Appendix D

Analysis of Size Economies and Comparative Advantage in Crop Production in Various Areas of the United States

This appendix provides the detailed analysis of size economies and comparative advantage by area for crop production. A summary of this analysis was presented in chapter 8. The analysis was conducted at the University of Minnesota by Steve Cooke under the guidance of Burt Sundquist. Cooke's manuscript "Size Economies and Comparative Advantage in the Production of Corn, Soybean, Wheat, Rice, and Cotton in Various Areas of the United States" is published in a second volume to this OTA report,

The following analysis is organized by commodity. Each section follows the same format. First, there is a discussion of size economies by selected producing areas. Second, there is a discussion of comparative advantage, including the relationship between comparative advantage and size economies. Each of these commodity sections includes a summary of the size economy indices and "scoring table. "

Corn

The corn-producing areas selected are:

1. Illinois area 300—Corn for grain
2. Indiana area 101—Corn for grain
3. Iowa area 201—Corn for grain
4. Nebraska area 400—Irrigated corn for grain

Size Economies in Corn Production

The four measures, or indicators, of size economies are estimated according to the procedures outlined by Cooke (1985). These indicators include production cost, use of harvesting equipment, and static and dynamic Herfindahl production concentration indices.[1] A summary of these indices is presented in a table for each commodity by enterprise size for each of the selected production areas (table D-l). There is an element of judgment required in using these indices.

To clarify and facilitate the judgment used, a scoring table was set up and marked for each of the measurement categories (table D-2). Each enterprise within a category was given a plus or minus for the presence or absence, respectively, of a "clear advantage" that enterprise size exhibited relative to the others within a given production area. Each measurement category was weighted equally so that the overall or total measure of size economies was expressed as the sum of the phases. The range in scoring was from 0 to 4. Zero implies no advantage for that enterprise size. Four implies a clear advantage for that enterprise size relative to one or both of the other enterprise sizes within a production area. A table for each commodity presents the results of the scoring procedure (table D-3).

In Illinois the very large corn enterprises have a cost advantage both in cost per bushel and in capital ownership costs per acre (table D-l). Very large corn enterprises in this area can fully use one to five self-propelled, six-row harvesters. These harvesters are assumed to have an annual harvesting capacity of about 450 acres per harvester, The static Herfindahl index (which is the measure of relative production concentration) in 1982 was greatest for large and very large enterprises. The dynamic Herfindahl index (which is the change in relative concentration) from 1978 to 1982 was positive only for the very large enterprise size. The scoring results are 4, 1, and O for the very large, large, and moderate-size enterprises, respectively (table D-2). There is strong evidence to argue for the existence of size economies for very large enterprises relative to large and moderate enterprises in corn production in Illinois.

In Indiana large and very large enterprises have nearly identical costs per bushel, In ownership cost per acre, very large enterprises have a cost advantage. Very large enterprises can fully use two, and large enterprises can fully use one, self-propelled,

[1] For simplicity, linear production possibilities curves and homogeneous commodity price ratios were assumed in the analysis

Table D-l. -Indices Used to Determine Size Economies in Selected Corn. Producing Areas, 1983

State, area, and enterprise size	Total cost[a] per bushel (percent)	Ownership cost[a] per acre (percent)	Harvest machinery full utilization ‘		Herfindahl indices	
			Maximum	Minimum	Static (percent)	Dynamic (percent)
IL 300						
VL	100	100	5.4	0.9	100	35
L	105	105	0.9	0.7	96	0
M	119	110	0.6	0.5	43	–15
IN 101						
VL	100	100	2.1	1.7	100	32
L	99	105	1.4	0.9	95	21
M	105	105	0.9	0.4	79	11
1A 201						
VL	100	100	1.8	1.0	100	48
L	107	128	0.6	0.5	118	11
M	105	155	0.5	0.3	85	–11
NE 400[b]						
VL	100	100	5.2	2.6	100	42
L	107	100	2.1	0.9	62	11
M	113	105	0.8	0.5	43	– 2

[a]Excluding land charge
[b]Irrigated

SOURCE Office of Technology Assessment

Table D.2.—Scoring Table Used to Determine Size Economies in Selected Corn. Producing Areas, 1983

State, area, and enterprise size	Production cost	Harvester utilization	Herfindahl indices		Total
			Static	Dynamic	
IL 300					
VL	+	+	+	+	4
L		–	+	–	1
M	–	–	–	–	o
IN 101					
VL	-t	+	+	+	4
L	+	+	+	+	4
M	–	–	+	+	2
1A 201					
VL	+	+	+	+	4
L	–	–	+	+	2
M	–	–	+	–	1
NE 400[a]					
VL	+	+	+	+	4
L	–	+	–	+	2
M	–	–	–	–	o

[a]Irrigated

SOURCE: Office of Technology Assessment

Table D-3.—Production Costs and Yield by Enterprise Size in Selected Corn. Producing Areas, 1983

State, area, and enterprise size	Total cost[a]		Yield[b]		Total cost[a]	
	$/bu.	Percent	Bu/acre	Percent	$/acre	Percent
IL 300						
VL	1.67	100	130.3	100	217	100
L	1.75	105	128.6	99	225	103
M	1.99	119	123.1	94	245	113
IN 101						
VL	1.69	100	125.6	100	212	100
L	1.67	99	125.3	100	209	98
M	1.77	105	122.4	97	217	102
1A 201						
VL	1.67	100	119.0	100	199	100
L	1.80	107	117.4	99	211	106
M	1.75	105	113.0	95	198	99
NE 400C						
AL	2.83	100	118.6	100	336	100
L	3.03	107	112.6	95	341	102
M	3.21	113	106.2	90	341	102

[a]Excluding land charges
[b]State level yields per harvested acre for irrigated and nonirrigated in 1982.
[c]Irrigated.

SOURCE: Office of Technology Assessment

six-row harvesters. The relative production concentration in 1982 was nearly uniform across enterprise sizes within 21 percent. The change in relative production concentration from 1978 to 1982 was positive and nearly uniform across enterprise sizes in this area within 21 percent. The scoring results are 4,4, and 2 for the very large, large, and moderate enterprises, respectively. There is evidence to argue that size economies exist for large and very large enterprises relative to moderate enterprises in corn production in Indiana.

