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The small family farm: can it survive ?

Mark R. Drabenstott
Iowa State University

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Can it survive?

by

Mark Richard Drabenstott

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CHAPTER I.

INTRODUCTION

United States agriculture has been characterized by rapid change for four decades. Foremost in this long list of alterations is a structural realignment of farm size. Large farms displacing thousands of small family farms is the net result of this changing structure of American agriculture. The reasons for this dramatic transformation of farms in America lie in a rapidly growing technology and government farm policy. Public research efforts played a major role in expanding farming technology in America. Government farm policy, both explicitly and implicitly, encouraged larger farms. So when we consider small family farms, we must recognize that public institutions encouraged the growth of larger production units and the concurrent disappearance of small farms.

Interest in small farm research is rekindling at the present time because of a new awareness of American agriculture. The trend of increasingly larger farms raises many important questions. Is a smaller farm structure with healthier rural communities to be socially preferred to continued rural migration to cities? Do small farms provide relief from the environmental problems of capital, energy, and chemical intensive large farms? Is government policy reflecting adequate concern for small farm problems? This project does not intend to address all of these broad questions. Nonetheless, these questions do point out the current need for research on small farms.

Objectives

The primary objective of this project is to determine whether small family farms can continue to be viable economic units in American agriculture. "Small" is a relative measure--for the purposes of this research it will be a 240 acre cash grain and livestock farm in north central Iowa. While this may not seem small by some comparisons, it is an appropriate size on which to base forecasts given the past and current trend to larger farm units. Nikolitch's definition of a family farm will be adopted here: "the family farm is one for which the operator is a risk-taking manager, who with his family does most of the farm work and performs most of the managerial activities." [16, p. 249]. Many definitions of the small family farm center around annual sales. For the purposes of this study, an "acreage" classification is superior for constructing a model of a representative farm firm. An acreage classification allows for easily discernible changes in the model resources base which a sales approach does not.

Specifically, the objectives of this study are directed towards answering the following questions:

(1) What level of farm income may small farmers expect given various price levels?

(2) What investments over time should be made to maximize income given limited capital resources?

(3) Will small farms become increasingly dependent upon off-farm income in order to maintain total income?

(4) What government policies might be suggested to aid the problems of the small farmer?

Small Farms in United States Agriculture

Examination of some current statistics on the size structure of United States agriculture is useful in placing the outlook of small farms in perspective. "Changes--radical changes--are the order of the day in agriculture." [15, p. 545]. The restructuring of farm sizes has been a constant and even accelerating process. Evidence of the demise of small farms can be found in data concerning numbers of farms, farm income, and market share. Table 1 illustrates how farms have become fewer in number and larger in average size. Total number of farms dropped from a high of 6.8 million in 1935 to 2.7 million in 1977. At the same time, average farm size rose from 155 acres to 393 acres. If one considers only commercial farms (i.e., farms with annual farm sales greater than $2500), only 1.7 million farms existed in 1974 for an average size of 534 acres. The number of farms in the U.S. may be below 1.5 million in 1980 if the current trend continues [25, p. 1].

Iowa has been no exception to the rule of larger farms. As shown in Table 2, farm numbers peaked in 1935 at 222,000 with an average size of 155 acres. The total number of farms fell to 131,000 in 1977 for an average size of 261 acres. In north central Iowa, the 1977 average farm size was 265 acres [10, p. 13].

Table 3 reveals the income situation facing small farmers. For the purposes of these data, it is useful to define small farms as those

Table 1. Farms in the United States: number, total land, and average size, 1850-1977[a]

Year	Number of farms	Total land (1000 acres)	Average size (acres)
1850	1,449,073	293,561	203
1870	2,659,985	407,735	153
1890	4,564,641	623,219	137
1900	5,737,732	838,592	146
1910	6,361,502	878,798	138
1920	6,448,343	955,884	148
1930	6,288,648	986,771	157
1935	6,812,350	1,054,515	155
1940	6,096,799	1,060,852	174
1945	5,859,169	1,141,615	195
1950	5,382,162	1,158,566	215
1954	4,782,416	1,158,192	242
1960	3,962,520	1,175,646	297
1965	3,356,170	1,139,597	340
1970	2,954,200	1,102,769	373
1975	2,808,480	1,086,025	387
1977	2,752,080	1,081,293	393

[a]Source: [22, p. 422].

Table 2. Iowa farms: number, total land, and average size, 1925-1977[a]

Year	Number of farms	Total land (1,000,000 acres)	Average size (acres)
1925	213,000	33.3	156
1930	215,000	34.0	158
1935	222,000	34.4	155
1940	213,000	34.1	160
1945	209,000	34.5	165
1950	206,000	34.8	169
1955	195,000	34.9	179
1960	183,000	34.7	190
1965	158,000	34.6	219
1970	145,000	34.4	237
1971	143,000	34.4	241
1972	141,000	34.3	243
1973	139,000	34.3	247
1974	138,000	34.3	249
1975	136,000	34.2	251
1976	133,000	34.2	257
1977	131,000	34.2	261

[a]Source: [8].

Table 3. Income per farm operator family by major source and by value of sales classes: 1960, 1970, and 1976[a]

Economic class by farm sales	Realized net farm income[b]			Off-farm income			Total net income		
	1960	1970	1976	1960	1970	1976	1960	1970	1976
$100,000 and over	$30,826	$41,124	$55,716	NA	$7,596	$13,310	NA	$48,720	$69,026
40,000-99,999	13,812	17,034	16,558	NA	3,943	6,906	NA	20,977	23,464
20,000-39,999	8,080	10,305	9,622	1,678	3,350	5,762	9,758	13,655	15,384
10,000-19,999	5,095	5,800	5,248	1,258	4,165	7,060	6,353	9,965	12,308
5,000-9,999	3,212	3,220	3,030	1,574	5,419	9,124	4,786	8,639	12,154
2,500-4,999	1,931	1,692	1,725	1,848	6,151	10,342	3,779	7,843	12,067
Less than 2,500	806	1,018	1,921	2,732	7,391	15,630	3,538	8,409	17,551
All farms	2,806	4,788	7,885	2,140	5,874	11,174	4,946	10,662	19,059

[a]Source: [23].

[b]Includes government payments.

with $10,000 to $39,999 annual sales. Since 1960, realized net farm income has remained relatively constant for small farmers. Total net income has increased only from a growing off-farm income. This illustrates the growing dependence of small farmers upon off-farm income sources. In 1976, over half of all farms received off-farm income and the average farm collected nearly 60.0 percent of its total net income from off-farm sources [25, p. 1].

The difference between large and small farms becomes even more evident by comparing farm sales. From Table 4 we see that small farms control 27.0 percent of all farm value of land and buildings and nearly 30.0 percent of machinery and equipment. Large farms control only 16.7 percent of land and 12.9 percent of machinery and equipment. Yet Table 5 shows that small farms account for only 16.9 percent of all agricultural sales while large farms achieve 37.0 percent. Large farms number only 2 percent of all farms yet their market share is double that of the 27.0 percent of all farms in the small category. Finally, we should note that the average total income for large farms is eight times that of small farms (Table 6).

This information illustrates the growing dominance of the larger farm and the weakening influence of the small farm in American agriculture. This trend summarizes the transformation of farming in the United States over the last four decades. In order to further place the present study in perspective, it will now be useful to review briefly the economic literature on small farms.

Table 4. United States farm assets by size classification, 1974[a]

Size classification / Farm assets	"Part-time and subsistence" farms sales of less than $10,000	"Small" farms sales of $10,000-39,999	"Medium" farms sales of $40,000-99,999	"Large" farms sales of $100,000-199,999	"Largest" farms sales of $200,000+
Value of land and buildings ($1000)	42,890,300	83,287,579	85,032,209	46,036,345	51,643,198
Percent of total	13.9	27.0	27.5	14.9	16.7
Value of machinery and equipment ($1000)	5,936,578	13,118,032	13,146,628	6,102,978	5,652,474
Percent of total	13.5	29.8	29.9	13.9	12.9
Irrigated land					
Percent of total farms	20.9	32.9	23.9	11.8	14.3
Percent of total acres	4.4	14.9	21.4	18.3	41.1
Percent of farms irrigated in each size	7.2	10.6	14.9	23.7	56.0
Grain storage facilities					
Percent of farms in each size with					
None	59.0	34.6	24.8	27.9	37.8
Less than 5,000	38.1	44.3	24.4	13.6	11.2
5,000-24,999	2.8	20.2	43.7	36.1	20.3
25,000-49,999	0.1	0.7	5.9	16.1	13.7
50,000+	0.0	0.2	1.2	6.3	16.9
	100.0	100.0	100.0	100.0	100.0

[a]Source: [25, p. 85].

Table 5. United States farm profiles: structural characteristics by size classification, 1974[a]

Size classification / Profile characteristics	Declining sector: "Part-time and subsistence" farms sales of less than $10,000	Declining sector: "Small" farms sales of $10,000-39,999	"Medium" farms sales of $40,000-99,999	Expanding sector: "Large" farms sales of $100,000-199,999	Expanding sector: "Largest" farms sales of $200,000+
General structural characteristics					
No. of farms[b]	1,203,084	631,782	324,310	101,153	51,446
Percent of farms[b]	52.2	27.3	14.0	4.5	2.1
Ave. farm size in acres	203	416	761	1299	2826
Percent of land	23.3	25.7	24.1	12.8	14.1
Percent of farm sales	4.7	16.9	24.7	17.0	36.8
Ave. market value of agricultural products sold	$5,321.00	$21,696.00	$61,890.00	$136,012.00	$581,996.00
Farm labor					
Hired					
Percent of farms	23.37	34.29	25.57	10.29	6.47
Percent of dollars	2.60	9.11	16.57	15.54	56.17
Contract					
Percent of farms	26.17	32.81	22.26	10.09	8.67
Percent of dollars	4.84	11.13	14.74	12.22	57.08

[a]Source: [25, p. 77].

[b]These figures represent all farms, not just commercial farms with sales of $2500 and over.

Table 6. United States farm liabilities and income by size classification, 1974[a]

Size classification Liabilities and income	"Part-time and subsistence" farms sales of less than $10,000	"Small" farms sales of $10,000-39,999	"Medium" farms sales of $40,000-99,999	"Large" farms sales of $100,000-199,999	"Largest" farms sales of $200,000+
Farm liabilities					
Percent of farms in debt	29.3	39.3	51.4	57.4	59.0
Ave. loan size of those in debt ($)	17,868	30,234	54,566	95,825	278,512
Farm income					
Value of farm sales ($)	5,321	21,696	61,890	136,012	585,692
Production expenses ($)	5,129	14,022	41,438	94,728	475,446
Production expenses as % of total farm sales	(96.4%)	(68.3%)	(67.0%)	(69.6%)	(81.1%)
Ave. farm income per farm ($)	192	6,874	20,452	41,284	110,246
Farm-related income (excludes direct farm income)	1,331	2,274	2,431	3,924	12,032
Percent from custom work	(34.8%)	(43.7%)	(48.4%)	(46.0%)	(33.6%)
Percent from direct gov't farm payments	(14.6%)	(20.1%)	(20.6%)	(18.6%)	(17.5%)
Family off-farm income ($)	10,665	8,404	6,713	8,047	13,577
Ave. total income per farm family ($)	12,188	17,552	29,596	53,255	135,855

[a]Source: [25, p. 87].

CHAPTER II.

REVIEW OF THE LITERATURE

Survival of the Family Farm

The family farm is surviving in America despite the increasing growth of farming units. It is surviving much like any other organism in nature: by adapting to a changing environment. The farms we just examined, while larger units than 40 years ago, are still predominantly family farms. They are family farms which have adapted to a more capital intensive agricultural production pattern. Advances in agricultural production technology have led many to question the survival of family farms. Nikolitch concludes that "the record of continued proportions of family farms and their sales of farm products sufficiently refutes any notion that they have yet suffered any decline in economic importance." [16, p. 259].

Nikolitch cites several reasons for the economic resiliency of the family farm [16, p. 267]. Competitive flexibility in altering production methods is one key element. The operator of a family farm is a risk-taking manager who is also the primary laborer. When adverse economic conditions develop, he may be willing to forego any compensation for his risk. If his equity is large enough, he may even forego both his labor and management returns. The biological nature and spatial distribution of farms may make a large concentration of capital, management, and labor more difficult in farming than other industries. As a result, this smaller size has been adapted successfully to the

managerial and working capacities of the family farm [15, p. 544]. Nikolitch does foresee family farms becoming bigger. He leaves unanswered the question of what sizes of farms will survive and which will not.

