2	4.5	1.3
Idle Land	ac.	0	0	0	0	0
Total Land	ac.	145.4	117.4	103.5	94.2	110.8
Livestock Enterprises						
Beef Cows	hd.	0	0	0	0	0
Purchased Cattle (Finish to Slaughter)*	hd.	60	44	42	41	84
Purchased Cattle (Feeding System A)**	hd.	480	414	344	296	93
Other Activities						
Corn Sold***	bu.	0	0	0	0	0
Seasonal Hired Labor	hrs.	1,057	671	383	267	0
Financial Summary						
Operating Capital (prorated)	$	43,627	36,187	30,485	26,833	18,938
Investment Capital (nonland)	$	24,727	21,240	18,272	16,228	10,691
Land Investment	$	48,709	39,329	34,673	31,557	37,118
Total Capital Investment	$	117,063	96,756	83,430	74,618	66,747
Gross Farm Income	$	114,645	96,589	81,829	72,083	46,934
Total Costs	$	107,645	89,589	74,829	65,083	39,934
Operator's Equity, Labor and Mgt. Returns	$	7,000	7,000	7,000	7,000	7,000

* This enterprise involves purchasing 625# feeders, grazing for 60 days, then self-feeding grain on pasture to 1045# slaughter weight (November 1).

** This enterprise involves 400# feeders, half purchased Dec. 1 and rest July 1, fed silage in confinement for 150 days, and sold as 625# feeder.

*** Corn purchase or sale was not permitted in this analysis of tobacco, beef and feed alternatives.

organization includes two cattle feeding enterprises. The largest cattle feeding enterprise involves 480 calves weighing 400 pounds, fed a silage ration for 150 days in semi-confinement, and sold as 625 pound feeders. Half are purchased around December 1st, and the remainder about July 1st. Two lots per year spread fixed costs of facilities and equipment. The second enterprise involves fattening out 60 heavier feeders to slaughter weight (1,045 pounds). These 625 pound feeders are purchased about May 1st, pastured for 60 days, and then self-fed a grain ration on pasture until November 1st. As programmed, this enterprise involves purchased feeders, but the animals could be feeders kept from the winter feeding lot of the primary enterprise in this solution.

The land use program naturally reflects the feed requirements of the feeder-cattle. The main crop is corn silage, with corn for grain and pasture being produced on the remaining available land. The entire burley tobacco allotment (1.74 acres) is grown. As opposed to previously discussed solutions, all openland is used in this optimum organization.

As the operator's equity is increased to 25, 50 and 75% levels, the expected results occur. Quantities of resources needed decline steadily through the 75% level, where only $74,618 capital investment and 94.2 acres of land are needed to achieve the $7,000 income target. Enterprises also decline in size, with the largest drop occurring in the number of 400 pound calves fed silage in semi-confinement.

At the 100% equity level, however, some unexpected things occur. Capital investment, the decision criterion in this analysis, declines almost $8,000 to $66,747. But, the amount of land increases more than 16 acres to a total of 110.8 acres. This is more land than in either the 50 to 75% solutions.

There is a major shift in enterprise emphasis at the 100% equity level. The largest beef enterprise remains the feeding of 400 pound calves on silage for 150 days, but the number declines to 93 head (a drop of 203 head from the 75% level). On the other hand, the enterprise involving fattening out of 625 pound feeders to slaughter-weight more than doubled in size, to 84 head. This shift in livestock production brings about a corresponding shift in land use, with the largest acreages being in corn for grain, and pasture. The program determined, based on the assumed land values and enterprise capital requirements, that the added investment in land and heavier feeders was more than offset by the drop in capital requirements of the 203 head of 400 pound feeders which left the optimum solutions.

Effects of Decision Criteria on Optimum Solutions

Previously reported results were obtained using average capital investment as the minimization decision criteria. It was hypothesized, however, that if some other decision criterion is used the resources needed and the optimum farm organization could be considerably different. Thus, for the two primary situations in each area (zero equity situations) four additional decision criteria were used to determine the optimum solutions for $7,000 return to operator's labor, equity and management.[3] These decision criteria are: (1) total annual costs, (2) total annual variable costs, (3) total openland, and (4) total hours of labor use.

Bluegrass Area — A comparison of the optimum solutions to achieve $7,000 return using the five different decision criteria, if all feasible enterprises are permitted to compete, is presented in Table 9.