In Iowa very large corn enterprises have a cost advantage both in total cost per bushel and in capital ownership cost per acre. Very large enterprises can fully use one to two self-propelled, six-row corn harvesters. The relative production concentration in 1982 was nearly uniform across enterprise size within 33 percent. The change in relative production concentration from 1978 to 1982 was positive for large and very large enterprises in this area. The scoring results are 4, 2, and 1 for very large, large, and moderate enterprises, respectively. There is evidence to argue that size economies exist for very large enterprises relative to large and moderate enterprises in corn production in Iowa.

In Nebraska very large irrigated corn enterprises have a production cost advantage in terms of total cost per bushel. However, ownership costs per acre are equal for large and very large enterprises and less than those for medium enterprises. Very large enterprises can fully use three to five, and large enterprises one to two, self-propelled, six-row harvesters. The relative production concentration from 1978 to 1982 was substantially higher for very large enterprises relative to large and moderate enterprises. The change in relative production concentration from 1978 to 1982 was positive for large and very large enterprises in this area. The scoring results are 4, 2, and O for very large, large, and moderate enterprises, respectively. There is clear evidence to argue that size economies exist for very large enterprises in irrigated corn production in Nebraska.

The source of size economies can be found by examining the components of the production cost measures (table D-3). Very large enterprises in general tend to have the lowest total cost per bushel. Large and very large enterprises all have at least slightly higher yields per acre relative to moderate enterprises. Yield is a source of size economies in corn production. Total cost per acre is relatively uniform across enterprises in which very large enterprises have a slight cost advantage.

In Illinois yield is a source of size economies. The very large enterprises in this area have lower expenditures per acre for fertilizer, fuel lubrication, repairs, and labor relative to large and moderate enterprises. In Indiana yield is also a source of size economy. Preharvest and capital ownership costs are not a source of size economies in this area. In Iowa yield is again a source of size economy, as is

custom harvesting. In Nebraska yield is a source of size economies. Purchased irrigation water represents a potential for size diseconomies in Nebraska,

Very large enterprises in each of the selected producing areas consistently have slightly lower variable and ownership costs associated with machinery and equipment. This implies that very large corn enterprises tend to use some combination of fewer and/or smaller machines and tractors, and ones that go over the field fewer times. This is a constant source of size economies in the selected corn-producing areas.

Comparative Advantage in Corn Production

The overall objective for including a discussion on comparative advantage is to provide a context within which to analyze size economies and to determine the source or explain the absence of comparative advantage between the selected production areas.

In Illinois the total cost of corn production is about 14 percent higher than that in Iowa. There are size economies for very large corn enterprises only. The relative lack of comparative advantage is due to higher expenditures on phosphate, potash, herbicide, and pesticide in conjunction with a 6-percent lower yield compared with that in Iowa. The trends in relative yield and land prices indicate that the competitive position in corn production will decrease in this area. The absolute measure of production concentration in this area is low compared with the other selected producing areas. In addition, corn production is not particularly concentrated in any one enterprise size category, which implies that producers are not beginning to exploit size economies to increase their competitive position.

In Indiana the total cost of producing corn is about 10 percent more than in Iowa, and size economies exist for large and very large enterprises relative to moderate enterprises. The lack of comparative advantage is due to the relative price of nitrogen and additional expenditures on pesticides compared with those in Iowa. The absolute measure of production concentration in this area is high compared with that of the other selected areas. This implies that corn production is concentrated in one or more enterprise size categories and that producers are moving toward larger enterprise sizes to exploit size economies in this area so as to increase their competitive position.

In Iowa the total cost of producing corn is the lowest of the selected corn-producing areas. Size economies exist in this area for very large enterprises relative to large and moderate enterprises. Iowa's comparative advantage is related to higher yields relative to fertilizer, herbicide, and pesticide use. The absolute measure of production concentration is also the lowest of the selected producing areas, implying that corn production is not concentrated in any one particular enterprise size in this area. However, size economies exist for very large enterprises and can be exploited to improve Iowa's comparative advantage.

In Nebraska the total cost of producing irrigated corn is 8 percent higher than in Iowa, and size economies exist for very large enterprises relative to large and moderate enterprises. The lack of comparative advantage is due to the additional cost of irrigation water pumped from wells. The trends in yield and land prices indicate that the competitive position of this area will substantially decrease. The absolute measure of production concentration in this area is the highest of the selected corn-producing areas. This implies that production is concentrated in one or more enterprise size categories and that producers are moving toward larger enterprise sizes to exploit size economies and to enhance or maintain their competitive positions.

Soybeans

The soybean-producing areas are:
1. Illinois area 300
2. Iowa area 201
3. Mississippi area 100
4. Ohio area 101

Size Economies in Soybean Production

In Illinois very large soybean enterprises have about a 5-percent cost disadvantage relative to large enterprises in total cost per bushel (table D-4). Large and very large enterprises in this area have nearly equal capital ownership costs per acre. Large and very large soybean enterprises in this area can fully use one and two self-propelled, six-row harvesters, respectively. This size harvester has an annual harvesting capacity of about 380 acres, The static Herfindahl index (or measure of relative production concentration) in 1982 was greatest for the large enterprises. Finally, the dynamic Herfindahl index (or the measure of the change in relative production concentration) between 1978 and 1982 was positive only for the large and very large enterprises in this production area. The scoring results are 2,4, and O for the very large, large, and moderate enterprises, respectively (table D-5). Thus, there is evidence to argue that size economies exist for the large enterprises

Table D.4.–Indices Used to Determine Size Economies in Selected Soybean-Producing Areas, 1983

State, area, and enterprise size	Total cost per bushel (percent)	Ownership cost per acre (percent)	Harvest machinery full utilization		Herfindahl indices	
			Maximum	Minimum	Static (percent)	Dynamic (percent)
IL 300						
VL	100	100	2.4	1.4	100	65
L	95	102	1.3	0.9	142	16
M	102	106	0.9	0.6	80	– 4
1A 201						
VL	100	100	2.7	1.3	100	38
L	104	86	1.2	0.7	202	19
M	108	90	0.7	0.4	198	– 5
MS 100						
VL	100	100	2.1	1.2	100	9
L	116	98	1.2	1.1	24	11
M	99	72	1.1	1.0	24	11
OH 101						
VL	100	100	2.5	2.2	100	71
L	84	90	1.6	1.0	115	21
M	86	90	0.9	0.3	73	– 3