Heady perceives the small family farm as one of social choice. He points out that for nearly two hundred years "public policies for American agriculture have generally provided the impetus for growth in farm size." [6, p. 620]. The predominant force in the growth of larger farms is not corporations, but rather comes from "large family operations growing even larger" [6, p. 620]. Policy alternatives for reversing this trend are available. The survival of small family farms, viewed in this manner, thus becomes the choice of rural communities and the public in general.

Economic Theory

Two areas of theoretical research are relevant to the study of small family farms: economies of scale and firm growth theory. These are briefly considered in succession.

Economies of scale

Three types of empirical evidence have been used to examine economies of scale in farming: synthetic firm studies, cross-sectional data from actual farm records, and census data on changing size distribution of farms. Since the present study will be based on a synthetic firm and to a lesser extent farm records, it is instructive to look at these studies.

Jensen, in reviewing farm management literature, concludes that "most economies to size studies have shown that important economies do exist but that most of these are exhausted within the scope of the family farm operator" [11, p. 44]. Carter and Dean, in one of their pioneering works on economies of scale [4], derived a long run average cost (LRAC) curve from farm data in Yolo County, California. They admitted that cost economies are one reason for the trend toward consolidation and expansion in size of smaller farms. However, they found unit costs to be approximately constant over a wide range of total farm revenue sizes ($120,000-$400,000). This led them to conclude that "the analyses do not indicate a strong economic incentive for expansion to extremely large size" [4, p. 277].

Madden reported similar findings in an exhaustive study of economies of scale in various types of farms. He concluded that "in most of these studies, all of the economies of size could be obtained by modern and fully mechanized 1-man or 2-man farms" [14, p. 54]. Van Arsdall and Elder researched the economies of size on Illinois cash grain and hog farms, farms very similar in nature to the synthetic firm in this study. They examined cost economies in hog farms over a range of 355 to 2,104 acres and cash grain farms over a range of 574 to 3,937 acres. The authors concluded that, in either case, "any size of farm considered in this study can compete effectively with the optimal two or three-man units" [26, p. 53].

While economies of scale studies all point towards efficient production possibilities in the framework of the family farm, these

studies are not without their faults. Raup singles out the chief shortcoming to be the static nature of the research. In addition, none of the economies of scale studies considered the after-tax position of owners which Raup considers "crucial to the analysis" of large farms [18, p. 1276]. He states that an important but unanswered question of farm size research is: What sizes and types of farms are likely to survive a variety of simulated shocks or crises? Raup contends that to fully understand economies of size one must account for the dynamic growth of the farm firm as well as growth in management skills over time.

The dynamic development over time of the LRAC planning curve in agriculture has gained recent attention from Seckler and Young. Their objective is to determine which size survival theory is correct in explaining the LRAC curve and relate this result to the current controversy over water rights in California. Two theories exist to explain the typical "lazy L" agriculture LRAC curve which many empirical studies have generated. The first survival theory (S_1), developed by Stigler, attributes increasing firm size to economies of size. Farms become large simply because of technical and cost advantages inherent in expanded operations. S_1 predicts the following disposition of farms: "(a) comparatively small differences in cost/revenue ratios (C/R) between farms of the same size, with comparatively large differences in C/R ratio between farms of different size; and (b) that the variations between farms of different sizes would have a systematic quality such that there would be an area of optimum size of

farm, in which many farms are concentrated, and the smaller the farm the larger the C/R ratio" [20, p. 582]. Stated simply, S_1 says that small farms are eventually doomed due to cost disadvantages in an environment of technological economies to scale.

Seckler and Young offer a second survival theory (S_2) to explain agriculture's LRAC curve. S_2 assigns the cause of increasing farm size to different managerial abilities among farmers. In short, this theory says that at each size category of farms there exist both efficient and inefficient managers. The efficient farmers will want to expand their operations and probably can at the expense of the inefficient managers. The efficient managers tend to end up in the larger size categories while the inefficient managers who remain in the smaller sales category make up a progressively higher proportion of farmers in these categories. The net result is a "lazy L" which charts the migration of managerial ability over size categories. Specifically, S_2 predicts the following disposition of farms: "(a) that variations in C/R ratio between farms of the same size would be larger than variations in C/R ratio between farms of different sizes; and (b) consequently, there would be little clustering around a particular farm size, with no systematic variation in C/R ratio values across farm sizes" [20, p. 582]. In short, small farms may survive if managers are efficient. The authors conclude by advocating an S_2 approach in the water rights controversy.

Seckler and Young provide a novel framework for viewing farm size vs. efficiency. Traditional theories of economies of scale have led

most to associate efficiency with large farm size. A valid alternative to this hypothesis is that farms become large because the managers are efficient. One theoretical assumption of this study will be that society may not be worse off in terms of allocative efficiency if small family farms survive. Ball and Heady [2, p. 388] argue that with only 5 percent of all labor and 6 percent of all nonland capital in the agricultural sector, the nation's standard of living is not dependent upon the last degree of efficiency in agricultural production.

Firm growth theory

Another response to the static nature of traditional economies of scale farm research has been the development of firm growth models. Loftsgard and Heady provided early research on multiperiod linear programming [13]. They developed an application of dynamic linear programming which solved for optimum farm family business plans over a period of years. Further work by others produced the intertemporal investment and capital flow decisions in multiperiod analysis. Boehlje and White [3] constructed a dynamic model which examined investment in a central Indiana corn/hog farm over time. Their results proved consistent with the trend of capital for labor substitution as well as "the current trend in midwestern agriculture towards specialization" [3, p. 560]. These authors, as well as others, indicate that one of the major limitations of multiperiod linear programming formulation of firm growth is the difficulty in incorporating elements of risk and uncertainty into the analysis.

Technology and Agriculture

Technology is one dimension of the changing size structure of American agriculture that has received sizeable consideration in economic thought. The 1950's and 1960's witnessed tremendous increases in the use of capital on American farms. Large farms proved to be the major beneficiaries of the technology which induced these increases in capital inputs. Big farms not only possessed more initial capital with which to purchase additional capital improvements but they also were in a better position to take on the risk of new technology. Additionally, large farms had a greater land base with which to fully utilize the new capital intensive techniques. As a net result, large farmers became early adopters of new technology and reaped profits before the market expansion effect reduced profit incentives and margins.

On the other hand, small farms were left behind. They held less land on which to apply the new techniques. They possessed little capital with which to acquire additional capital. Small farmers tended to have less information on leading production techniques. Finally, small farmers tended to be more risk averse than large farmers and much less willing to go into debt. Consequently, a main result of the technology explosion in agriculture has been the purchase of small farms by larger farms.

While technology has created larger farms, it has not removed the problems of farm operators. As farms expanded in size, they tended towards a higher degree of specialization. With relatively constant

commodity prices and generally rising costs of production farmers "found themselves requiring more equipment and then more land to stay ahead of narrowing profit margins, inflation, and competitive pressures" [25, p. 3]. The increased dependence upon purchased inputs has been dramatic. From 1954 to 1974, use of purchased inputs rose by 45 percent while use of nonpurchased (farm produced) inputs declined by over 30 percent [25, p. 11]. In addition, farmers have become more reliant upon agricultural services from technical and financial areas. As farm commodity prices remained steady and the total purchase of inputs rose, farmers increasingly found themselves in a cost/price squeeze. Small farms are subject to this pressure in a more crucial manner than large farms. A major unanswered question is the ability of all farm sizes to withstand future cost/price squeezes.

Government Policy

Several analyses reveal that, intentionally or not, large farms have thrived on U.S. farm policy at the expense of small farms. The government did maintain policies in the past which were specifically intended to aid small family farms: the Resettlement Administration, Farm Security Administration, and Farmers Home Administration. Other programs such as minimum wage legislation and government commodity payment limitations discouraged large farms. Quance and Tweeten emphasize that, ironically, such policies "were completely overshadowed by the policies that were designed to help the family farm but in an unintended manner encouraged large farms" [17, p. 36]. These

overshadowing policies were the commodity price support programs.

Numerous authors have demonstrated the relationship of government payments to farm size. Because support price payments were distributed on a grain volume basis, farms with the largest quantity of grain received the most aid. Commodity program benefits thus tended to be allocated in direct proportion to income. Large farms benefitted greatly while small farms shared proportionately less. Besides the direct income distribution problem, other indirect affects of these programs became apparent.

Quance and Tweeten clarify some noticeable impacts of U.S. government farm policy [17, p. 37]. They argue that commodity programs have encouraged large farms by:

(1) Aiding the development and adoption of new labor-saving technology, thus exacerbating the trends towards large farms;

(2) Capitalizing program benefits into higher land values thereby increasing the wealth of large land owners;

(3) Hindering the small, landless farmer by placing him in a comparative disadvantage with large farms in competing for higher valued land.

The net effect of commodity price support programs has been an ever increasing growth of large farms.

Ball and Heady add further basis to the contention that government policy benefitted large farms. They argue that while U.S. farm policy has long focused on family operation and control of farms it has not

been a "small farm" policy [2, p. 386]. U.S. agriculture is still dominated by family farms but the magnitude of such farms has grown tremendously. Public funding of agricultural research, which induced the size adjustments discussed earlier, encouraged the growth of larger, capital intensive family farm units. Ball and Heady further show that public credit supply mechanisms, such as the Farm Credit Administration, favor farmers who already have the most equity, i.e., large farmers.

Finally, Kaldor elucidates the argument that commodity programs have aided neither small farms nor the rural nonfarm poor. Small farmers receive little help because benefits accrue in direct proportion to volume of output. Commodity programs are unable to appreciably benefit incomes of nonfarm rural poor. This impact depends upon "a trickle down mechanism and the linkages between this mechanism and many of the rural nonfarm poor are tenuous at best" [12, p. 154].

The historical pattern of government farm benefits gives every indication of remaining unchanged. Table 7 clearly illustrates this. In 1974, large farms (which account for only 2.1 percent of all farms) received 16.6 percent of all government payments with an average payment of $6,646. Small farms (which account for 27.3 percent of all farms) received 31.6 percent of all government payments but with an average payment of only $1,220. Finally, a higher proportion of large farmers receive government payments than do small farmers.

Table 7. Government payments to U.S. farms by size classification, 1974[a]

Size classification Government payments	"Part-time and subsistence" farms sales of less than $10,000	"Small" farms sales of $10,000-39,999	"Medium" farms sales of $40,000-99,999	"Large" farms sales of $100,000-199,999	"Largest" farms sales of $200,000+
Government payments					
Total farms in each category	586,356	631,782	324,310	101,153	51,446
Farms receiving gov't payments	49,382	68,839	40,691	12,832	6,661
Percent of farms within each size that receive gov't payments	8.4	10.9	12.6	12.7	13.0
Total amount of payments to each farm size ($1000)	37,788.00	84,037.00	68,245.00	31,555.00	44,272.00
Percent of total payments received by each farm size	14.2	31.6	25.7	11.9	16.6
Ave. payment of those receiving payments ($)	765.00	1,220.00	1,677.00	2,459.00	6,646.00

[a]Source: [25, p. 89].

Sociological Aspects

The demise of many small family farms brought with it the weakening economic vigor of several rural communities. Fewer small farms meant a lower farm population, less total farm income, and less demand for purchases in rural communities. The growing size of American farms calls into question not only the ability of small family farms to survive but also the future economic viability of many rural communities.

Raup argues that small family farms embody three functional beliefs on which American society founded itself: self-governing democracy, freedom of occupational choice, and competitive economic markets [19, p. 6]. He believes that deviations from an agriculture based upon small farms have far greater symbolic impact then economic factors display. When value added on farms in the production of food is only one percent of total GNP, "society's real interest in the size of farm question has less to do with costs of production or allocative efficiency and more to do with intangible values, including distributive equity, community structure, population distribution, and rural amenities" [19, p. 9]. Citing the production efficiency which can be achieved on a moderately sized family farm, Raup concludes that the question of farm size is largely irrelevant on agro-technical grounds while "highly relevant on social, political, and in the broadest sense, cultural grounds" [19, p. 16].

A study by Heady and Sonka [7] determined that total U.S. rural income is indeed higher under a scenario of all small farms as opposed to typical or large farms. They concluded that an agricultural

production system in the United States composed of all small farms would have the following results: increase prices for farm output; increase returns to cropland; provide a higher total farming sector income; and increase economic activity in rural communities. However, this scenario would also increase consumer expenditures for food and lower average net farm income.