In terms of the amount of resources needed, when all enterprises can compete it makes little difference which criterion is used. The range in acres of openland needed is only from 96.9 to 103.4 acres. Similarly, small ranges in capital investment and labor use are evident. Capital investment among the five solutions varies from $79,393 to $83,353, and hours of labor use varies from 2,037 to a maximum of 2,309.

Two primary cash income producing enterprises are in all optimum farm organizations: (1) burley tobacco (which ranges

[3] While returns are officially stated to reward operator's equity, labor and management, at the zero equity the returns actually reward the operator's labor and mangement.

TABLE 9

Optimum Farm Plans and Resources Needed to Achieve $7,000 Returns to Operator's Labor and Management Using Different Minimization Criteria: Farms in Bluegrass Area, Zero Equity and All Enterprises Considered

Item	Unit	Minimization Decision Criteria: Capital Investment	Total Cost	Variable Cost	Land	Labor
Crop Enterprises						
Burley Tobacco	ac.	2.04	2.17	2.15	2.04	2.17
Corn (No till)	ac.	42.6	45.3	44.9	42.6	44.8
Wheat	ac.	6.8	7.2	7.2	6.8	7.2
Barley	ac.	5.7	6.1	6.0	5.7	6.1
Corn Silage	ac.	--	--	--	--	.5
Alfalfa Hay	ac.	3.4	--	--	3.3	--
Grass-Nitrogen Pasture	ac.	--	--	1.3	--	5.0
Grass-Legume Pasture	ac.	--	--	3.5	--	--
Livestock Lots	ac.	5.3	4.3	4.3	5.3	4.3
Idle Land	ac.	31.3	38.1	32.9	31.2	33.3
Total Land	ac.	97.1	103.2	102.2	96.9	103.4
Livestock Enterprises						
Hogs-Feeder Pigs Produced	sows	11	--	--	17	--
Hogs-Farrow to Finish	sows	25	29	28	23	27
Beef Cows	hd.	--	--	2	--	--
Purchased Cattle (Finish to Slaughter)*	hd.	--	--	--	--	6
Purchased Cattle (Feeding System B)**	hd.	--	--	--	--	3
Purchased Cattle (Feeding System C)**	hd.	17	--	--	15	--
Other Activities						
Corn Sold***	bu.	0	0	0	0	0
Seasonal Hired Labor	hrs.	448	393	392	559	372
Total Labor Used	hrs.	2,198	2,071	2,078	2,309	2,037
Financial Summary						
Operating Capital (prorated)	$	6,031	4,943	5,041	6,152	5,901
Investment Capital (nonland)	$	31,869	34,310	32,421	32,197	32,109
Land Investment	$	41,494	44,100	43,673	41,408	44,186
Total Capital Investment	$	79,394	83,353	81,135	79,757	82,196
Gross Farm Income	$	27,531	24,268	24,304	26,930	25,995
Variable Costs	$	13,004	11,584	11,476	14,023	13,066
Total Cost	$	20,531	17,268	17,304	19,930	18,995
Operator's Labor and Management Returns	$	7,000	7,000	7,000	7,000	7,000

* This enterprise involves purchasing 625# feeders May 1, grazing for 60 days, then self-feeding grain on pasture to slaughter weight of 1045# (November 1).

** System B-400# feeders, purchased December 1, wintered on silage, grazed 60 days, sold July 1 as 720# feeders.
System C-400# feeders, purchased December 1, wintered on hay, sold May 1 as 550# feeders.

*** Corn purchase was not permitted, but corn sale was permitted in this analysis.

from 2.04 to 2.17 acres) and (2) swine. In every case, all or the majority of pigs produced are fed out to slaughter weight. Sizable numbers of feeder pigs are sold, however, when land and average capital investment are used as the decision criteria. A few beef cattle are in all solutions, except where total cost is minimized. These are minor enterprises, in all but one case involving purchased feeder cattle.

The land use programs emphasize grain (primarily corn) to feed the hogs produced. Substantial amounts of land (Class VI) are left idle.

While the selection of decision criterion has little effect on the results when all feasible enterpries are permitted to compete, and these enterprises include some that are quite intensive (i.e., high net income per unit of land), the results are considerably different when competition is limited to burley tobacco, beef and feed producing alternatives. Table 10 presents the optimum farm organizations to achieve $7,000 returns, when competition is limited.