SOURCE Office of Technology Assessment

Table D-5.—Scoring Table Used to Determine Size Economies in Selected Soybean-Producing Areas, 1983

State, area, and enterprise size	Production cost	Harvester utilization	Herfindahl indices		Total
			Static	Dynamic	
IL 300					
VL	–	+	–	+	2
L	+	+	+	+	4
M	–	–	–	–	0
1A 201					
VL	+	+	–	+	3
L	–	+	+	+	3
M	–	–	+	–	1
MS 100					
VL	+	+	+	–	3
L	–	–	–		0
M	+	+	–	–	2
OH 101					
A L	–	–	+	+	2
L	+	+	+	+	4
M	+	–	–	–	1

SOURCE Office of Technology Assessment

relative to very large and moderate enterprises in soybean production in Illinois.

In Iowa very large soybean enterprises have about a 4- to 8-percent cost advantage relative to large and moderate enterprises in total cost per bushel. However, very large enterprises in this area have about a 10-to 14-percent cost disadvantage relative to large and moderate enterprises in ownership costs per acre. Large and very large enterprises can fully use one and two self-propelled, six-row harvesters, respectively. The relative production concentration in 1982 was greatest for large and moderate enterprises. Finally, the change in relative production concentration between 1978 and 1982 was positive only for very large and large enterprises in this area. The scoring results are 3, 3, and 1 for very large, large, and moderate enterprises, respectively. There is evidence to argue that size economies exist for very large and large enterprises relative to moderate enterprises in soybean production in Iowa.

In Mississippi very large and moderate soybean enterprises have about a 16-percent cost advantage relative to large enterprises in total cost per bushel. However, very large enterprises have a 26- to 28-

percent cost disadvantage in ownership costs per acre in this area relative to large and moderate enterprises, respectively. Moderate and very large soybean enterprises can fully use one and two self-propelled, eight-row harvesters, respectively. This size harvester has an annual harvesting capacity of about 800 acres, The relative production concentration in 1982 was greatest for very large enterprises. Finally, the change in relative production concentration between 1978 and 1982 was relatively low and uniform across enterprise sizes in this area. The scoring results are 3,0, and 2 for very large, large, and moderate enterprises, respectively. The evidence suggests that there is no clear advantage for any enterprise size relative to another in soybean production in Mississippi.

In Ohio very large soybean enterprises have between a 14-to 16-percent cost disadvantage relative to large and moderate enterprises in total cost per bushel. Similarly, very large enterprises have about a lo-percent cost disadvantage in ownership cost per acre relative to large and moderate enterprises in this area. Large and very large soybean enterprises can fully use one and two self-propelled, six-row harvesters, respectively. The relative production concentration in 1982 was greatest for very large and large enterprises. Finally, the change in relative production concentration between 1978 and 1982 was positive for very large and large enterprises in this area. The scoring results are 2,4, and 1 for very large, large, and moderate enterprises, respectively. Thus, there is evidence to argue that size economies exist for the large enterprises relative to very large and moderate enterprises in soybean production in Ohio.

The source or absence of size economies can be found by examining the components of the production cost measure. Total cost per unit of output is equal to the total cost per acre divided by the yield per acre. Table D-6 summarizes the production costs and yield by enterprise size for the selected soybean-producing areas, In Illinois soybean yields for large and very large enterprises are equal and 2 percent higher than those of moderate enterprises. In Iowa soybean yields are nearly uniform across enterprise sizes, with larger enterprises having 1 percent higher yields. In Mississippi soybean yields are 6 percent higher for very large enterprises relative to large and moderate enterprises. In Ohio soybean yields are nearly uniform across enterprise sizes, with larger enterprises having 2 to 3 percent higher yields. Yield is only a slight source of size economies in soybean production (table D-6).

In Illinois size diseconomies for very large enterprises are associated with the substantially higher fertilizer, herbicide, and pesticide expenditures, without corresponding higher yield, In Iowa the modest size economies for very large and large enterprises relate to lower costs of owner-provided relative to custom-provided durable services. In Mississippi the absence of size economies relate to the diseconomies of additional horsepower used by very large enterprises, In Ohio size diseconomies for very

Table D-6.-Production Costs and Yield by Enterprise Size in Selected Soybean-Producing Areas, 1983

State, area, and enterprise size	Total cost[a]		Yield[b]		Total cost[a]	
	$/bu.	Percent	Bu/acre	Percent	$/acre	Percent
IL 300						
VL	3.56	100	38.2	100	136	100
L	3.38	95	38.2	100	129	95
M	3.64	102	37.4	98	136	100
IA 201						
VL	3.32	100	36,8	100	122	100
L	3.44	104	36.6	99	126	103
M	3.58	108	36.3	99	130	107
MS 100[c]						
VL	5.20	100	25.0	100	130	100
L	6.02	116	23.6	94	142	109
M	5.17	99	23.6	94	122	94
OH 101						
VL	4.27	*100*	35,6	100	152	100
L	3.59	*84*	34.8	98	125	82
M	3.66	86	*34.4*	97	126	83

[a]Excluding land charges.
[b]State level yields per harvested acre for irrigated and nonirrigated in 1982.
[c]Production year data for 1982.

SOURCE: Office of Technology Assessment.

large enterprises relate to the diseconomies of additional horsepower used in land preparation and to the substantially higher expenditure on fertilizer, herbicide, and pesticide, without corresponding higher yields.

Comparative Advantage in Soybean Production

In Illinois total cost per bushel of soybeans is about 3 percent higher than in Iowa. Size economies exist for large enterprises only. The slight lack of comparative advantage is due to higher expenditures on herbicides, pesticides, and land. Trends in relative yield and land value indicate that the competitive position of Illinois will substantially improve. Soybean production is not concentrated in one or more enterprise sizes; however, size economies exist for large enterprises and can be exploited to improve comparative advantage.