Finally, the question of farm size is important to the interests of society in terms of agriculture's response to adverse economic conditions. Large farms are more susceptible to precipitous declines in production under adverse economic conditions. Hence, U.S. agricultural output may be more stable under a size structure of small farms. Society must decide whether control of U.S. agriculture by a relatively small number of farmers is in its best interest. The loss in economic resiliency of operating units may exceed the gain in allocative efficiency.

Summary of Literature

In order to more sharply focus the scope of this study and by way of review, we now wish to compare the key issues raised in the literature and how these relate to present objectives.

The family farm appears fully capable of surviving in today's agriculture. The important, unanswered question is whether or not the small family farm can continue to exist. This project hopes to provide an answer to this vital question.

Studies have shown that most economies of scale may be achieved in

the small to moderate sized family farm. This is taken as an assumption from which to study the future economic viability of a small north central Iowa farm. This study will point out the difficulty (or lack thereof) of maintaining farm income and give some indication of future reliance upon off-farm income sources. Most importantly, this research hopes to determine what levels of income the small family farm can expect in the future and whether or not this amount of income will be high enough to attract families to operate them.

Government programs in the past have aided the growth of large farms. Future government policy decisions will need to be more cognizant of the distributional impact of farm policy. Such a perspective requires an understanding of the problems and needs of farms of all sizes. This study intends to provide policymakers with a better idea of the problems which small family farms face.

Rural communities are increasingly forced to ask the question: With the demise of small family farms, will the American rural socio-economic infrastructure decline even further? An important dimension in answering this question is the future economic viability of small family farms themselves. This is the major objective of this study.

"Rapid changes in farming and related industries will extend the pell-mell decline in the number of smaller commercial farm units" [5, p. 314]. This continuing transformation of small farms into larger farms is the dominant force facing United States agriculture today. How we respond to this force will have far-reaching impact upon the number of farms in America, what types of farms these will be, and the general economic health of our rural communities.

CHAPTER III.

ECONOMIC MODEL OF THE PROBLEM

A dynamic linear programming (LP) framework is chosen to model the small family farm. While other models (such as simulation or recursive linear programming) might be used, multi-period linear programming offers several advantages. These are the following:

(1) It provides an optimized solution for allocating farm resources over an entire planning horizon;

(2) It is easily altered to reflect exogenous shifts in prices or resource base;

(3) It closely patterns the constrained optimization decisions facing the small family farmer.

The strengths listed above provide compelling reasons for using dynamic linear programming. Of primary importance to the small family farm is what future courses of action to take in order to maintain a profitable business. A multi-period LP model will provide direct and useful guidance on this issue.

A small family farm in north central Iowa is the model firm. Three separate LP models are used to capture different combinations of financial and economic conditions. The farm situation in each of these three models is as follows:

Model I : a 75 percent equity operation with limited off-farm employment options and investment opportunities in swine facilities only;

Model II : a 25 percent equity operation with many off-farm employment options and investment opportunities in swine facilities only;

Model III: a 50/50 crop share lease tenant farmer with 50 percent equity in equipment, a wide choice of off-farm employment options and expansion opportunities in both land and swine facilities.

Each model considers three discrete sizes of farms: 160, 240, and 320 acres. This range of sizes allows comparison of the relative economic strength of a spectrum of small farms. Specific discussion and analysis of these models follows in the next chapter.

Dynamic Framework

The small family farm operates like any other business: it must plan. Both short run and long run objectives will enter into the planning process. Since many small family farms are operated by young or beginning farmers, the importance of a long run planning horizon cannot be underemphasized. This study incorporates a five year time horizon in order to model such economic behavior.

The dynamic LP models (Model I, Model II, and Model III) each consist of five major, interrelated blocks, each corresponding to one year. The models represent business conditions for the small farmer in the period, 1980-1984. Each year in the models contains analogous activities and constraints. Transfer activities allow for the transfer of capital between periods. A final sixth block completes the LP matrix.

This corresponds to a 25-year-in-1 period. This period serves to force repayment of all debts contracted in the fifth year. No new borrowing may occur in this sixth period. All model analysis will focus upon the period 1980-1984 and this final period will largely be ignored.

The models each contain a total of 717 activities and 394 rows. Each of the first five years is a block consisting of 122 activities by 68 rows. The activities in each period may be divided into the following sectors: crop production, swine production, investment, labor, and transfer. Restraints may be partitioned into three basic categories: land, labor, and capital. Further elaboration of activities and restraints follows in a later section.

Any multiperiod model must address the issue of time preference. In this study, discounting future cash flow by an appropriate discount rate reflects the time value of money. A discount rate of 8 percent was chosen since this corresponds to the long run interest rate for land mortgages in the model. All costs and returns which enter into the objective function are discounted by the factor, $\frac{1}{(1.08)^t}$. Costs and returns are not discounted as they enter into the cash constraint row within a given period. This allows the models to reflect growing cash expense requirements over time because of inflation.

Inflation poses another important dimension of a dynamic LP model. Rising costs have become an economic fact of life in the United States. The impact of inflation upon small farmers is a key issue. For the purpose of this study, a constant inflation rate of 7 percent is assumed. This rate is deemed appropriate against the background of current

government policy objectives. In the face of the current performance of the economy, this estimate of 7 percent is conservative. Costs increase from 1980 through 1984 at a compound rate of 7 percent. At the same time, commodity prices are assumed to remain constant at an average level over the five year period. Using two different price levels allows us to consider the plight of the small family farm under varying degrees of a cost/price squeeze. Prices and costs in the model are explained in a later section. We now turn to a mathematical statement of the model.

The economic model as discussed above is here presented in standard mathematical form. The notation used follows the general format of Boehlje and White [3]. All activities are denoted by capital letters. Technical coefficients are lower case letters. Constraint levels are identified by capital letters. Subscripts are small letters. (The subscript "t" always refers to the t-th time period.) A full explanation of variables follows the model equations.

The following equations specify the model:

Maximize: Discounted Net Returns

$$(1)\quad NR = \sum_{t=1}^{\ell} \frac{\sum_{j=1}^{m} A_{jt} X_{jt} + \sum_{j=1}^{n} F_{jt} Y_{jt} + \sum_{k=1}^{p} G_{kt} Z_{kt} - C_t - \sum_{i=1}^{q} [R_{it} + P_{it}] - T(NI)_t}{(1 + r)^t}$$

(present value of stream of net returns)

(sum of discounted annual disposable income)

subject to: Crop Production Capacity

$$(2)\quad \sum_{j=1}^{m} a_{cjt} X_{jt} \leq L_{ct} \qquad \text{for all } c = 1, \ldots, u$$

(resource utilization) (resource availability)

subject to: Swine Production Capacity

$$(3)\quad \sum_{j=1}^{n} f_{sjt} Y_{jt} \leq B_{st} \qquad \text{for all } s = 1, \ldots, v$$

(resource utilization) (resource availability)

subject to: Labor Capacity

$$(4)\quad \sum_{j=1}^{m} \ell_{jt} X_{jt} + \sum_{j=1}^{n} m_{jt} Y_{jt} + \sum_{k=1}^{p} n_{kt} Z_{kt} \leq E_{to} + O_{t}$$

(labor utilization) (labor availability)

subject to: Investment Capacity

$$(5)\quad \sum_{b=1}^{s} g_{bt} V_{bt} \leq M_{bt}$$

(on-farm investment) (available liquid capital)

where: Liquid Capital Availability

$$(6)\quad M_{bt} = M_{to} + \sum_{i=1}^{q} N_{it} + (DI)_{t}$$

(available liquid capital) (cash at year beginning) (total new borrowing) (disposable income)

where: Annual Disposable Income

$$(7)\quad (DI)_{t} = \sum_{j=1}^{m} A_{jt} X_{jt} + \sum_{j=1}^{n} F_{jt} Y_{jt} + \sum_{k=1}^{p} G_{kt} Z_{kt} - C_{t} - \sum_{i=1}^{q} [R_{it} + D_{it}] - T(NI)_{t}$$

(annual disposable income) (sum annual net returns)

subject to: Borrowing Capacity

(8) $N_{it} \leq d_i \, (AT)_{t-1}$ for all i = 1, ..., q

(new borrowing) (proportion of assets)

subject to: Debt Repayment

(9) $\sum_{i=1}^{q} p_i D_{it} = \sum_{i=1}^{q} [R_{it} + P_{it}]$

(annual debt service due) (interest and principal paid)

subject to: Consumption Requirements

(10) $C_t = C_r$

(consumption allowance) (consumption required)

subject to: Income Transfer

(11) $(TR)_t \leq M_{to} + (DI)_t$

(cash transfer to t+1 period) (cash at year beginning) (annual disposable income)

subject to: Nonnegativity Condition

(12) X_{jt}, Y_{jt}, Z_{kt}, D_{ct}, V_{bt}, N_{it}, and $(TR)_t \geq 0$

Subscripts:

t = the period of time, t = 1, ..., ℓ;

j = the production activity, j = 1, ..., z;

k = the labor activity, k = 1, ..., z;

i = the borrowing activity, i = 1, ..., q;

c = the crop production physical resource, c = 1, ..., u;

s = the swine production physical resource, s = 1, ..., v;

o = resource level at beginning of year;

b = the investment activity, b = 1, ..., s.

Coefficients:

A_{jt} = the annual return above total cost of one unit of activity j in period t;

F_{jt} = the annual return above variable cost of one unit of activity j in period t;

G_{kt} = the annual return of one unit of activity k in period t;

T = income tax schedule;

a_{cjt} = annual utilization of resource c in one unit of activity j in period t;

f_{sjt} = annual utilization of resource s in one unit of activity j in period t;

ℓ_{jt} = annual labor utilized in crop production activity j in period t;

m_{jt} = annual labor utilized in swine production activity j in period t;

n_{kt} = annual labor utilized in off farm job k in period t;

g_{bt} = capital requirement for investment b in period t;

d_i = proportion of assets that can be borrowed for borrowing activity i;

p_i = the annual debt constant for borrowing activity i.

Decision Variables:

X_{jt} = the level of crop production activity j in period t;

Y_{jt} = the level of swine production activity j in period t;

Z_{kt} = the level of off-farm employment activity k in period t;

V_{bt} = the level of farm investment activity b in period t;

N_{it} = the dollar amount of new borrowing of type i in period t;

D_{it} = the dollar amount of debt service on borrowing type i in period t;

$(TR)_t$ = the dollar amount of net revenue transferred to period t+1.

State Variables:

NR = the present value of the stream of net returns;

R_{it} = the annual interest payable for borrowing activity i in period t;

P_{it} = the annual principal payment for borrowing activity i in period t;

$(NI)_t$ = net taxable income in period t;

$C_{t=r}$ = annual family consumption requirements in period t;

L_{ct} = the physical amount of resource c available for crop production activities in period t;

B_{st} = the physical amount of resource s available for swine production activities in period t;

E_{to} = family labor available in period t;

O_t = hired labor available in period t;

M_{bt} = available liquid capital in period t;

M_{to} = beginning cash amount in period t;

$(DI)_t$ = annual disposable income in period t;

$(AT)_t$ = dollar amount of all physical assets controlled in period t.

The objective function maximizes the present value of the annual net return stream. Equation (1) specifies that the present value of net returns is the sum of discounted annual disposable income over the model's planning horizon. Disposable income includes net returns from crop production, swine production, and off-farm labor income less consumption, debt payments, and income taxes (equation (7)). Since all expenditures are accounted for, net returns reflects pure profit or loss.

Physical and institutional constraints on the model are expressed in equations (2), (3), (4), (5), (8), (9), (10), and (11). Equations (2) and (3) state the farm's physical capacity to produce crops and hogs in any given period. Labor allocation between on- and off-farm employment is constrained by equation (4). Capital investment is restrained by the availability of liquid capital (equation (5)). As expressed in equation (6), liquid capital may be obtained from beginning of period cash balances, new borrowing, or annual disposable income.

New borrowing in any period is limited by the dollar size of assets in the previous period (equation (8)). The proportion of assets which may be borrowed differs by type of loan. Equation (9) requires repayment of interest and principal on all outstanding debt. Family

consumption requirements must be met in each period by equation (10). Equation (11) allows excess cash at year's end to be transferred to the next period. Finally, equation (12) expressed the standard linear programming nonnegativity condition.

As pointed out earlier, the models each contain 717 activities and 394 rows. The major columns and rows of the matrix are now given further consideration.

Model Activities

The activities contained in a one year block of the models may be divided into five sectors: crop production, swine production, investment, labor, and transfer. These categories are now examined in turn.

Crop production activities

Five crop rotations are available to the farm operator:

(1) Continuous Corn, (CC);

(2) Corn - Soybeans, (C-Sb);

(3) Corn - Corn - Soybeans, (C-C-Sb);

(4) Corn-Soybeans - Corn - Oats - Meadow, (C-Sb-C-O-M);

(5) Corn - Soybeans - Oats - Meadow, (C-Sb-O-M).