Although five different minimization decision criteria were used, there are basically two different optimum plans. Identical optimum plans are obtained when minimizing total cost, variable cost and labor. Moreover, almost identical plans are obtained using average capital investment and land as the decision criterion.

To achieve $7,000 return using total cost, variable cost or labor as the criterion requires 387.5 acres of land, more than $295,000 capital investment and 3,480 hours of labor. Two beef enterprises involving purchased feeders, and large burley tobacco enterprise (8.14 acres) are the cash income producing enterprises. The largest beef enterprise is 212 head of 625 pound feeders, purchased around May 1st, grazed for two months, then self-fed a grain ration on pasture until they reach the desired slaughter weight (1,045 pounds) about November 1st. An additional 103 head of 400 pound feeders are purchased December 1st, wintered on corn silage in semi-confinement, then grazed for two months and sold as 720 pound feeders around July 1st. To supply the feed for these two cattle feeding enterprises requires nearly 69 acres of corn for grain, 18.4 acres of corn silage and more than 164 acres of improved grass pasture (fertilized regularly with nitrogen). Even with the large number of cattle, all Class VI land (nearly 125 acres) is left idle.

Minimizing average capital investment or minimizing land gives a considerably different optimum plan. To achieve $7,000 net return using these criteria requires approximately 256 acres of openland – only 2/3 of the acreage needed when using the other criteria. A capital investment of about $240,000 is needed, nearly $55,000 below that of the other solution. On the other hand, around 500 hours additional labor is needed.

When one compares solutions for minimizing average capital with minimizing land, the livestock and land use programs are similar but not identical. Moreover, the livestock programs are more complex (involving three and four different enterprises); and involve considerably more cattle than the optimum program using the other criteria. The fattening out of 625 pound feeders to slaughter weight is important in both optimum programs (58 and 53 head). By far the largest cattle feeding enterprise is the two lot per year, feeding of 400 pound calves on corn silage (and selling them as 625 pound feeders); 606 and 617 head of cattle are involved in this enterprise. Also, in both organizations is a small enterprise (28 and 26 head) involving the wintering of 400 pound calves on silage and then grazing them for 60 days before sale. Additionally, a small enterprise of 16 head of 400 pound feeder calves wintered on hay is included when land is minimized. This enterprise substitutes for a few head of cattle in two other enterprises as the program sought the very minimum amount of land.

Because of the large number of silage-consuming cattle being fed, corn silage is by far the main crop produced (94-95 acres). Burley tobacco, produced on 5.39 acres, is a major cash income producing crop. All Class VI land is left idle.

Pennyroyal-Ohio Valley Area – When all feasible enterprises compete in the

TABLE 10

Optimum Farm Plans and Resources Needed to Achieve $7,000 Return to Operator's Labor and Management Using Different Minimization Criteria: Farms in Bluegrass Area, Zero Equity and only Tobacco, Beef and Beef-Feed Enterprises Considered

Item	Unit	Minimization Decision Criteria: Capital Investment	Total Cost	Variable Cost	Land	Labor
Crop Enterprises						
Burley Tobacco	ac.	5.39	8.14		5.38	
Corn (No till)	ac.	18.7	68.7		17.2	
Wheat	ac.	--	--		--	
Barley	ac.	--	--		--	
Corn Silage	ac.	94.0	18.4		95.2	
Alfalfa Hay	ac.	--	--		2.9	
Grass-Nitrogen Pasture	ac.	45.9	164.4		42.4	
Grass-Legume Pasture	ac.	--	--		--	
Livestock Lots	ac.	10.1	3.1		10.6	
Idle Land	ac.	82.7	124.8		82.5	
Total Land	ac.	256.8	387.5		256.2	
Livestock Enterprises						
Beef Cows	hd	--	--	SAME AS TOTAL COST	--	SAME AS TOTAL COST
Purchased Cattle (Finish to Slaughter)*	hd.	58	212		53	
Purchased Cattle (Feeding System A)**	hd.	606	--		617	
Purchased Cattle (Feeding System B)**	hd.	28	103		26	
Purchased Cattle (Feeding System C)**	hd.	--	--		16	
Other Activities						
Corn Sold***	bu.	0	0		0	
Seasonal Hired Labor	hrs.	2,234	1,807		2,316	
Total Labor Used	hrs.	3,970	3,480		4,066	
Financial Summary						
Operating Capital (prorated)	$	57,830	45,693		58,843	
Investment Capital (nonland)	$	72,776	83,877		73,239	
Land Investment	$	109,738	165,590		109,482	
Total Capital Investment	$	240,344	295,160		241,564	
Gross Farm Income	$	152,743	106,061		155,746	
Variable Costs	$	128,057	82,320		133,303	
Total Cost	$	145,743	99,061		148,746	
Operator's Labor and Management Returns	$	7,000	7,000		7,000	