In Iowa total cost per bushel of soybeans is the lowest of the selected soybean-producing areas. This comparative advantage is related to the level of yield, which is high relative to seed, herbicide, pesticide, and fertilizer expenditures. Trends in relative yields and land values indicate that Iowa's comparative position will decrease in the future. The measure of production concentration in Iowa is the lowest of the selected States, implying that soybean production is not concentrated in one or more enterprise sizes. Size economies exist for the large and very large enterprises and can be exploited to improve comparative advantage in this area.

Total cost per bushel of soybeans in Mississippi is about 24 percent higher than in Iowa. The substantial lack of comparative advantage relative to Iowa is a result of low yields and high expenditures on herbicides, pesticides, and ownership costs. Trends in yield and land values indicate that the competitive position of Mississippi will substantially decrease in the future. Production is concentrated in one or more enterprise sizes, and no size economies remain to be exploited in this area.

In Ohio total cost per bushel of soybeans is about 5 percent higher than in Iowa. The slight lack of comparative advantage is the result of lower yields and higher expenditures on herbicides, pesticides, potash, and phosphate. Trends in yield and land values indicate that the competitive position of Ohio will improve slightly in the future. Production is concentrated in one or more enterprise size categories. Size economies exist for large soybean enterprises only and can be exploited to improve comparative advantage in this area.

Wheat

For wheat the selected producing areas, type of wheat grown, and cultural practices followed are:

1. Kansas area 100—Hard red winter wheat following fallow
2. Montana area 200—Hard red spring wheat following fallow
3. North Dakota area 200—Hard red spring wheat following crop
4. Washington area 400—White wheat following fallow

Size Economies in Wheat Production

In Kansas very large wheat enterprises have a substantial cost advantage both in cost per unit of output and in ownership cost per acre (table D-7). Very large, large, and moderate wheat producers in this area can fully use 4 to 20, 2 to 3, and 1 to 2 self-propelled, 20-foot-wide harvesters, respectively. This size harvester has an annual capacity of harvesting about 500 acres. The static Herfindahl index (or measure of relative production concentration) in 1982 was greatest for the large and very large producers. This difference in static concentration was less pronounced in this area than in other wheat-producing areas in this study, however. Finally, the dynamic Herfindahl index (or the change in relative concentration) from 1978 to 1982 was positive for the large and very large enterprises. The scoring results are 4, 3, and 2 for very large, large, and moderate enterprises, respectively (table D-8). There is evidence to argue for the existence of size economies advantages for very large enterprises relative to the large and moderate wheat enterprise in Kansas.

In Montana very large wheat enterprises have a cost advantage both in cost per unit of output and ownership cost per acre. The very large, large, and moderate-size enterprises can fully use one to six self-propelled, 20-foot-wide harvesters, The static measure of relative production concentration in 1982 was greatest for the very large enterprises. Finally, the change in the relative concentration from 1978 to 1982 was positive only for the very large enterprise size. The scoring results are 4, 1, and 1 for the very large, large, and moderate categories, respectively. There is strong evidence to argue for the existence of size economies for very large enterprises relative to large and moderate sizes in the production of wheat in Montana.

In North Dakota large wheat enterprises have a cost advantage when measured either in cost per unit of output or ownership cost per acre. Large and

Table D"7.–Indices Used to Determine Size Economies in Selected Wheat-Producing Areas, 1983

State, area, and enterprise size	Total cost per bushel (percent)	Ownership cost per acre (percent)	Harvest machinery full utilization		Herfindahl indices	
			Maximum	Minimum	Static (percent)	Dynamic (percent)
KS 100						
VL	100	100	*20.6*	4.1	100	17
L	112	109	*3.9*	2.0	100	17
M	118	113	*2.0*	1.1	*75*	–7
MT 200						
VL	100	100	*6.9*	1.5	100	20
L	*106*	115	*1.5*	1.0	*23*	–12
M	110	108	1.0	0.6	*6*	–31
ND 200						
VL	100	100	*3.5*	*1.6*	100	47
L	*95*	90	*1.6*	*0.9*	*72*	11
M	*103*	*98*	*0.9*	*0.4*	*36*	–8
WA 400						
VL	100	100	*6.2*	*3.7*	100	*3*
L	118	117	*2.7*	1.9	100	*3*
M	85	91	*1.9*	1.3	31	*–2*

SOURCE: Office of Technology Assessment.

Table D-8.—Scoring Table Used to Determine Size Economies in Selected Wheat-Producing Areas, 1983

State, area, and enterprise size	Production cost	Harvestor utilization	Herfindahl		Total
			Static	Dynamic	
KS 100					
VL	+	+	+	+	*4*
L	–	+	+	+	*3*
M	–	+	+	–	*2*
MT 200					
VL	+	+	+	+	*4*
L	–	+	–	–	1
M	–	+	–	–	1
ND 200					
VL	–	+	+	+	*3*
L	+	+	+	+	*4*
M	–	–	–	–	*0*
WA 400					
VL	–	+	+	–	*2*
L	–	+	+	–	*2*
M	+	+	–	–	*2*

SOURCE: Office of Technology Assessment

very large enterprises can fully use one and two to three self-propelled, 20-foot-wide harvester(s), respectively. The static measure of relative production concentration in 1982 was greatest for large and very large enterprises. Finally, the change in the relative concentration from 1978 to 1982 was positive for both large and very large enterprises. The scoring results are 3, 4, and O for the very large, large, and moderate categories, respectively. There is evidence to argue for the existence of size economies for large and very large enterprises relative to moderate enterprises in the production of wheat in North Dakota. The production data suggests size economies for large enterprises in particular.

In Washington moderate wheat enterprises have a substantial cost advantage when measured in cost per unit of output or ownership cost per acre. Moderate, large, and very large producers can fully use one to two and four to six self-propelled, 19.4 -foot-wide harvesters, Washington wheat producers in this area typically use a combination of "regular" and "hillside" harvesters in approximately a 70:30

ratio in harvesting their crop. A "composite" harvester is assumed to have an annual harvesting capacity of 495 acres per harvester. The static measure of relative production concentration in 1982 was greatest for large and very large enterprises. Finally, the change in the relative production concentration from 1978 to 1982 was positive for both large and very large enterprises, but only by 3 percent. There was virtually no change in production concentration between enterprise sizes from 1978 to 1982. The scoring results are 2, 2, and 1 for very large, large, and moderate enterprise categories, respectively, There is no clear evidence on which to argue for size economies in the production of wheat in Washington.