These rotations represent the most typical cropping patterns found in north central Iowa. Yield and fertilizer assumptions for these rotations are discussed later in this chapter. All crops are sold in the year of harvest. Corn may be either sold as grain or fed out to hogs. All other crops must be sold although only a limited market for hay exists. The model provides two harvest alternatives for all crops: custom or self harvest.

Swine production activities

Swine production activities are organized on a quarterly basis. The farmer may produce hogs to either feeder size or finished market weight. Feeder pigs may be purchased to finish out or a total farrow-to-finish system may be employed. The hog production alternatives may be summarized as follows:

Farrow-to-Finish:

Pasture (March and September only);

Partial confinement;

Total confinement;

Farrow-to-Feeder:

Total confinement;

Feeder-to-Finish:

Partial confinement;

Total confinement.

Initial livestock resource endowments and costs will be discussed later in this chapter.

Investment activities

Investment activities allow the farm operator to increase physical production capacity. The investment opportunities open to the farmer vary under the different model alternatives. Model I and Model II farms (the two owned farm situations) may only expand into additional hog facilities. No land investment option was given so that income levels for discrete sizes of small owner operated farms could be determined. Hog expansion alternatives are the following:

(1) breeding stock;

(2) pasture farrow house;

(3) partial confinement farrow-to-finish facility;

(4) total confinement farrow-to-finish facility;

(5) open front finish facility;

(6) total confinement finish facility;

(7) total confinement farrow facility.

The model may choose among these options to allow for a labor intensive, a capital intensive, or a mixture of both alternatives in expanding hog operations.

The tenant farmer (Model III) may, in addition to the above investment alternatives, expand in land. Acreage may be increased through either (1) renting up to 40 additional acres in any year or (2) purchasing up to 40 more acres in any year. The purchased land returns all production revenues to the tenant operator. The tenant farmer is given an opportunity to acquire additional land so that he may attempt to bring his income up to the levels of owner operated farms over time.

In each of the three models, the capital needed for investment may be obtained from three sources: annual disposable income, beginning of period cash balances, or new borrowing. The amount which may be borrowed is a constant proportion of the dollar level of assets in the preceding period. This proportionality constant for swine facility borrowing is 0.75. Loans for swine facilities require 8.5 percent interest and repayment over five years. Land secured mortgages (for the

tenant farmer) charge 8.0 percent interest over a 25 year repayment period. Finally, operating capital for production expenses may be borrowed for a one year period at 9.0 percent interest. All loans begin repayment in the year following issuance.

Labor activities

The models contain activities for both hiring additional labor and employing family labor off the farm. Labor may be hired for farm work in each of the twelve months in the year. However, the amount of additional labor is bounded by 80 hours per month during the winter months of November through March. During these months the supply of hired labor is assumed to be less, due to the large number of young workers in school.

The off-farm employment activities in the models depend upon the specific model alternative in question. Table 8 describes the off-farm opportunities for the different models. These estimates represent a best guess of expected off-farm labor opportunities in 1980. Two publications, Iowa Labor Market [9] and Iowa Agricultural Statistics [8], were consulted in forming these estimates. The wife's $120 a week part time job corresponds to clerical work for 20 hours a week at $6 per hour. A business/office position pays an annual salary of $13,000 for the wife. The husband's $7 per hour part time job reflects expected pay in an industrial/factory job. The $17,500 annual salary is for a year round sales or business position.

Salaries and pay are assumed to keep up with inflation. Thus, off-farm income may grow at an annual rate of seven percent. The off-farm

Table 8. Off-farm employment opportunities in model alternatives

	Husband		Wife	
	Job	Pay[a]	Job	Pay[a]
Model I	None		Part time	$120 per week
			Full time	$13,000 per year
Model II and Model III	Part time	$7 per hour	Part time	$120 per week
	Full time	$17,500 per year	Full time	$13,000 per year

[a]Compensation in 1980.

opportunities for the operator in 1984 would be a $22,939 full time or a $9.18 per hour part time job. Off-farm prospects for the wife in 1984 would be a $157 per week part time or a $17,040 per year full time job.

Transfer activities

Activities are included in the models which allow capital to move between periods. Cash flow is organized on a quarterly basis within each year in the models. Four cash transfer activities move cash from quarter one to quarter two and similarly up through quarter four to quarter one of the next year. Additional activities transfer the dollar value of assets and net worth from one year to the next.

Model Restraints

The three basic resource restraint categories will now be considered: land, labor, and capital.

Land

Worth County is chosen as a representative location for the north central Iowa farm. The land composition assumes the following soil types:

Clarion loam, 2-5% slope	30%
Nicollet loam, 0-2% slope	30%
Webster silty clay loam, 0-2% slope	20%
Canisteo silty clay loam, 0-2% slope	20%

Crop yields for each of the above soil types were obtained from the U.S.D.A. Soil Survey of Worth County. These yields were multiplied by the percentage weights listed above to give expected yields on the composite soil. The yields in all three models are the same. These yields are expressed in Table 9.

Table 9. Crop yields in the models

Crop	Yield (bushels per acre)
Corn	
CC	110.0
C-SB	117.0
C-C-Sb	115.0
C-Sb-O-M	122.0
C-Sb-C-O-M	120.0
Soybeans	41.5
Oats	87.5
Alfalfa	4.5 (tons per acre)

In order to maintain soil quality and produce the above yields, the fertilizer rates expressed in Table 10 are assumed in the models.

Table 10. Fertilizer rates in the models

Crop	Fertilizer Application (lbs per acre) Nitrogen	Phosphorus	Potassium
Corn (after corn)	170	60	60
Corn (after soybeans)	120	60	60
Corn (after hay)	75	60	60
Soybeans	0	60	60
Oats	0	60	60
Hay	0	0	0

Labor

The total farm supply of labor consists of 2880 annual operator hours and 50 weeks of the wife's labor. The operator has 240 hours monthly which he may allocate between on- and off-farm uses. The wife may also choose to work on or off the farm. If she works on-farm, each week of her labor adds 30 hours to the farm labor supply. The models do not make allowance for household production. Hence, off-farm work for the wife is implicitly encouraged except when the labor hiring activity is constrained. Farm labor may be augmented through hired labor as discussed earlier.

Capital

Cash use and availability are organized on a quarterly basis. The transfer activities outlined above allow cash to be moved from one quarter to the next. A first year beginning cash balance is allotted in each model alternative: $10,000 for Model I, $2,500 for Model II, and $5,000 for Model III. Cash balances for all other periods in the models must be generated internally. Additional capital to cover operating expenses or family consumption may be borrowed in any quarter. Any excess cash in a quarter may be used for investment.

Debt servicing in each period depends upon the model alternative. The debt payment assumptions are listed in Table 11. These figures represent the repayment of the debt portion of assets controlled by the farm. For Model I and Model II, $480,000 of assets (land + equipment) are assumed at the start. Assets of $120,000 (equipment only) are assumed in Model III.

Table 11. Annual debt service for 240 acre farm

	Annual debt service	
	Intermediate term	Long term
Model I	0	$10,000
Model II	$22,842	$33,732
Model III	$15,228	$10,000

Consumption drains on cash balances are given in Table 12. These figures estimate the annual living expenses of a farm family of four. Consumptions are expected to keep up with the rate of inflation. Estimates were obtained by consulting the Bureau of Labor Statistics publication, Family Budgets. No rural budgets were available so the 1977 budgets for nonmetropolitan families (cities of 2,500-50,000 population) were used. A middle to upper middle class standard of living was assumed. The 1977 budget for nonmetropolitan families was adjusted for seven percent inflation to give the 1980 consumption estimates in Table 13.

Table 12. Annual family consumption, 1980-1984

Year	Consumption
1980	$18,000
1981	$19,260
1982	$20,608
1983	$22,051
1984	$23,594

Table 13. Family consumption pattern in 1980

Category	Dollars spent
Food	$4,783
Housing	4,925
Transportation	1,809
Clothing	1,621
Personal care	518
Medical care	1,031
Other consumption	1,137
Other items	1,186
Total personal consumption	17,010
Social Security Tax	990
Total household budget	18,000

The family budget costs in Table 13 are for a hypothetical list of goods and services which portray a middle to upper middle class standard of living. The family is assumed to have average inventories of clothing, housefurnishings, major durables, and other equipment consistent with this standard of living. Housing costs include ownership costs as well as house furnishings. Food costs include food consumed both at and away from home. Social security tax is included in the budget while income tax is not. (The models have separate income tax paying activities.)

Subsumed in the model is a standard machinery complement for a small north central Iowa farm. Fixed costs for maintaining this equipment (including depreciation and repairs) are included in production costs. The farm is given an initial endowment of 20 sows and facilities to allow pasture farrow-to-finish operations. Any additional hog facilities must be purchased via investment activities.

Data Sources

The model data were obtained from several sources. The crop and swine production budgets were acquired from the 1976 FEDS (Firm Enterprise Data System) budget generator installed on the Iowa State University computer system. The data in these budgets are maintained by the Commodity Economics Division of the Economic Research Service in cooperation with Oklahoma State University. Budgets for north central Iowa were used. Since these budgets represent area wide averages over many farms, an additional data source was consulted to make the budgets appropriate for one farm. This secondary source of production data was the 1976 Iowa Farm Business Association records for north central Iowa. Cost budgets were projected to 1980-1984 by assuming a seven percent annual inflation rate. Investment costs for swine facilities were obtained from the U.S.D.A. publication, Pork Production Systems: Determining Capital Requirements, April, 1977 [24]. These costs were also assumed to rise at an annual rate of seven percent. A more thorough description of cost budgets may be found in the Appendix.

Two sets of constant commodity prices are used in the model. These two levels represent a best guess as to what farm prices to expect and an optimistically higher set of prices. Commodity prices were determined by examining farm prices over the period 1960-1972. The average parity price for corn over this period was established at 75 percent. Using this percentage and the current parity price of corn, the corn price was set at $2.92. Next, the 1960-1972 average ratios of crop and hog prices to the price of corn were computed. These ratios were used, along with

the base price of corn (2.92), to peg the relative prices of other crops and hogs to the price of corn. This process resulted in price level one (P1). An analogous method produced price level two (P2) by assuming a 90 percent parity price for corn of $3.50. P1 and P2 are listed below in Table 14.

Table 14. Commodity prices in the models

Crop	P1	P2
Corn (bushel)	$2.92	$3.50
Soybeans (bushel)	6.86	8.23
Oats (bushel)	1.75	2.10
Hay (ton)	49.64	59.57
Feeder pigs (head)	40.00	48.00
Finished hogs (cwt.)	46.75	56.10

Model Assumptions

In concluding this chapter's description of the models and before proceeding to a discussion of model results, we briefly review the assumptions of this study.

The models are constructed in a dynamic linear programming framework. Hence, the models carry all the assumptions of linear programming: linear production functions; activities and resources may be fractionally divided; a finite number of activities may be specified; and finally,

costs and prices in the models are single valued expectations held with certainty. The last point merits emphasis. These models assume that prices and costs in the period 1980-1984 are known with certainty. A crucial assumption behind cost estimates is an estimated seven percent inflation rate. Moderate deviations in this factor alone will alter model results significantly. Nonetheless, these models will provide useful information on small farm problems. Finally, the models do not reflect all the risk which faces the small family farm. This is beyond the scope of this study.

CHAPTER IV.

MODEL RESULTS AND DISCUSSION

The results of optimizing the LP models are now presented and discussed. A number of alternative LP solutions were obtained for each of the three models (Model I, Model II, and Model III). A discussion of these farm situations precedes the discussion of results. Analysis of the results from this study will proceed under the following categories: income levels, investment, labor allocation, cropping patterns, and swine production. Implications of the results from the various farm situations will be discussed under each category. The greatest emphasis will be placed on the levels of income section since the most significant findings are to be found here.

Model Alternatives

We recall from the last chapter that this study attempts to model three real world small farm situations. A high equity (75 percent), well-established farmer with no off-farm job opportunities and hog expansion options is patterned by Model I. Model II captures the economic conditions facing a low equity (25 percent), beginning farmer with several nonfarm job opportunities and swine facility investment options. Finally, Model III models a 50/50 crop share lease tenant farmer with off-farm employment offerings and hog facility or land investment opportunities. In short, Models I, II, and III represent high equity, low equity, and tenant farming conditions respectively.