* This enterprise involves purchasing 625# feeders May 1, grazing 60 days, then self-feeding grain on pasture to 1045# slaughter weight (November 1).

** System A - 400# feeders, half purchased December 1 and rest July 1, fed silage in confinement for 150 days, sold as 625# feeders.

System B - 400# feeders, purchased December 1, wintered on silage, grazed 60 days, sold July 1 as 720# feeders.

System C - 400# feeders, purchased December 1, wintered on hay, sold May 1 as 550# feeders.

*** Neither corn purchase nor corn sale was permitted in this analysis of tobacco, beef and beef-feed alternatives.

Pennyroyal-Ohio Valley Area, there is not much difference in the amount of resources needed and the optimum organization to obtain the $7,000 return using capital investment, total cost, variable cost or land as the minimization criterion (Table 11). However, minimizing labor gives a completely different optimum solution.

The closeness of the solutions to achieve the target income using the first four criteria is evident by the narrow ranges in resource use. The range is only about 7 acres in the amount of openland, less than $17,000 capital investment, and 300 hours of labor used. The burley tobacco allotment, although small per unit of openland in this area, is grown in all four optimum organizations. Swine dominates the livestock programs, although there is some difference in the size and kind of enterprise involved. When minimizing total cost or variable cost the swine herd is comprised of 26 sows, with all pigs fattened out for sale as slaughter hogs. However, when minimizing capital investment or land, there are 40 sows in the herd, and half (or slightly over half) of the pigs are sold as feeder pigs. A small beef cow herd (4 cows) is in the optimum program when minimizing variable cost; and 28 calves, to be wintered on hay, are handled in the land minimization solution. Basically, the beef enterprises utilize Class VI land.

Using labor as the minimization decision criterion results in an entirely different optimum solution. To achieve $7,000 returns using this decision criterion requires about 278 acres of land and a capital investment of nearly $127,500. This is more than four times as much land as in the other solutions, and more than three times the amount of capital needed. Only 809 hours of labor are needed to achieve this target income, however, which makes the solution feasible for part-time operators (even though a full-time operator is assumed available in the analysis).

The optimum organization when minimizing labor involves maximum production of corn. Nearly 16,000 bushels of corn are sold annually, and the remainder fed to cattle being finished for slaughter. A total of 119 feeders, weighing 625 pounds and purchased around May 1st, are grazed for 60 days, then self-fed a grain ration on pasture until they reach about 1,045 pounds. This enterprise utilizes the pasture produced on all land not in corn production. In this solution no burley tobacco is produced, and no land is left idle.

Limiting enterprises to burley tobacco, beef and feed alternatives results in basically three different optimum solutions in the Pennyroyal-Ohio Valley Area (Table 12). Identical solutions are obtained using capital investment and land as the decision criteria. Similar solutions, involving more land and capital investment, result when minimizing total cost and variable cost. Again, the entirely different optimum solution is attained when minimizing labor.

Resources needed when minimizing capital investment or land, include 145.4 acres of openland, a capital investment of about $117,000, and 2,606 hours of labor. Cash income is obtained from burley tobacco (1.74 acres) and two cattle feeding enterprises. The largest cattle feeding enterprise is 480 calves weighing 400 pounds, fed on a silage ration for 150 days in semi-confinement and sold as 625 pound feeders. Half are purchased around December 1st and the remainder July 1st.

The second enterprise involves feeding out 60 heavier feeders to slaughter weight (1,045 pounds). These 625 pound feeders are purchased May 1st, pastured grazed for 60 days, then self-fed on pasture. While shown as a separate enterprise involving purchased animals, the timing is such that these could be feeders kept from the winter feeding lot of the other cattle enterprise. As indicated by the livestock enterprises, corn silage is the major crop produced, with corn for grain and pasture utilizing remaining available land. No burley tobacco is produced.