Yield is only a slight source of size economies in wheat production (table D-9). Wheat yields in Kansas are nearly uniform across enterprise size. In Montana and North Dakota the very large enterprise has the greatest yield per acre, by about 3 to 6 percent. In Washington large and very large enterprises have the same yield. The moderate enterprises, however, have substantially (20 percent) higher yields per acre than do the large and very large enterprises in this area. In fact, 1982 data reveals that small and very small enterprises have substantially higher yields than do moderate enterprises in this area. In Washington wheat yield is inversely related to enterprise size. Otherwise, yield is only a slight source of size economies in wheat production.

In Kansas the important factor for size economies relates to economies associated with custom harvest rates. In Montana size economies are the result of the combination of slightly higher yields and lower costs, again related to the use of custom harvesting. In North Dakota size economies for large enterprises relate to higher yield and lower ownership and harvest costs relative to those of moderate and very large enterprises. In Washington size economies do not exist for very large enterprises relative to moderate enterprises because of the substantial diseconomies associated with yield and the slightly higher ownership and harvesting costs. In Washington size economies for very large enterprises relative to large enterprises exist because of the substantially lower ownership costs of the very large enterprises in this area, which are related to the differences in horsepower tractors used particularly inland preparation.

Comparative Advantage in Wheat Production

In Kansas and Washington the comparative advantages in producing wheat are nearly equal and are the greatest of the areas studied. Kansas also has the potential for increasing its comparative advantage relative to unexploited size economies that exist for large and very large enterprises. This area has a relatively low level of production concentration. Finally, there is little change (about 1 percent per year) in production concentration in this area. The relatively large average size of the wheat enterprise in Kansas implies that enterprises are larger on average across size categories and that no one enterprise size dominates production in the area. (A similar set of characteristics exists for Iowa corn enterprises

Table D-9.-Production Costs and Yield by Enterprise Size in Selected Wheat. Producing Areas, 1983

State, area, and enterprise size	Total cost		Yield		Total cost	
	$/bu.	Percent	Bu/acre	Percent	$/acre	Percent
KS 100						
VL	2.05	100	33.1	100	68	100
L	2.30	112	33.1	100	76	112
M	2.41	118	33.2	100	80	118
MT 200						
VL	2.77	100	31.1	100	86	100
L	2.94	106	29.9	96	88	102
M	3.05	110	29.2	94	89	103
ND 200						
VL	3.79	100	31.7	100	100	120
L	3.60	95	30.8	97	111	93
M	3.91	103	29.7	94	116	97
WA 400						
VL	3.26	100	39.9	100	130	100
L	3.86	118	39.9	100	154	118
M	2.76	85	47.8	120	132	102

SOURCE: Office of Technology Assessment.

except that the enterprises there tend to be smaller, on average.)

It is only about 3 percent more costly to produce a bushel of wheat in Montana than in Kansas. This slight lack of comparative advantage is due to high ownership costs associated with more and larger machines being used on the land more times in land preparation. Unlike those in Kansas, size economies in Montana exist for very large enterprises only. This implies that producers in Montana can exploit size economies as a strategy to remain competitive.

It is about 9 percent more costly to produce a bushel of wheat in North Dakota than in Kansas. The increased costs **are** due to additional expenditures on seed, fertilizer, and chemicals associated with increasing relative yields, spring planting, and continuous cropping. Size economies exist for very large and large enterprises in North Dakota. Production concentration, though higher than in Kansas, is still low, Thus, no one enterprise size dominates production in this area. Size economies can be exploited to improve North Dakota's comparative advantage.

Washington's comparative advantage in wheat production is nearly identical to that of Kansas. It is less than 1 percent more costly to produce a bushel of wheat in Washington than in Kansas. All size economies within Washington are nearly fully exploited. The average enterprise size is quite large, about 1,600 acres. The level of production concentration is the highest of any of the wheat-producing areas studied. This implies that one or more enterprise sizes dominate production in this area.

Rice

For rice the selected producing areas and type of rice grown include:

1. California area 400–medium-" and short-grain rice
2. Texas area 1001—long-grain rice
3. Delta (Mississippi 100 and Arkansas 300–long-grain rice
4. Arkansas area 200—long-grain rice

Size Economies in Rice Production

In California the total cost per hundredweight of rice for all three enterprise sizes is nearly identical, with moderate enterprises having a slight advantage of about 3 percent (table D-10). On the basis of ownership cost per acre, the moderate enterprise has a cost advantage of about 8 percent relative to very large enterprises, Very large, large, and moderate enterprise sizes can fully use 5 to 11, 3 to 4, and 2 self-propelled, 16-foot-wide harvesters, respectively. This size harvester has an annual harvesting capacity of 465 acres. The static Herfindahl index (or measure of relative production concentration) in 1982 was greatest for the large and very large producers, The dynamic Herfindahl index (or the change in relative concentration) from 1978 to 1982 was negative for all enterprise sizes in this rice-producing area. Unfortunately, the data associated with the Herfindahl indices are not sufficiently disaggregated at the large and very large rice enterprise sizes to allow

Table D.10.—Indices Used to Determine Size Economies in Selected Rice-Producing Areas, 1979

State, area, and enterprise size	Total cost per cwt[a] (percent)	Ownership cost per acre (percent)	Harvest machinery full utilization		Herfindahl indices	
			Maximum	Minimum	Static (Percent)	Dynamic (percent)
CA *400*[b]						
VL	100	100	11.7	*4.7*	100	–4
L	99	103	4.6	*2.4*	100	–4
M	*97*	92	2.4	*1.3*	*25*	–19
TX 1001[b]						
VL	100	100	*6.2*	*3.7*	100	*28*
L	98	**98**	*2.8*	*1.8*	*80*	*24*
M	*97*	*95*	*1.8*	1.1	*61*	*20*
DLT 100 and 300[b]						
VL	100	100	*6.5*	*2.2*	100	*–35*
L	*94*	109	*3.3*	1.0	*85*	*–19*
M	*92*	113	*1.5*	*0.6*	*58*	11
AR 200[b]						
VL	100	100	*6.3*	2.1	100	21
L	100	105	*2.1*	1.0	*84*	–20
M	98	102	1.0	0.6	*67*	– 7

[a]Hundredweight.
[b]Irrigated.