In order to provide a wide spectrum of farm situations, three sizes

of farm (160, 240, and 320 acres) and two farm price levels are considered for each of the three models. (The two price levels, P1 and P2, were presented in Table 14.) Combining each size level with both price levels gives a total of six solutions for each level of farm ownership and a grand total of 18 farm situations. However, the 240 acre solutions for the high equity farm showed positive net income at both price levels in 1984. Consequently, the 320 acre solutions were not run since this information could only confirm that high equity farms are profitable at this size. The total number of solutions is thus reduced to 16.

For ease of explanation in result analysis, the 16 farm situations are labelled with code names. An explanation of these code names is found in Table 15. Here, the relevant parameters which combine in a particular farm situation are summarized. The solutions are collected according to which model they use. Thus, D161 models a high equity farm of 160 acres operating under farm price level P1. Similarly, T328 patterns a tenant farmer operating on 320 acres with farm price level P2. We might add that all owner operator solution labels (Models I and II) begin with a "D". All tenant farm solution names (Model III) start with a "T".

Before turning to a discussion of results, one segment of the LP construction which impinges upon solution analysis requires clarification. Annual debt service for initial levels of debt in the three models is handled as a fixed bound on a separate set of borrowing activities in year one. These activities allow for the separation of

Table 15. Description of solution alternatives for Models I, II, and III

Farm situation	Solution label	Price level	Acreage
Model I:	D161	P1	160
High equity farm	D162	P2	160
	D241	P1	240
	D242	P2	240
Model II:	D164	P1	160
Low equity farm	D165	P2	160
	D244	P1	240
	D245	P2	240
	D324	P1	320
	D325	P2	320
Model III:	T167	P1	160
Tenant farm	T168	P2	160
	T247	P1	240
	T248	P2	240
	T327	P1	320
	T328	P2	320

annual debt service into interest for tax credit and principal for equity accumulation. Because debt repayment for all borrowing begins in the year following issue, initial debt repayment begins in year two (1981). Hence, net income for 1980 in all farm situations is overstated. 1981 net income may be overstated to a limited extent through possible carryover of 1980 profits. Nonetheless, net income in 1984 and the period 1982-84 should be correctly stated. (A slight upward bias may exist if 1980 profits are invested in additional assets.) For the reasons stated above, analysis of income levels will focus upon 1984. The 1982-84 annual average income will be used to provide a broader measure. This emphasis should be appropriate because the objectives of this study pertain to 1984 results.

Levels of Income

The levels of income generated in the various farm situations carry striking significance in discussing future small farm problems. Model results point to a dismal future for some small family farms. One of the most important bits of information the models provide is which farms will succeed and which will not. Income levels can best be analyzed in two categories: net income with off-farm income and net income excluding nonfarm income. Before we begin, a few words need to be said on what constitutes net income.

Presentation of income levels is organized in the following manner. Farm income consists of crop sales plus hog sales. Nonfarm income includes earnings from off-farm employment by the husband and wife. Total gross income is the sum of farm and nonfarm income. Subtracting

farm expenses, consumption, income taxes, and annual debt service from total gross income leaves net income from all sources. Finally, subtracting nonfarm income (off-farm earnings) from net income from all sources leaves net farm income.

Two points need emphasis. Net farm income technically is not profit since it contains management return as well as the return to all factors of production. In order to isolate the management return, one would have to subtract imputed returns on labor, land, and capital. Second, all solutions were run with the off-farm employment opportunities outlined in Table 8 of the last chapter. No solutions were run without any off-farm jobs. Net farm income was computed by simply subtracting off-farm earnings from net income from all sources. These figures are not the result of separate optimization solutions in which no off-farm employment is allowed. In this sense, the net farm income figures are not entirely precise. The figures do, nonetheless, provide a strong indication of future incomes on small farms in the absence of off-farm earnings.

Net income with off-farm income

We now examine future farm incomes which include off-farm earnings. Results will be viewed with a dual purpose in mind: (1) to determine a "breakeven" farm situation for each mode of ownership (high equity, low equity, and tenant); and (2) to compare the potential relative economic strength of various farm situations. The breakeven farm will be defined as having those conditions which will allow it to earn a positive net income. In this section, we will be concerned with a

positive net income from all sources. This breakeven concept will be more narrowly defined in the next section to be those farm conditions which combine to produce a positive net farm income.

Table 16 presents a ranking of the 16 farm situations by net income from all sources. Results for 1984 as well as the broader measure of the annual average over 1982-84 are listed. We might begin by noting that we expect 1984 net income to be less than the three year average. This is due to the fact that farm profit margins decline over the five year period as inflation pushes costs up while prices remain at an average level.

Table 16 allows us to immediately compare the incomes of various farm situations. Looking at the three year average we see that half of the farm situations have positive net incomes while the other half incur net losses. The high equity farm provides adequate income at 160 or 240 acres under either price level. Indeed, the high equity farm owns the strongest income position; earning more on 160 acres with low prices than low equity or tenant farms can earn on 320 acres and high prices. The low equity and tenant farms can generate adequate income for a family only by having at least 240 acres and high farm prices. The 160 acre tenant and low equity farms cannot provide positive net income at either level of farm prices. Income would also be inadequate for farm families under small farm situations represented by: tenant farms of 240 and 320 acres with farm price level P1; and 240 and 320 acre low equity farms with price level P1.

The net income figures for the various farm situations strongly

Table 16. Ranking of farm situations by net income from all sources, 1984 and annual average for 1982-84[a]

Rank	1984		1982-84 annual average	
	Model alternative	Net income from all sources	Model alternative	Net income from all sources
1	D242	$29,676	D242	$29,143
2	D162	20,581	D162	20,375
3	D241	15,285	D241	15,285
4	D325	6,017	D161	7,818
5	D161	5,672	T328	5,074
6	T328	2,364	D325	4,757
7	D245	1,310	D245	2,015
8	T248	(2)	T248	92
9	D165	(2,031)	D165	(646)
10	T168	(8,673)	T327	(3,941)
11	T247	(11,437)	T168	(4,107)
12	T327	(13,820)	T247	(6,760)
13	T167	(18,406)	T167	(9,453)
14	D164	(18,567)	D164	(9,527)
15	D244	(20,737)	D244	(10,181)
16	D324	(22,227)	D324	(11,057)

[a]Constant 1980 dollars.

indicate that a high equity level of ownership will be crucial in providing adequate income for small farm families. The next section, in which off-farm earnings are excluded, will further emphasize this premise. The only 160 acre farms which show positive net income from all sources are the high equity farms. 240 and 320 acre low equity and tenant farms must have higher farm prices in order to earn positive net incomes. The key determinant between positive net income and net loss is annual debt service. For the low equity and tenant farms, the debt load is high enough relative to cash flow to result in losses. The owner operator with high equity has a much reduced annual debt service and thereby can generate positive net income from all sources. In short, the owner-operated farm with 75 percent equity gives all indications of being the healthiest economic farm unit in 1984.

Before discussing a breakeven size of farm, it will be useful to present more complete income statements for the 16 various farm situations. This statement of income sources for high equity farms is presented in Table 17. Similarly, Tables 18 and 19 contain income statements for the low equity and tenant farm situations.

The relative economic strength of different farm situations is again made apparent by comparing breakeven sizes of farm. From Table 17, we see that an owner operated farm with 75 percent equity can earn positive net income from all sources on somewhat less than 160 acres under farm price level P1. This operation would include a large swine operation and would earn about 15 percent of its income off-the-farm. On the other hand, a 25 percent equity owner-operated farm

Table 17. Income levels for high equity farms, 1984 and annual average for 1982-84[a]

	D161		D162		D241		D242	
	1984	Annual average 1982-84	1984	Annual average 1982-84	1984	Annual average 1982-84	1984	Annual average 1982-84
(1) Crop sales	16,733	18,105	21,284	22,134	33,214	34,436	46,575	40,577
(2) Hog sales	56,694	61,795	63,808	84,457	60,011	66,665	57,335	80,613
(3) Total farm sales [line (1) + line (2)]	73,427	79,900	85,092	106,592	93,225	101,101	103,910	121,190
(4) Off-farm income	12,529	12,643	12,529	12,643	12,529	12,643	12,529	12,643
(5) Total gross income [line (3) + line (4)]	85,956	92,543	97,621	119,235	105,754	113,745	116,439	133,834
(6) Farm % total [line (3)/line (5)]	85	86	87	89	88	89	89	91
(7) Off-farm % total [line (4)/ line (5)]	15	14	13	11	12	11	11	9
(8) Net income from all sources	5,672	7,818	20,581	20,375	13,574	15,285	29,676	29,143
(9) Net farm income	(6,857)	(4,824)	8,052	7,732	1,045	2,463	17,147	16,500

[a]Constant 1980 dollars.

appears unable to provide adequate income at any size under price level P1. Looking at Table 18, we see that 1984 net losses increase as we go from 160 (D164) to 240 (D244) to 320 acres (D324). These results indicate that the high debt load imposes per unit losses on the farming operation which cannot be overcome at any size with farm price level P1. Even with 25 to 30 percent of total gross income coming from nonfarm sources and a sizeable swine operation, the low equity farmer cannot generate adequate income to support a family.

The tenant farm appears to be able to reach a breakeven size at approximately 400 acres with farm price level P1. Looking at the three year average net income from all sources in Table 19, the results show a declining net loss as farm size increases from 160 to 320 acres. We might expect net income to become positive at about 400 acres if we extend this trend. This farm would include a large hog operation and would earn approximately a third of its total gross income off-farm.

If we examine breakeven sizes of farms operating under farm price level P2, we are not surprised to find smaller farms than under P1. For the 75 percent equity farm, the sizeable income on 160 acres (D162 from Table 17) indicates that positive net income might be achieved on as little as 120 acres. This would include 12 percent nonfarm income and a large swine operation. The 25 percent equity owner operator farm under price level P2 reaches a breakeven size at approximately 240 acres (D245 from Table 18). Nonfarm earnings would form a considerable share of total gross income at 28 percent and a large

Table 18. Income levels for low equity farms, 1984 and annual average for 1982-84[a]

	D164		D165	
	1984	Annual average 1982-84	1984	Annual average 1982-84
(1) Crop sales	21,923	20,869	31,534	25,551
(2) Hog sales	51,986	59,783	44,067	68,312
(3) Total farm sales [line (1) + line (2)]	73,909	80,652	75,601	93,863
(4) Off-farm income	31,637	30,764	31,839	30,669
(5) Total gross income [line (3) + line (4)]	105,546	111,416	107,440	124,531
(6) Farm percent total [line (3)/line (5)]	70	72	70	75
(7) Off-farm percent total [line (4)/ line (5)]	30	28	30	25
(8) Net income from all sources	(18,567)	(9,527)	(2,031)	(646)
(9) Net farm income	(50,204)	(40,290)	(33,870)	(31,315)

[a]Constant 1980 dollars.

D244		D245		D324		D325	
1984	Annual average 1982-84	1984	Annual average 1982-84	1984	Annual average 1982-84	1984	Annual average 1982-84
40,337	42,378	60,427	50,556	65,223	66,569	78,028	71,653
52,037	59,263	20,220	58,177	29,556	41,964	34,023	65,261
92,374	101,641	80,647	108,733	94,779	108,553	112,051	136,914
31,093	31,066	31,517	29,665	30,963	30,202	30,737	27,615
123,467	132,707	112,164	138,398	125,742	138,753	142,788	164,529
75	77	72	79	75	78	78	83
25	23	28	21	25	22	22	17
(20,737)	(10,181)	1,310	2,051	(22,227)	(11,057)	6,017	5,074
(51,830)	(41,248)	(30,207)	(27,650)	(53,190)	(41,259)	(24,720)	(22,858)

Table 19. Income levels for tenant farms, 1984 and annual average for 1982-84[a]

	T167		T168	
	1984	Annual average 1982-84	1984	Annual average 1982-84
(1) Crop sales	13,365	16,029	10,331	11,179
(2) Hog sales	49,545	42,848	31,841	61,560
(3) Total farm sales [line (1) + line (2)]	62,910	58,877	42,172	72,740
(4) Off-farm income	32,744	31,534	32,579	30,773
(5) Total gross income [line (3) + line (4)]	95,654	90,412	74,746	103,512
(6) Farm percent total [line (3)/line (5)]	66	65	56	70
(7) Off-farm percent total [line (4)/ line (5)]	34	35	44	30
(8) Net income from all sources	(18,406)	(9,453)	(8,673)	(4,107)
(9) Net farm income	(51,150)	(40,988)	(41,247)	(34,879)

[a]Constant 1980 dollars.