The optimum solutions to achieve $7,000 using total cost and variable cost are very similar in their basic structure; but more land and capital is needed minimizing variable costs, and most enterprises are somewhat larger. Resources needed using these two criteria are 276.5 and

TABLE 11

Optimum Farm Plans and Resources Needed to Achieve $7,000 Returns to Operator's Labor and Management Using Different Minimization Criteria: Farms in Pennyroyal-Ohio Valley Area, Zero Equity and All Enterprises Considered

Item	Unit	Minimization Decision Criteria: Capital Investment	Total Cost	Variable Cost	Land	Labor
Crop Enterprises						
Burley Tobacco	ac.	.72	.77	.76	.69	0
Corn (No till)	ac.	36.8	39.5	38.9	35.3	173.0
Wheat	ac.	4.9	5.3	--	4.7	--
Barley	ac.	3.0	3.4	8.6	1.9	--
Red Clover Hay	ac.	--	--	1.8	9.4	--
Grass Nitrogen Pasture	ac.	--	--	6.0	--	36.4
Grass Legume Pasture	ac.	--	--	3.7	--	68.3
Livestock Lots	ac.	5.0	3.9	3.8	5.7	--
Idle Land	ac.	9.8	11.7	--	--	--
Total Land	ac.	60.3	64.6	63.6	57.7	277.7
Livestock Enterprises						
Hogs-Feeder Pigs Produced	sows	20	--	--	22	--
Hogs-Farrow to Finish	sows	20	26	26	18	--
Beef Cows	hd.	--	--	4	--	--
Purchased Cattle (Finish to Slaughter)*	hd.	--	--	--	--	119
Purchased Cattle (Feeding System C)**	hd.	--	--	--	28	--
Other Activities						
Corn Sold***	bu.	0	0	0	0	15,847
Seasonal Hired Labor	hrs.	72	25	24	97	71
Total Labor Used	hrs.	1,707	1,519	1,559	1,805	809
Financial Summary						
Operating Capital (prorated)	$	3,878	3,705	3,946	5,444	21,397
Investment Capital (nonland)	$	15,035	14,237	15,540	15,970	13,041
Land Investment	$	20,200	21,624	21,306	19,330	93,030
Total Investment	$	39,113	39,566	40,792	40,744	127,468
Gross Farm Income	$	19,949	19,658	19,880	23,962	56,256
Variable Costs	$	8,964	8,873	8,801	12,849	40,783
Total Cost	$	12,949	12,658	12,880	16,962	49,256
Operator's Labor and Management Returns	$	7,000	7,000	7,000	7,000	7,000

* This enterprise involves purchasing 625# feeders May 1, grazing 60 days, then self-feeding grain on pasture to 1045# slaughter weight (November 1).

** This enterprise involves 400# feeders purchased December 1, wintered on hay, sold May 1 as 550# feeders.

*** Corn purchase was not permitted, but corn could be sold in this analysis.

TABLE 12

Optimum Farm Plans and Resources Needed to Achieve $7,000 Return to Operator's Labor and Management Using Different Minimization Criteria: Farms in Pennyroyal-Ohio Valley Area, Zero Equity and Only Tobacco, Beef and Beef-Feed Enterprises Considered

Item	Unit	Minimization Decision Criteria: Capital Investment	Total Cost	Variable Cost	Land	Labor
Crop Enterprises						
Burley Tobacco	ac.	1.74	3.31	3.63		0
Corn (No till)	ac.	17.6	47.6	45.6		120.7
Corn Silage	ac.	66.8	17.9	21.2		--
Alfalfa Hay	ac.	--	3.1	5.0		--
Grass-Nitrogen Pasture	ac.	17.4	80.3	81.3		122.6
Grass-Legume Pasture	ac.	34.6	124.3	145.6		213.5
Livestock Lots	ac.	7.3	--	--		--
Idle Land	ac.	--	--	--		--
Total Land	ac.	145.4	276.5	302.3		456.8
Livestock Enterprises						
Beef Cows (System A)*	hd.	0	19	30		--
Beef Cows (System B)*	hd.	0	55	66		--
Purchased Cattle (Finish to Slaughter)**	hd.	60	153	144		408
Purchased Cattle (Feeding System A)***	hd.	480	--	--		--
Other Activities						
Seasonal Hired Labor	hrs.	1,057	843	1,229		286
Total Labor Used	hrs.	2,606	2,593	2,979		1,312
Financial Summary						
Operating Capital (prorated)	$	43,627	28,709	29,326		60,083
Investment Capital (nonland)	$	24,727	36,533	43,453		19,118
Land Investment	$	48,709	92,628	101,271		153,028
Total Capital	$	117,063	157,870	174,050		232,229
Gross Farm Income	$	114,645	66,307	67,686		126,505
Variable Costs	$	98,331	47,500	47,464		105,588
Total Cost	$	107,645	59,307	60,686		119,505
Operator's Labor and Management Returns	$	7,000	7,000	7,000		7,000