SOURCE: Office of Technology Assessment.

for more detailed analysis. The scoring results are 2,2, and 2 for very large, large, and moderate enterprises, respectively (table D-II). There is evidence to argue that no size economies exist in California rice production, given the 1979 configuration of enterprise sizes.

In Texas large and moderate rice enterprises have a slight cost advantage (3 to 4 percent), both in cost per unit of output and ownership cost per acre. The very large, large, and moderate enterprises can fully use four to six, and one to two self-propelled, 16-foot-wide harvesters. The static measure of relative production concentration in 1982 was relatively uniform across enterprise sizes in this area. Finally, the change in the relative concentration from 1978 to 1982 was also relatively uniform and positive across enterprise sizes in this area. The scoring results are 2, 2, and 2 for the very large, large, and moderate categories, respectively. There is evidence to argue that no size economies exist in Texas rice production, given the 1979 configuration of enterprise sizes.

In the Delta large and moderate enterprises have a cost advantage, when measured in cost per unit of output, by about 6 to 8 percent. However, very large enterprises have a cost advantage in capital ownership cost per acre. Very large, large, and moderate enterprises in this area can fully use three to six, two to three, and oneself-propelled, 17-foot-wide harvesters, respectively. This size harvester has an annual harvesting capacity of 495 acres per harvester. The static measure of relative production concentration in 1982 was nearly uniform across enterprise sizes. Finally, the change in the relative concentration from 1978 to 1982 was positive for the moderate enterprise size only. The scoring results are 1,2, and 3 for the very large, large, and moderate enterprises, respectively. There is evidence to argue that no size economies exist in the Delta rice production, given the 1979 configuration of enterprise sizes,

In Arkansas moderate enterprises have a cost advantage, when measured in cost per unit of output, by about 4 percent. However, very large enterprises have a cost advantage in capital ownership costs per acre. Very large, large, and moderate enterprises can fully use three to six, one to two, and one self-propelled, 17-foot-wide harvesters, respectively. The static measure of relative production configuration in 1982 was nearly uniform across enterprise sizes. Finally, the change in the relative production concentration from 1978 to 1982 was positive for the very large enterprise size only. The scoring results are 2, 1, and 2 for the very large, large, and moderate enterprises, respectively. There is evidence to argue that no size economies exist in Arkansas rice production, given the 1979 configuration of enterprise sizes.

The absence of size economies in rice production can be explained by examining the components of the production cost measures (table D-12). Rice yield in all the production areas studied is inversely related to enterprise size, except in Texas. In the case of the Delta, large and moderate rice enterprises have a substantial yield advantage over very large enter-

Table D-n .—Scoring Table Used to Determine Size Economies in Selected Rice-Producing Areas, 1979

State, area, and enterprise size	Product ion cost	Harvester utilization	Herfindahl		Total
			Static	Dynamic	
CA 400[a]					
VL	–	+	+		2
L	–	+	+	–	2
M	+	+	–	–	2
TX 1001[a]					
VL		+	+		2
L	+	+	–	–	2
M	+	–	+	–	2
DLT 100 and 300[a]					
VL		+	+		2
L	+	+		–	2
M	+	+	–	+	3
AR 200[a]					
VL		+		+	2
L	–	+	–	–	1
M	+	+	–	–	2

[a]Irrigated

SOURCE: Off Ice of Technology Assessment.

Table D-12.—Production Costs and Yield by Enterprise Size in Selected Rice-Producing Areas, 1979

State, area, and enterprise size	Total cost		Yield		Total cost	
	$/cwt	Percent	Cwt/acre	Percent	$/acre	Percent
CA 400[a]						
VL	6.34	100	51.3	100	325	100
L	6.29	99	52.6	103	331	102
M	6.12	97	52.1	102	319	98
TX 1001						
VL	7.70	100	47.4	100	365	100
L	7.39	96	46.3	98	342	94
M	7.46	97	46.4	98	346	95
DLT 100-300[a]						
VL	6.78	100	39.8	100	270	100
L	6.36	94	42.6	107	271	100
M	6.26	92	43.6	110	273	101
AR 200[a]						
VL	6.33	100	43.1	100	273	100
L	6.31	100	44.7	104	282	103
M	6.09	96	44.5	103	271	99

[a]Irrigated.

SOURCE: Office of Technology Assessment

prises by about 7 to 10 percent. Total cost per acre for very large enterprises is less than or equal to total cost per acre for large and moderate enterprises in all the production areas again except Texas. In general, rice production has diseconomies of size relative to yield and no economies of size in relation to total costs per acre. Yield diseconomies are related in large part to timeliness of fertilizer and water application, which can be managed better at smaller enterprise sizes than at larger ones.

Size diseconomies in rice production exist uniformly across the selected production area. These diseconomies are primarily the result of yield diseconomies of size assistance in California, the Delta, and Arkansas. Yield diseconomies are related to timeliness of fertilizer, herbicide, pesticide, fungicide, and water application. In Texas size diseconomies are associated with purchased canal water used for irrigation, which in turn allows for lower ownership costs associated with producers' well-pumped irrigation.

Comparative Advantage in Rice Production

The comparative advantage of California in rice production is the greatest of the areas studied. It is the result of high yields, relatively inexpensive irrigation water, and reduced herbicide and fungicide costs relative to those of other selected producing areas. This comparative advantage is not expendable through size economies, since size economies have been more than fully exploited in this area. California has the largest average size rice acreage per enterprise, at **1,071** acres. This implies that production is concentrated in one or more size categories. The combination of size economy and comparative advantage information shows that rice enterprises in California should not increase their size as a means of reducing cost and thereby improving comparative advantage.