T247		T248		T327		T328	
1984	Annual average 1982-84	1984	Annual average 1982-84	1984	Annual average 1982-84	1984	Annual average 1982-84
17,263	20,812	24,788	20,119	27,399	26,512	38,817	28,576
47,059	39,843	35,011	62,617	32,924	41,162	22,047	58,468
64,322	60,656	59,799	82,736	60,323	67,674	60,864	87,044
31,897	31,272	32,065	29,732	31,714	30,158	31,691	28,934
96,229	91,928	91,864	112,468	92,037	97,832	92,555	115,979
67	66	65	74	66	69	66	75
33	34	35	26	34	31	34	25
(11,437)	(6,760)	(2)	92	(13,820)	(3,941)	2,364	5,074
(43,334)	(38,033)	(32,063)	(29,430)	(45,534)	(34,098)	(29,327)	(23,860)

swine setup would again be employed. The tenant farm likewise reaches positive net income from all sources at 240 acres under farm price level P2 (T248 from Table 19). Nonfarm share of total gross income rises to 35 percent and swine production is central to farm operations.

From the preceding discussion, we may conclude that level of ownership is a key issue in a consideration of future small farm problems. The 75 percent equity owner operator will fare better on 160 acres than his low equity or tenant counterparts on larger farms. The implication of this is that avoiding a high debt load will be crucial for small farmers if they are to overcome the cost/price squeeze which inflation will create. Well-established farmers will continue to earn positive net incomes while highly leveraged beginning farmers will face a much harder struggle. As the high equity farmers retire, their farms will much more likely be added to large existing farm operations than taken on by small beginning farmers. In order for the small beginning farmer to earn adequate income to support a family, he will have to receive high prices for his commodities, be willing to work off farm in addition to his farm work, and have at least 240 acres under his control.

The analysis to this point has concentrated on net income from all sources. We now wish to turn to a more narrow measure of income, net farm income. As we shall see, the prospects for small beginning farmers dim even further.

Net income excluding nonfarm income

The potential future problems which face small family farms grow in size and importance when we exclude nonfarm income and focus the analysis on net farm income. The results of the 16 various farm situations hold important implications concerning the future ability of small farms to provide adequate family income in and of themselves. As in the previous section, the results will be analyzed with the purposes in mind of comparing the relative economic strength of farm situations and determining breakeven sizes of farm for the different ownership levels. Before turning to the analysis, we need to reiterate the derivation of net farm income. This figure is arrived at by subtracting nonfarm earnings from net income from all sources. Net farm income is not the result of separate optimized solutions in which no nonfarm earnings were allowed. While separate solutions without off-farm employment might alter the magnitude of the results slightly, the current results exhibit a strong pattern which is likely to remain.

To provide an immediate comparison of net farm incomes, the 16 farm situations are ranked in Table 20. In examining this table we are immediately struck by the fact that only three farm situations provide positive farm incomes. All three of these situations are high equity owner-operated farms with large hog setups. The 160 acre high equity farm can provide adequate income only at the higher farm price level. The startling result is that none of the low equity owner-operated farms or tenant farms can earn a positive net farm income. The sizes of these net losses are significant, ranging from a 1984 loss of

Table 20. Ranking of farm situations by net farm income, 1984 and annual average for 1982-84[a]

Rank	1984		1982-84 annual average	
	Model alternative	Net farm income	Model alternative	Net farm income
1	D242	$17,147	D242	$16,500
2	D162	8,052	D162	7,732
3	D241	1,045	D241	2,463
4	D161	(6,857)	D161	(4,824)
5	D325	(24,720)	D325	(22,858)
6	T328	(29,327)	T328	(23,860)
7	D245	(30,207)	D245	(27,650)
8	T248	(32,063)	T248	(29,430)
9	D165	(33,870)	D165	(31,315)
10	T168	(41,247)	T327	(34,098)
11	T247	(43,334)	T168	(34,879)
12	T327	(45,534)	T247	(38,033)
13	D164	(50,204)	D164	(40,290)
14	T167	(51,150)	T167	(40,988)
15	D244	(51,830)	D244	(41,248)
16	D324	(53,190)	D324	(41,259)

[a]Constant 1980 dollars.

$24,720 on an owner-operated low equity farm with 320 acres and high farm prices to a considerable $53,190 loss in 1984 on the same farm operating under a lower level of farm prices. The implications which these results carry for small farms are striking and several.

The net farm income figures verify the future strong dependence of small family farms on nonfarm income. Off-farm earnings play a key role in providing adequate family income for the small farm in 1984. This is particularly true for the 25 percent equity owner-operator and tenant farmer. The reasons for a strong reliance on off-farm earnings lie in a diminished farm profit margin. The low equity and tenant farmers are carrying considerable debt load relative to incoming cash flow. When this fact is combined with the squeeze which inflation places upon farm profits, the result is a negative net farm income. As nonfarm earnings keep pace with inflation, the small farm attempts to supplement farm income by working off-the-farm. As the results in Table 20 indicate, the problems which face small farms in the future are more completely revealed when the nonfarm income supplements are removed.

Another important implication of the net farm income results is expressed in the manner in which they verify and magnify the aforementioned problems of small beginning farmers. If we refer back to the net farm incomes listed in Table 18 for low equity farms, we see that small beginning farmers cannot break even either with high prices or expanded operations. The combination of inflation pushing up costs and a high debt load deals a fatal blow to net farm income.

Simply stated, the results indicate that, in the absence of government aid, small beginning farms will not survive in the future.

This result points to the same conclusion made in the last section: level of ownership plays a key role in the future of small family farms. Well-established high equity farms will continue to provide positive returns in the future. On the other hand, tenant farms and beginning, low equity farms will face a real struggle just to avoid net losses. The implication is that America's trend to fewer and larger farms will continue. As the well-established small farmers retire, their farms will be added to existing large farms rather than taken over by beginning farmers.

At this point, we might step back and ask whether the results in Table 20 are realistic. The figures reveal losses of such magnitude that we might call the validity of the models into question. In order to answer this claim, we might lead the discussion into two areas: (1) why the net farm incomes are so depressed in the models, and (2) exactly what information do the net farm income figures convey.

An explanation for the large net losses of Table 20 may be found in examining the cash flow problems which face the low equity and tenant farm situations. If we look at the 25 percent equity farm of 320 acres under price level P1 (D324), the farm faces several drains on the cash stream. Annual debt service for land and equipment totals $67,818 in 1984 while family consumption amounts to $23,594. These enter as fixed costs which must be paid; a total of $91,412 or $286 per acre. In order to meet these fixed costs, the farmer may raise

corn in a C-Sb rotation at an average cost of $235 per acre. The land yields 117 bushels of corn which may be sold at $2.92 per bushel. Thus, the farmer has a return above variable cost amounting to $106 per acre. This simply cannot meet the $286 of fixed costs per acre. Part of the difference might be made up by feeding the corn to hogs. Nonetheless, the low equity farmer faces a severe cash flow problem. A similar argument could be made for the tenant farmer. His fixed costs are lower, but then so are his receipts.

This example raises some questions regarding the models. A change in the inflation rate will directly affect the size of costs in 1984. Similarly, a different choice of price level would have direct impact on profit margins in 1984. The models, as presently constructed, contain cost and price assumptions which have substantial effect upon the cash flow problem outlined above. In addition, the models use a fixed rate of consumption. Quite likely, the small family farm will cut back on consumption during periods of economic stress. Relaxing consumption requirements would improve the small farm outlook. In short, the cost, price, and consumption assumptions in the models will have direct impact on the magnitude of net farm losses.

The second question we might wish to ask about the net farm income figures is what information this measure of income actually contains. The measure attempts to capture the net farm income which remains in the absence of nonfarm earnings. The easiest way to arrive at this net farm income is to subtract nonfarm income from net income from all sources. This has been the approach used. If one wishes to examine what small

farm income would be without any off-farm employment opportunities, then the net farm income measure just described contains a potential flaw.

First, farm output mix may change when there are no off-farm job opportunities. The farmer will have a lower opportunity cost for his own labor and may readjust his production decisions accordingly. We have no a priori way of knowing what path these changes might take. However, we can assume that net income from all sources will be less now than when off-farm income was allowed. The reason for this is that if it was not profitable to work off-the-farm, the operators would not have worked off-farm to the extent they did. So while we might expect the Table 20 net farm incomes to improve in a new set of optimized solutions which contained no off-farm job opportunities, net incomes could not rise to the levels of Table 16. Because of the cash flow problem outlined above, we would expect the results of this net set of solutions to lie closer to the levels of Table 20 than Table 16.

Another potential flaw contained in the net farm income figures of Table 20 is that they contain no adjustment for hired labor. If we want net farm income to measure small farm incomes when no off-farm job opportunities exist, we need to make a correction for labor hired. When the farm operator must use all of his labor on-farm, he will hire labor only after exhausting his own supply. In the current farm situations, hired labor has been substituted for operator labor to enable off-farm work by the operator. Hence, we might wish to delete

the cost of hired labor from net farm income. This will have a positive effect upon net farm income.

Table 21 contains 1984 net farm incomes for the 16 solutions after a correction for hired labor has been made. Since the high equity farms hire no labor, their results are unchanged. The low equity and tenant farms show lower losses. Nonetheless, the results still indicate severe problems for small farms in providing adequate family. The correction for hired labor is thus a relatively minor consideration.

The problems of small farms in providing adequate income for a family in the future are made apparent by discussing breakeven sizes of farms. We now define a breakeven farm as having those conditions which enable a farm to earn positive net farm income." The high equity owner-operated farm needs 240 acres with farm prices at level P1. Should prices be at level P2, a 160 acre 75 percent equity farm provides positive returns. The low equity or beginning farmer faces a much more dismal future. The results indicate that, for reasons already discussed, this farm cannot earn positive net farm income at any size under either farm price level. The size of the net farm income losses listed in Table 18 speak to the potential magnitude of the beginning farmer's problems. The tenant farmer faces the same dilemma. Net farm incomes in Table 19 indicate that a breakeven point, if it occurs at all, will occur for the tenant at no size of farm which could be considered small.

The income results of this study do not point to a bright future for most small family farms. Many large problems face the small farm which tries to provide an adequate family income. Chief among these

Table 21. Net farm income in 1984 after adjustment for hired labor

Rank	Model alternative	Net farm income[a]
1	D242	$17,147
2	D162	8,052
3	D241	1,045
4	D161	(6,857)
5	D325	(19,231)
6	T328	(22,977)
7	D245	(27,268)
8	T248	(26,541)
9	D165	(31,297)
10	T168	(37,096)
11	T247	(37,105)
12	T327	(38,675)
13	D164	(46,871)
14	T167	(45,200)
15	D244	(47,371)
16	D324	(49,130)

[a]1980 constant dollars.

problems is carrying a high debt load as inflation erodes farm profit margins. If America wishes the small family farm to survive, government policy will have to be directed towards alleviating the small farm situation in the future. Many policy options might be employed to aid small family farms. These policy alternatives will be discussed in the next chapter.

Investment

The solutions provide less than complete results concerning investment activities. The models are, in many respects, not well-suited to analyzing investment behavior. They were not constructed so as to emphasize the analysis of farm investment. In this brief section, I hope to outline the results as they relate to two issues: investment paths and borrowing. First, a discussion of the shortcomings of these models as an investment analysis tool will be presented.

One of the chief shortcomings of the models is that the sixth (25 year in one) block of the LP matrix is not entirely consistent with the first five years. Costs were put into this sixth period with an inflation factor of $(1.07)^{17}$, the average inflation rate over the final 25 years. Even at price level P2, the models were infeasible. Sufficient cash flow could simply not be generated to meet the costs. So, prices in the sixth period were increased $(1.07)^{12}$. The relative cost/price ratio in the final period is, therefore, the same as in the fifth year but at a higher absolute level. For these models to provide rigorous investment analysis, more attention would have to be paid to what costs and prices in the final period should be. As

presently constructed, the costs and prices in this long run period are distorted and thus lead to somewhat inconclusive results.

Another problem in the models is that they do not contain asset sale activities. This precludes the realization of asset appreciation (or depreciation) over time. Also, the models do not present exhaustive investment options. Off-farm investments are not included. Finally, an investment model should have an objective function which maximizes net equity. This objective function was attempted with the present models with very limited success. The sixth period distortions mentioned above caused investments to be undertaken with little apparent economic meaning attached.