SAME AS CAPITAL INVESTMENT

* Calves sold as 500# feeders in both systems. In System A cows are fed hay in winter and pasture the rest of year. In System B, cows are fed silage in winter and summer months when adequate pasture is not available.

** This enterprise involve purchasing 625# feeders on May 1, grazing for 60 days and then self-feeding grain on pasture to slaughter weight of 1045# (November 1).

*** System A involves 400# feeders, half purchased December 1 and rest July 1, fed silage in confinement for 150 days, sold as 625# feeders.

302.3 acres of land $157,870 and $174,050 capital investment, and 2,593 and 2,979 hours of labor, respectively.

The largest beef enterprise involves 153 (144 for variable cost) head of 625 pound feeders, fattened to slaughter weight. This is the same enterprise described a number of times earlier. The optimum farm organizations also include a major beef cow herd enterprise, the only time in all the minimization programming that this occurs. A herd of 74 cows, with calves to be sold at 500 pounds is in the total cost minimization program, and 96 cows are in the variable cost minimization solution. Some corn silage is produced to feed the cows during the winter and summer months when adequate pasture is not available. Burley tobacco enterprises (3.31 and 3.63 acres) in these solutions are major cash income producers.

If labor minimization is used as the decision criterion, considerably greater quantities of land and capital are needed to attain the income target than are needed using the other criteria. Limiting competition to burley tobacco, beef and feed producing crops results in the need for 456.8 acres of land and more than $232,000 capital investment to achieve $7,000 return. On the other hand, only 1,312 hours of labor is needed.

The optimum organization to achieve the income target is very simple. The only mechanically harvested crop grown is corn (120.7 acres). Burley tobacco is not grown, because of its high-labor requirement. All land not in no-till corn is in pasture.

As sale of corn is not permitted in this analysis, all corn and pasture produced is utilized by the cattle fattening enterprise. All cash income is received from 408 head of 625 pound feeders, purchased about May 1st, pastured for 60 days and then self-fed grain on pasture until they reach the desired slaughter weight.

SUMMARY AND CONCLUSIONS

Even though profit maximization is the goal most frequently stressed in farm management research, researchers working on Southern Regional Project S-67, officially entitled "Evaluation of Beef Production Industry in the South" recognized the importance of minimization type questions to beef cattle producers. Thus, for each subregion a core of 10 situations were programmed to determine the minimum resources needed and the optimal farm organization to obtain $7,000 return to operator's labor, equity and management. Average capital investment was the minimization criterion used.

This report contains the results of the minimization analysis for the Bluegrass Area, and the Pennyroyal-Ohio Valley Area in Kentucky. Two basic competitive situations were analyzed. In the first, all feasible crop and livestock enterprises were permitted to compete; whereas in the second, competition was limited to burley tobacco, beef and feed producing alternatives. For each of these competitive situations, solutions were obtained assuming five different levels of operator's equity – 0, 25, 50, 75 and 100%.

When all feasible enterprises are permitted to compete, the $7,000 return can be achieved in both areas with less than 100 acres of openland. Increasing the operator's equity in total farm capital, which reduces the interest charge on capital, has the anticipated effect of reducing the amount of land, capital and labor needed to attain the income target. Increasing the equity level did not appreciably affect the optimum combination of enterprises.

Burley tobacco and hogs dominate the optimum organizations when all enterprises are permitted to compete. These intensive enterprises consistently are the two major sources of cash income. Some of the pigs produced from the sow herd are sold as feeder pigs, and some fed to slaughter weight. There is a tendency to more feeder pigs as equity is increased in the Bluegrass Area but not in the Pennyroyal-Ohio Valley Area. A small beef enterprise involving the wintering of 400 pound calves on hay is also in the Bluegrass Area organization. The land use program in both areas stresses grain production for use by the hogs. All land not suitable for grain production is left idle.