The comparative disadvantage of Texas in producing rice is the greatest of the areas studied. The data indicate that in 1979 it was about **25** percent more costly to produce a hundredweight of rice in Texas than in California. This substantial lack of comparative advantage is related to relatively low yields and high irrigation, herbicide, and fungicide costs. It is not correctable by increasing enterprise size in attempting to be more competitive, since size economies have been more than fully exploited. If trends in relative yield and land values continue, Texas will decline from its already marginal competitive position.

It is about 14 percent more costly to produce a hundredweight of rice in the Delta than in California. This lack of comparative advantage is related to additional expenditures on herbicides, fungicides, and irrigation water. This comparative disadvantage is not correctable by simply increasing enterprise size in an attempt to be more competitive, since size economies have been more than fully exploited. The average enterprise size in this area is about **700** acres. Production is very highly concentrated in one or

more of the enterprise size categories, and size economies have been more than fully exploited. The dynamic Herfindahl index shows that there was a substantial decrease in rice production concentration between 1978 and 1982 in this area. Rice production in the absence of size economies is becoming less concentrated and may continue to be so into the future. The combination of size economy and comparative advantage information implies that rice enterprises in the Delta could not increase enterprise size as a means of enhancing comparative advantage.

The comparative disadvantage in Arkansas in 1979 was such that it was 8 percent more costly to produce a hundredweight of rice in Arkansas than in California. This lack of comparative advantage is due to additional expenditures on herbicides, fungicides, and irrigation water pumped from wells. This comparative disadvantage is not correctable by increasing enterprise size in an attempt to be more competitive, since size economies do not exist. The average enterprise size in this area is about 485 acres, the smallest of the selected rice-producing areas. Production is distributed relatively uniformly across enterprise sizes, and there is a modest trend toward resource dispersion, or reconcentration. The combined information on size economies and comparative advantage implies that rice enterprises in Arkansas could not increase enterprise size to enhance comparative advantage. In fact, the current size distribution of rice enterprises is well suited for rice production by being small on average and yet capable of fully using a single rice harvester.

Cotton

For cotton the selected upland cotton-producing areas and cultural practices include:

1. Alabama area 600—dryland
2. California area 500—irrigated
3. Mississippi area 100—-mixed
4. Texas area 200-irrigated
5. Texas area 200—dryland

Size Economies in Cotton Production

In Alabama very large cotton enterprises have the lowest total cost per bale and lowest ownership costs per bale by about 7 to 8 percent and lowest cost per acre relative to large and moderate enterprises by about 20 to 26 percent (table D-13). Very large enterprises in this area can fully use three to six self-propelled, two-row cotton pickers. This size harvester has an annual harvesting capacity of about 400 acres. The static Herfindahl index (or measure of relative production concentration) in 1982 was greatest for the very large producers. Finally, the

Table D-13.—Indices Used to Determine Size Economies in Selected Cotton. Producing Areas, 1982

State, area, and enterprise size	Total cost per bale (percent)	Ownership cost per acre (percent)	Harvest machinery full utilization		Herfindahl indices	
			Maximum	Minimum	Static (percent)	Dynamic (percent)
AL 600						
VL	100	100	6.7	2.9	100	63
L	107	120	2.6	2.1	64	8
M	108	126	1.8	1.3	64	8
CA 500'						
VL	100	100	9.3	5.2	100	39
L	91	86	4.2	2.3	100	39
M	98	98	2.0	0.9	6	9
MS 100						
VL	100	100	11.3	5.2	100	24
L	103	101	5.1	2.3	100	24
M	100	97	2.3	1.6	48	21
TX 200[a]						
VL	100	100	4.7	2.5	100	77
L	94	88	2.4	1.3	70	80
M	99	94	1.1	0.6	35	80
TX 200						
VL	100	100	29.5	5.8	100	6
L	114	143	5.0	2.7	100	6
M	117	124	2.7	1.4	51	5

[a]Irrigated

SOURCE" Off Ice of Technology Assessment

dynamic Herfindahl index (or the change in relative concentration) from 1978 to 1982 was positive for each enterprise size, particularly for very large enterprises. The scoring results are 4, 1, and 1 for very large, large, and moderate enterprises, respectively (table D-14). There is strong evidence to argue that size economies exist for very large cotton enterprises in Alabama.

In California large cotton enterprises have the lowest total cost per bale and ownership costs per acre relative to very large and moderate enterprises. Very large, large, and moderate enterprises can fully use six to nine, three to four, and one to two self-propelled, two-row cotton pickers, respectively. The static Herfindahl index in 1982 was greatest for the large and very large enterprises. Finally, the dynamic Herfindahl index for 1978 to 1982 was positive for each enterprise size, particularly for the large and very large enterprise sizes. The scoring results are 3, 4, and 1 for very large, large, and moderate enterprises, respectively. There is evidence to argue that size economies do exist for very large enterprises in the production of irrigated cotton in California, given the enterprise configuration in 1982.

In Mississippi the total cost per bale and the ownership cost per acre is nearly equal across cotton enterprise size categories. Very large, large, and moderate enterprises can fully use 5 to 11, 3 to 5, and 2 self-propelled, two-row cotton pickers. The measure of relative production concentration in 1982 was greatest for very large and large enterprise sizes. The change in relative production concentration from 1978 to 1982 was nearly constant across all enterprise sizes. The scoring results are 4,4, and 3 for very large, large, and moderate enterprises, respectively. There is evidence to argue that size economies do not exist for large and very large cotton enterprises relative to moderate enterprises in Mississippi, given the enterprise configuration in 1982,

In Texas (irrigated) large cotton enterprises have the lowest total cost per bale, by about 6 percent. Large and moderate enterprises have the lowest ownership cost per acre. Moderate, large, and very large enterprises can fully use one, two, and three to four, "composite" cotton strippers with an annual harvesting capacity of about 525 acres per harvester. The measure of relative production concentration in 1982 was greatest for large and very large enterprises. The change in relative production concentration from 1978 to 1982 was nearly constant across enterprise size categories. The scoring results are 3, 4, and 2 for very large, large, and moderate enterprises, respectively. There is evidence to argue that size economies do not exist for very large enterprises in irrigated cotton in Texas, given the 1982 configuration of enterprises.