The models do provide partial insight into the investment paths that small farmers should take. Table 22 lists total dollar investment over two time periods: 1980-84 and 1982-84. The investment for each period to which the bulk of the money was devoted is listed as the primary investment. By looking at the primary investments, we may immediately see that high equity, low equity, and tenant farms all follow the same investment path: capital intensive hog facilities. We would expect the high equity farmer to follow this path because he has the most capital to invest. We would similarly expect the low equity and tenant farmer to choose more labor intensive investment. However, while the low equity and tenant farms invest at a smaller scale, they do invest in total confinement facilities. The explanation for this lies in their attempt to minimize farm labor and maximize off-farm labor exposure. The low equity and tenant farmers rely heavily upon

Table 22. Dollars invested and primary investments, 1980-84 and 1982-84

Farm situation	Total investment dollars	Primary investment(s)[a]	Total investment dollars	Primary investment(s)[a]
D161	$74,198	T.C. F/Fe, T.C. Fe/F	$25,269	T.C. F/F
D162	145,946	T.C. F/Fe, T.C. Fe/F	73,478	T.C. F/F
D241	113,360	T.C. F/Fe, T.C. Fe/F	50,324	T.C. F/F
D242	201,334	T.C. F/Fe, T.C. Fe/F	106,775	T.C. F/F
D164	35,382	T.C. Fe/F	10,573	T.C. Fe/F
D165	56,718	T.C. F/Fe, T.C. Fe/F	0	
D244	32,906	T.C. Fe/F	0	
D245	75,651	T.C. F/Fe, T.C. Fe/F	7,510	T.C. F/F
D324	53,848	T.C. F/Fe, T.C. Fe/F	15,297	T.C. Fe/F
D325	98,919	T.C. F/Fe, T.C. Fe/F	18,156	T.C. F/F
T167	38,130	T.C. Fe/F	1,503	Past F
T168	23,433	T.C. Fe/F	6,595	T.C. Fe/F
T247	36,292	T.C. Fe/F	1,503	T.C. Fe/F
T248	29,704	T.C. Fe/F	7,193	T.C. Fe/F
T327	23,387	T.C. Fe/F	3,350	T.C. Fe/F
T328	55,153	T.C. F/Fe, T.C. Fe/F	10,607	T.C. F/F

[a]T.C. Fe/F = total confinement finish facility.
T.C. F/Fe = total confinement farrow facility.
T.C. F/F = total confinement farrow-to-finish facility.
Past F = pasture farrow facility.

off-farm income as the cost/price squeeze tightens. Thus, they attempt to lower farm labor requirements with capital intensive improvements. Finally, capital expenses per unit of production are likely to be less expensive than hiring additional labor.

The second major investment result which is significant is that no borrowing is undertaken to finance investment. Funds may be borrowed at 8 1/2 percent interest over five years to finance hog facilities. An explanation for this lack of borrowing may be found in the shadow prices on capital generated in the models. The marginal value product of a dollar of investment capital ranges below one dollar throughout all 16 solutions. Representative shadow prices for investment capital are the following: D161 -- $.78 in 1980 to $.39 in 1984; D242 -- $.62 in 1980 to $.32 in 1984; D165 -- $.70 in 1980 to $.43 in 1984; T328 -- $.78 in 1980 to $.44 in 1984. Clearly, it is uneconomic to borrow funds when the return is below the cost. The cause of the low shadow prices for capital lies in the low or even negative profits found in most solutions in 1984. Another contributing factor is that the sixth period does not provide a profitable scenario under which to make investments.

Labor Allocation

We have already noted the importance which off-farm income plays in small farm profits. In this section, we briefly consider the allocation of labor between on- and off-farm uses. Table 23 lists work allocation between farm and off-farm uses for the wife and operator. As a means of comparison, figures for 1980 and 1984 are presented.

Table 23. Labor allocation between on- and off-farm uses, 1980 and 1984

	1980						1984					
	Wife[a]		Husband[b]			Total	Wife[a]		Husband[b]			Total
	On-farm	Off-farm	On-farm	Off-farm	Hired hours	farm labor	On-farm	Off-farm	On-farm	Off-farm	Hired hours	farm labor
D161	0	50	1891	0	0	1891	0	50	1795	0	0	1795
D162	0	50	2037	0	0	2037	0	50	1558	0	0	1558
D241	0	50	2076	0	0	2076	0	50	1875	0	0	1875
D242	0	50	2201	0	0	2201	0	50	1464	0	0	1464
D164	0	50	403	1997	988	1391	0	50	148	2252	693	841
D165	0	50	664	1736	1147	1811	0	50	185	2215	535	720
D244	0	50	649	1751	956	1605	0	50	229	2172	927	1156
D245	0	50	915	1485	1161	2076	0	50	166	2234	611	777
D324	0	50	934	1466	1076	2010	0	50	248	2152	844	1092
D325	0	50	1235	1165	1141	2376	0	50	281	2119	850	1131
T167	0	50	379	2021	1203	1582	0	50	0	2400	1237	1237
T168	0	50	463	1937	1353	1816	0	50	7	2393	863	870
T247	0	50	621	1779	1286	1907	0	50	108	2292	1295	1403
T248	0	50	720	1680	1440	2160	0	50	83	2317	1148	1231
T327	0	50	891	1509	1484	2375	0	50	135	2265	1426	1561
T328	0	50	985	1415	1566	2551	0	50	139	2261	1320	1459

[a]Weeks of labor.

[b]Hours of labor.

Models I, II, and III solutions are each grouped separately. We now consider the work decisions of the wife and operator separately.

Wife's labor

In all solutions, the wife was given opportunity to work full or part-time in off-farm employment. The results show that she chooses to work full time off-the-farm in all cases. This is not surprising since the models do not place a value on household production. Inclusion of this would have resulted in a more realistic allocation of labor. As presently constructed, the models implicitly favor off-farm employment for the wife. Irrespective of this problem, the results do point to the fact that net income is positive in several farm situations only with a supplement of off-farm earnings. In this respect, the wife's off-farm employment plays a vital role in helping to bring income to an adequate level.

Operator's labor

The high equity farm situations do not include any off-farm income opportunities for the operator. We may note from Table 23 that operator hours of farm labor decline from 1980 to 1984 in all high equity farms. The explanation for this is that the cost/price squeeze causes hog production to decline. The farmer sells more corn directly instead of feeding it out. The cash flow problem mentioned earlier causes the farmer to economize on farm expenses. If hogs are produced, funds must be borrowed to cover production expense. To avoid this cost, hog production is trimmed and more corn is sold directly. This results in lower farm labor usage in 1984.

This same pattern of declining farm labor usage over time is also found in the low equity and tenant farm situations. In addition to the explanation listed above, we may say that farm labor declines as the operator attempts to devote more hours to off-farm employment. Operator off-farm labor hours increases in all low equity and tenant farms between 1980 and 1984. This increase becomes more dramatic as size of farm increases. As we might expect, the tenant farmer devotes more hours to off-farm work than the owner operator. The tenant farmer receives less farm income. Therefore, his off-farm income will play a more important role in total income.

Cropping Patterns

One of the most consistent results of the solutions is the use of the corn-soybean (C-Sb) crop rotation. Throughout all periods in all farm situations, the C-Sb rotation is used exclusively. This indicates that the C-Sb rotation provides the most profitable cropping pattern in north central Iowa on cash grain/hog operations regardless of level of ownership. In most solutions, the corn-corn-soybean (C-C-Sb) rotation carried the smallest income penalty of the remaining rotations. This shadow price typically carried a value of $20 per three acre rotation unit.

Another interesting cropping pattern result is the choice of custom harvest. In all low equity and high equity farm situations, the operator could choose between custom or self-harvest. Custom harvest was chosen in all cases. This happened because the custom services carried a marginal cost which was less than the fixed cost of

owning harvest equipment plus the opportunity cost of labor hours spent harvesting. This tends to indicate that small farms cannot economically spread the large fixed costs of harvest equipment over their limited scale of operations. A further explanation for the low equity situations is that custom harvesting minimizes farm labor and frees labor for off-farm employment.

We might note that these results are contingent upon several assumptions. The choice of a crop rotation will depend upon yield and price assumptions. In particular, a different set of relative crop prices would influence the crop rotation selected. Custom harvest activities did not include an allowance for difficulty in getting the harvest done in time. In reality, this may be an important consideration for the small farmer. Inclusion of this time dimension could swing the results to favor self-harvest.

Hog Production Patterns

We briefly examine hog production patterns in the various farm situations in this section. We will first look at how quantities produced vary across farms. Next, we analyze how production methods differ according to farm situations. A few notes must precede this discussion. In order to keep our family farm "small" in organization, the number of finished hogs which may be sold in one year is bounded by 750 (1650 cwt.). Similarly, the number of feeder pigs which may be sold annually is limited to 500. This was done in order to prevent the small family farm from becoming a large scale hog operation. Table 24 presents hog production figures for 1980 and 1984. Hundred

weight of finished hogs and number of feeder pigs sold are given.

Feeder pigs are produced only in situations when the farm has reached its upper bound on finished hog sales. If more finished sales were allowed, no doubt they would occur. The results show that by 1984, nearly all farms have trimmed their hog production from 1980 levels. The reason for this lies in rising hog production costs. As the costs of feed rise, hog profit margins decline. The farmer is thus led to sell more corn directly and economize farm expenses.

We see a strong consistent pattern of hog production methods in the results of Table 24. In 1980, nearly all farm situations produce the maximum quantity which pasture facilities allow. Above this amount, they purchase a total confinement finish facility and buy feeders to finish out. By 1984, almost all farms produce finish weight hogs in a total confinement feeder-to-finish setup. Only the high equity operators maintain pasture operations in 1984. This shift to capital intensive hog production may be explained by the economic conditions which the farms face.

As inflation drives up costs of production and increases off-farm income potentials, low equity and tenant farmers will try to economize on farm labor. The best way to do this in hog production is to cut out farrow activities and engage in total confinement finish operations. This is exactly what the results show. High equity farms will continue in pasture farrow-to-finish activities because the opportunity cost for operator labor is lower; i.e., no off-farm employment opportunities exist. The high equity farmer may well add confinement facilities because he has the most capital to invest.

Table 24. Hog production in 1980 and 1984

	1980					1984		
	Finished hogs		Feeder pigs			Finished hogs	Feeder pigs	
	Sold (cwt.)	Production method[a]	Sold (no.)	Production method[a]	Sold (cwt.)	Production method[a]	Sold (no.)	Production method[a]
D161	1650	Past F/F, T.C. F/F	0		1650	Past F/F, T.C. Fe/F	0	
D167	1650	Past F/F, T.C. Fe/F	220	T.C. F/Fe	1547	Past F/F, T.C. Fe/F	0	
D241	1650	Past F/F, T.C. Fe/F	166	T.C. F/Fe	1650	Past F/F, T.C. Fe/F	113	T.C. F/Fe
D242	1650	Past F/F, T.C. Fe/F	404	T.C. F/Fe	978	Past F/F, T.C. Fe/F	0	
D164	1650	Past F/F, T.C. Fe/F	0		1513	T.C. Fe/F	0	
D165	1650	Past F/F, T.C. Fe/F	189	T.C. F/Fe	1069	T.C. Fe/F	0	
D244	1650	Past F/F, T.C. Fe/F	0		1514	T.C. Fe/F	0	
D245	1650	Past F/F, T.C. Fe/F	175	T.C. F/Fe	490	T.C. Fe/F	0	
D324	1650	Past F/F, T.C. Fe/F	35	T.C. F/Fe	885	T.C. Fe/F	0	
D325	1650	Past F/F, T.C. Fe/F	230	T.C. F/Fe	850	T.C. Fe/F	0	
T167	825	Past F/F	0		1442	T.C. Fe/F	0	
T168	1650	Past F/F, T.C. Fe/F	0		772	T.C. Fe/F	0	
T247	825	Past F/F	0		1370	T.C. Fe/F	0	
T248	1650	Past F/F, T.C. Fe/F	0		849	T.C. Fe/F	0	
T327	1351	Past F/F, T.C. Fe/F	0		958	T.C. Fe/F	0	
T328	1650	Past F/F, T.C. Fe/F	66		535	T.C. Fe/F	0	

[a]Past F/F = pasture farrow-to-finish.
T.C. F/Fe = total confinement farrow-to-feeder.
T.C. Fe/F = total confinement feeder-to-finish.

CHAPTER V.

SUMMARY AND CONCLUSIONS

This study set out to examine the future economic prospects of small family farms in north central Iowa. Dynamic linear programming models have enabled us to look into the future and predict small farm levels of income over the next five years. The analysis has provided answers for pertinent questions regarding small family farms while at the same time pointing to some unanswered questions. This final chapter will summarize the findings of this study, examine public policies which might be directed at the problems of small family farms, and make suggestions for further research on small farms.