When swine and the alternative to sell grain are removed from the program, much greater quantities of resources are needed to attain the $7,000 return. In the Bluegrass Area when competition is limited to burley tobacco, beef and feed alternatives it takes nearly 257 acres of openland and $240,000 capital investment to reach that income goal. Because of the lower land values, slightly higher yields, and greater potential intensity of land use, the difference between resources needed in the two competitive situations in the Pennyroyal-Ohio Valley Area is not so great. At the zero equity level, it takes about 145 acres of openland and $117,000 capital investment.

Burley tobacco is produced to the maximum allowed by allotments in all solutions. It is major cash income enterprise, particularly in the Bluegrass Area. The beef enterprises in the optimum farm organization are predominantly of two types: (1) purchased feeder calves fed 150 days on silage, and (2) heavier feeders (625 pound) grazed and then self-fed a grain ration on pasture until they reach slaughter weight.

While other enterprises are in some programs, the largest enterprise is always the purchasing of 400 pound feeders, feeding them on silage in semi-confinement, and selling 150 days later as 625 pound feeders. Two lots per year are involved, thus making double use of facilities and equipment.

Corn silage is, therefore, the major crop in these solutions. Corn for grain is also produced, to supply the needs of the cattle fattening enterprise. In the Bluegrass Area all Class VI land is left idle.

Increasing the operator's equity has the expected impact of decreasing the amount of resources needed to achieve the $7,000 return. Equity level did not greatly affect the optimum farm organization.

One of the most important findings of this analysis is that the beef cow herd, by far the predominant beef enterprise in Kentucky, is not in any of the optimum farm organizations. Based on average capital investment as the minimization decision criterion, beef cows did not compete, even when the only livestock alternatives were other beef enterprises (purchased feeders).

The second objective of the research report herein was to determine the impact of different decision criteria on the minimum resources needed and the optimum farm organization to achieve $7,000 returns. The two basic competitive situations, assuming zero equity, were reprogrammed using four additional minimization criteria: (1) acres of openland, (2) total cost, (3) variable cost, and (4) hours of labor.

The results show that the optimum solution (resources used and crop and livestock enterprises) can be affected greatly by the decision regarding what is to be minimized. In situations where competing enterprises include some that produce high returns per unit of land (i.e., burley tobacco and the swine herd – producing market hogs), it makes little difference which decision criteria is used. But, when these enterprises are not considered as alternatives, or for some reason produce lower returns (for example, small tobacco allotment or lower yield), the selection of decision criteria is important.

Generally, solutions obtained minimizing capital investment and minimizing land are identical or very similar. This is not unexpected as capital invested in land is a major component of total investment. Similar solutions are also obtained using total cost and variable cost as the decision variables. These solutions involve generally considerably more land and capital investment. Different optimum farm organizations may also occur using total or variable costs rather than land or capital investment. For example, in the Pennyroyal-Ohio Valley Area major beef cow herd enterprises enter the solution – the only time in all the programming that this occurs.

The greatest variation and least predictability in results are obtained using hours of labor as the minimization criteria. Usually much more land and capital are needed when labor minimization is the goal. The amount of land needed to attain $7,000 return in the Pennyroyal-Ohio Valley Area when only tobacco, beef and feed enterprises are considered illustrates the variation that can

occur with different decision criteria. Total tillable land and open pasture acreages needed are: (1) total capital investment, and land – 145.4 acres, (2) total cost – 276.5 acres, (3) variable cost – 302.3 acres, and (4) total labor – 456.8 acres.

Minimizing labor can result in quite different optimum farm organizations than using the other decision criteria. For example, in the Pennyroyal-Ohio Valley Area, hogs and burley tobacco are not in the optimum farm organizations. These enterprises dominate other solutions (when permitted to compete).

Results of this study show that a researcher must give serious thought to the selection of the decision criterion when doing minimization programming. A case can be made for all five of the criteria analyzed under certain real-life circumstances.

Of all the criteria analyzed, labor requires the greatest specificity and precision. For all other criteria the constraints and requirements are in terms of one amount; whereas, constraints and requirements for labor must be broken down into monthly or bimonthly period (to reflect seasonal variations). Considerable care must be exercised in developing these periodic coefficients so that they accurately reflect conditions and needs.