Summary of Findings

The most significant results of this study concern the levels of income which small family farms may expect five years from now. The net income results indicate that the high equity, well-established small farm will provide the highest family income of all farm situations. The high equity small farm will survive. A 75 percent equity owner operated farm of 240 acres and an accompanying swine operation will be able to generate a positive net income from all sources as well as positive net farm income. This is true at either of the farm price levels used in this study. In order to earn adequate net farm income to support a family on 160 acres, the high equity farmer must rely on higher farm prices. The high equity owner will be able to overcome the squeeze of inflation without supplemental off-farm income. The

financial strength of the high equity farms is the key to its survival. Stated simply, the high equity small farm does not suffer the strain on cash flow of a high, fixed annual debt service.

While high equity small farms appear able to survive as a healthy economic unit in 1984, the future of small low equity and tenant farms is much less certain. The results on net income from all sources reveal that a low equity farm will provide adequate family income only with at least 240 acres, a sizeable swine operation, high farm prices, and roughly 30 percent of total income coming from off-farm employment. Similarly, the tenant farm requires a minimum of 240 acres, expanded hog operations, high farm prices, and off-farm income representing a third of total income in order to earn positive returns. Off-farm income will play a crucial role in the survival of the small low equity or tenant farm. The results of this study indicate that nonfarm income makes the difference between positive net income or net loss. This fact is borne out by the net farm income results.

The most striking results this study contains are the reported net farm incomes. These figures imply that, in the absence of supplemental off-farm income, the small beginning farm simply will not survive in 1984. This applies to the tenant situation as well as a low equity owner operator. In fact, a farm operation started with limited equity capital will face staggering losses five years from now. The squeeze of inflation on profit margins combined with a high debt load will not permit positive net farm income -- regardless of farm prices. These results indicate that small beginning farmers will be

able to survive only with the aid of an existing family operation or government assistance.

We might note that this study has concentrated on a north central Iowa cash grain/hog farm. While the results cannot be perfectly applied to other types of farms, we might expect that if small family farms cannot survive with the advantages of Clarion-Webster soils then they probably face even bigger problems elsewhere.

In summary, the findings of this study point to a mixed future for small family farms. The well-established, high equity small farms will continue as viable farming units. As these farmers retire, however, their operations are likely to be added to existing large family farms. Few possibilities will exist for young farmers to purchase small farms with limited equity capital and earn positive returns. In short, the long standing trend in America of large farms getting larger gives every indication of continuing.

Public Policy

This study has focused on the potential problems small family farms will face in providing adequate income in the future. Throughout this study we have discussed the trend to larger farms in American agriculture. A major cause of this transformation of farm structure has been government farm policy. The evidence of this study makes it clear that if public farm policy continues to follow the same pattern, many small family farms will simply disappear. In order to help small beginning farms, public policy must act in a positive manner to alleviate the problems which face these farms. Maintenance of status

quo in current farm policy will only continue the trend to larger farms.

In making a decision on a small farm policy, the American public needs to be aware of what the effects of such a policy would be. Heady and Sonka [7] compared the consequences of a small farm oriented agriculture as opposed to fewer and larger farms in the United States. Their results indicate that an agriculture composed of more small farms would have the following effects: slightly higher average costs of farm production, higher total cash receipts to farming, substantially lower average net farm income, higher retail food prices, increased economic activity in rural communities, and higher federal budget costs. The costs of a small farm agriculture would lie in higher food prices and government subsidies to small farmers. The benefits would consist of stronger rural communities, less concentration in American food production, and the continuation of an American social tradition -- the small family farm. Society must weigh these trade-offs in choosing its farm policy.

The policy options which are available in helping small family farms (and particularly the low equity small farms) have been formulated by many authors. The policies presented here are discussed in Heady [6] and a Congressional Budget Office study [21].

Commodity programs are one policy tool which might be used to aid small farm incomes. In the past, commodity programs have distributed benefits according to volume of sales. This meant that large farms were the chief beneficiaries of these commodity loan, target price, and direct payment programs. In order to reorient these programs to

primarily benefit small farms, two options are available. First, a realistic ceiling could be placed on benefits accruing to any one farm operation. This has been tried in the past, but the ceiling has been so high ($50,000 scheduled in 1980) that it has had little of its desired effect. Alternatively, commodity program benefits could be geared directly to farm size. Under such a scheme, program benefits would be distributed in inverse relationship to the size of farm operation. Small farmers could thus benefit relatively more than large farmers.

A number of tax and redistribution schemes could be formulated to aid small farms directly. In order to encourage more small farms, a progressive land tax could be used. This would have the effect of giving land a greater value for small than large farms and thus would discourage growth of farm size. This plan would doubtless face considerable political challenge from large landowners. Another tax which might be used to encourage small farms is the self-tax or check off tax. With this policy, a sales tax could be levied on total farm sales. Thus, large farms would pay more tax than small farms. The proceeds of this tax could then be used as a direct income subsidy to small farms. For this policy to be successful, the amount of income redistributed would have to be independent of sales volume.

U.S. farm policy could be used to subsidize resource costs for small farmers. Low interest long term loans would enable the limited equity small farmer to reduce high fixed costs. One of the problems with subsidized farm credit in the past has been that the amount of

credit extended has been linked with the farmer's equity position. This has contributed to the growth of larger farms. In order for small farms to benefit from loan subsidies, the issuance of loans needs to be independent of equity position. The results of this study indicate that the low equity farm could survive if it can obtain substantial amounts of capital at low rates of interest.

In addition to low interest loans, the government could use a purchase lease arrangement in providing low cost land to small beginning farmers. Under this policy, the government would purchase farmland and rent it at favorable terms to small beginning farmers. These farmers could be given the opportunity to purchase the land with a low interest loan after establishing their operations. Such policies are now being experimented with in South Dakota and Saskatchewan. The policies are attractive in that they permit small beginning farmers to avoid the high purchase cost of land.

Government incentives could be used to promote the development of industry in rural areas. This would ensure nonfarm employment of small farmers without their having to give up farming. Such incentives could take the form of tax credits for locating plants in rural areas. This policy appears to have merit in light of the results of this study. One way in which the small family farm can survive is to rely on off-farm earnings to supplement farm income. Providing attractive off-farm employment opportunities might thus be seen to take the place of direct government income subsidies.

Finally, the public may choose to devote more of its agricultural

research effort to small farm problems. In the past, public research has concentrated on new technology which has led to the growth of farm size in America. In order to deal properly with the problems of small family farms, we need to know more about them. If nothing else, society needs to be aware of the problems which face small family farms. This is currently a deficiency in our public research effort. Heady aptly summarizes the past tendencies in American agricultural research.

> Society probably does not recognize that its agricultural policies and programs provide strong impetus toward fewer and larger farms. It has no one to tell it so. The state agricultural colleges' extension programs are so heavily oriented to leading the larger farms that they have neither the time nor the inclination to take this information to society or its representatives in Congress [6, p. 619].

Society must choose whether or not it wants the trend towards larger farms in America to go unchecked. If the public wants larger farms, a status quo policy will likely meet this objective. On the other hand, if America desires the small family farm to form an integral basis for its agriculture, then positive policies such as those outlined above will have to be implemented.

Suggestions for Future Research

This study has not been done without limitations. Several key assumptions underlie the research. Notable among these are the following: a 7 percent inflation rate, farm price levels selected, no incorporation of risk in the models, and incomplete investment activities. There are many issues which might be addressed in future research on small farms. These are briefly outlined below.

(1) The methodology of this study might be used to predict income levels for other types of small family farms such as dairy or beef operations. This broader spectrum of information would enable us to know which types of farms will face the most problems in the future.

(2) An extension of these models to include risk would improve the results. Small farms face a relatively higher degree of risk than large farmers. The response of small farmers to risk may be a crucial element in their behavior. Including risk in a representative small farm model would thus provide more realistic results.

(3) An important unanswered question of this study is the sensitivity of the results to the inflation rate. Clearly, inflation rates above 7 percent will create more losses for small farms. But, the extent of these additional losses is unclear. Model solutions which included several rates of inflation would give an indication of the sensitivity of the small farm problem to inflation. This would require considerable time and expense since all cost coefficients would need several estimates. At the same time, results could be improved by including a more complete parameterization of farm prices. Combining this with several inflation rates would present future small farm incomes under varying degrees of a cost/price squeeze.

(4) A more complete treatment of investment activities would also improve the results. As noted earlier, the present models do have shortcomings in serving to analyze small farm investment behavior. More emphasis could be placed on small farm investment decisions while including risk in the models. Optimizing with a maximum net equity

objective function would provide an alternative small farm planning strategy maximizing net cash returns.

Conclusions

The small family farm: Can it survive? The results of this study indicate that for a large number of small family farms the answer will be no. American farm policy appears to be at a crossroads. The United States must decide whether or not it is content to continue along the road to bigger and bigger farms. If not, the time for positive action on the future problems of small family farms is now. Public policy which might aid small beginning farmers will be a departure from, if not a reversal of, our long standing path of farm expansion. Those who have benefited from this path are likely to pose strong objections to a policy focused on small farms.

Regardless of the farm policy direction America follows, it is encouraging that signs of public awareness of farm structure problems are beginning to show. Secretary of Agriculture Bergland has currently initiated a public dialogue on the future structure of United States agriculture. The future problems of small family farms have entered this discussion. After over 40 years of declining numbers of farms and continual growth in farm size, America is beginning to ask whether the small family farm can survive. This study hopes to have provided some answers to this vital question.

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APPENDIX

Table 25. Crop budgets for 1980

	Continuous corn	Corn after soybeans	Soybeans	Oats	Alfalfa
Variable costs					
Preharvest					
Seed	$14.29	$14.29	$13.98	$8.70	$13.77
Nitrogen	44.54	31.44			
Phosphate	18.54	18.54	18.54	18.54	18.54
Potash	7.26	7.26	7.26	7.26	7.26
Herb. & insect.	17.49	17.49	12.75		
Fert. & herb. appl.	4.72	4.72	4.72		1.97
Fuel & repairs	10.96	10.96	11.07	11.04	5.45
Total preharvest	117.80	104.70	68.32	45.54	46.99
Harvest					
Fuel & repairs	8.93	8.93	3.63	7.79	17.98
Drying cost	3.25	3.25			
Total harvest	12.18	12.18	3.63	7.79	17.98
Other variable	2.52	2.52			5.53
Total variable cost	132.50	119.40	71.95	53.33	70.50
Fixed costs					
Tractors	4.11	4.11	4.77	6.51	10.23
Mach. and eq.	29.19	29.19	17.63	20.83	15.01
Total fixed cost	33.30	33.30	22.40	27.33	25.24
Total cost	165.80	152.70	94.35	80.66	95.74

Table 26. Swine production budgets for 1980

	Pasture farrow-to-finish (per litter)	Total confinement farrow-to-finish (per litter)	Partial confinement farrow-to-finish (per litter)	Total confinement feeder-to-finish (per head)	Partial confinement feeder-to-finish (per head)	Total confinement farrow-to-feeder (per litter)
Variable costs						
Supplement	$141.40	$189.77	$185.75	$14.73	$15.48	$54.18
Vet charges	22.90	22.90	22.90	2.29	2.29	14.88
Hauling	1.98	1.98	1.98	.25	.25	.55
Eq. fuel	6.41	9.17	8.96	.65	.65	6.55
Eq. repair	15.07	39.72	40.60	1.85	1.03	28.04
Misc.	3.43	3.43	3.43			2.29
Total variable cost	191.19	266.97	263.62	19.77	19.70	106.49
Corn (bushels)	101	103	101	10.1	10.6	36.7
Pigs weaned per litter	6.79	7.54	7.28			

Table 27. Labor requirements for crop and hog activities

Activity	Labor used (hours)
Crops activities	
Grow and harvest:	
Corn	4.70
Soybeans	3.42
Oats	4.43
Hay	5.70
Hog activities	
Per litter:	
Pasture farrow-to-finish	17.00
Total confinement farrow-to-finish	11.00
Partial confinement farrow-to-finish	13.00
Total confinement farrow-to-feeder	11.00
Per head:	
Total confinement feeder-to-finish	.60
Partial confinement feeder-to-finish	.75

Table 28. Capital requirements for hog facilities, 1980

Facility	Size	Cost
Pasture farrow house	20 sows	$3,950
Total confinement farrow-to-finish	20 sows 660 feeders	$83,000
Partial confinement farrow-to-finish	20 sows 640 feeders	$56,672
Total confinement feeder-to-finish	640 feeders	$29,195
Partial confinement feeder-to-finish	640 feeders	$18,547