In Texas (dryland) very large cotton enterprises have the lowest total cost per bale, by about 14 to

Table D-14.—Scoring Table Used to Determine Size Economies in Selected Cotton-Producing Areas, 1982

State, area, and enterprise size	Production cost	Harvester utilization	Herfindahl		Total
			Static	Dynamic	
AL 600					
VL	+	+	+	+	4
L	–	–	+	–	1
M	–	–	+	–	1
CA *500*[a]					
VL	–	+	+	+	*3*
L	+	+	+	+	*4*
M	–	+	–	–	1
MS 100					
VL	+	+	+	+	4
L	+	+	+	+	
M	+	+	–	+	3
TX 200[a]					
VL	–	+	+	+	3
L	+	+	+	+	4
M	–	+	–	+	2
TX 200					
VL	+	+	+	–	*3*
L	–	+	+	–	*2*
M	–	+	–	–	*1*

[a]Irrigated.

SOURCE Office of Technology Assessment

17 percent, and lowest ownership cost per acre, by about 24 to 43 percent. Moderate, large, and very large enterprises can fully use 2, 3 to 5, and 6 to 30 "composite" cotton strippers, The measure of relative production concentration in 1982 was greatest for large and very large enterprises. The change in relative production concentration from 1978 to 1982 was positive, nearly constant, and quite small across enterprise sizes. The scoring results are 3, 2, and 1 for very large, large, and moderate enterprises, respectively. There is evidence to argue that size economies exist for very large enterprises in dryland cotton production in Texas.

Circumstances regarding size economies in the selected cotton-producing areas can be explained by examining the components of the production cost measures (table D-15). Cotton yields tend to be related to enterprise size, as in Alabama, California, and Mississippi, by about 3 to 7 percent. In Texas, yields tend to be inversely related to enterprise size by about 2 to 3 percent. Total cost per acre tends to be nearly uniform across enterprises in Alabama, Mississippi, and Texas (irrigated). In California total cost per acre is directly related to enterprise size, whereas in Texas (dryland) the total cost per acre is inversely related to enterprise size.

In summary, size economies exist for very large cotton enterprises in Alabama because these enterprises incur lower machinery and tractor-related expenses for a given field operation and still manage to obtain a slightly higher yield. In California, size diseconomies are primarily related to the pecuniary diseconomies of purchased irrigation water for cotton production. In Mississippi the lack of size economies in cotton production for large and very large enterprises relative to moderate enterprises relates to similar preharvest and ownership costs in conjunction with slightly higher yields, In Texas (irrigated) the lack of size economies is related to the combination of size diseconomies in harvesting and cultivation, along with slightly higher yields enjoyed by large and moderate enterprises in this area. In Texas (dryland) size economies for very large enterprises relate to the substantial preharvest and ownership cost advantages associated with lower machinery and tractor-related expenses for a given field operation, without substantial loss in yield.

Comparative Advantage in Cotton Production

In Alabama the average total cost per bale in producing cotton is about 23 percent higher than in Mississippi. This comparative disadvantage is due to low yields and high fertilizer, lime, insecticide, and harvesting costs. Size economies exist in cotton pro-

Table D-15.—Production Costs and Yield by Enterprise Size in Selected Cotton-Producing Areas, 1982

State, area, and enterprise size	Total cost[a]		Yield		Total cost[a]	
	$/bale	Percent	Bales/acre	Percent	$/acre	Percent
AL 600						
VL	279	100	1.52	100	424	100
L	298	107	1.47	97	438	103
M	301	108	1.47	97	443	104
CA 500[b]						
VL	298	100	2.28	100	680	100
L	271	91	2.28	100	619	91
M	291	98	2.11	93	613	90
MS 100						
VL	230	100	1.79	100	412	100
L	237	103	1.79	100	424	103
M	229	100	1.74	97	399	97
TX 200[b]						
VL	319	100	0.67	100	214	100
L	299	94	0,69	103	206	98
M	315	99	0.68	102	214	100
TX 200						
VL	259	100	0.44	100	114	100
L	298	114	0.45	103	134	118
M	302	117	0.45	102	136	119

[a]Excluding land charge.
[b]Irrigated

SOURCE: Off Ice of Technology Assessment

duction in this area for very large enterprises. The average enterprise size is about 1,200 acres and is one of the lowest of the cotton areas studied. Production concentration, on the other hand, is the highest of the areas studied, and production and resources were concentrating at a substantial rate of 36 percent between 1978 and 1982, or 9 percent per year. Since cotton production in this area is at a substantial competitive disadvantage, producers appear to be adopting a strategy of increasing enterprise size as a means of exploiting size economies and increasing competitiveness. This strategy will continue to work in the future, as well.

In California the average total cost per bale of cotton is about 9 percent higher than in Mississippi. This comparative disadvantage is due to high irrigation costs. Size economies do not exist for very large enterprises in California, given the 1982 enterprise configuration. The average cotton enterprise is about 2,100 acres in size and is the second most concentrated cotton-producing area in the selected areas, The diseconomies associated with the rates of purchased irrigation water limit the extent to which other size economies can be used to decrease production costs.

In Mississippi the average total cost per bale of cotton is the lowest of the areas studied. Size economies do not exist in this area for very large and large enterprises relative to moderate enterprises. The average cotton enterprise in this area is about 1,800 acres. Production concentration is "moderate" relative to the other areas in the study. Since cotton production is the most competitive, producers have adopted a strategy of moderate enterprise expansion as a strategy to increase total revenue rather than to increase comparative advantage.

In Texas (irrigated) the average total cost per bale of cotton is about 1 percent higher than in Mississippi. In part, this is because of a comparative advantage in soil. Size economies in Texas (irrigated) do not exist for very large enterprise sizes under the 1982 enterprise configuration. The average enterprise size is about 1,224 acres per enterprise. Production concentration is low relative to the other areas. Producers in this area seem to be adopting irrigation as a means of decreasing variability as well as increasing average yield. However, size economies do not appear to exist for very large irrigated cotton enterprises and, therefore, do not exist as an additional means of improving comparative advantage,

In Texas (dryland) the average total cost per bale of cotton is about 4 percent higher than in Mississippi. Again, this is due in part to the inherent quality of the soil. Size economies remain to be exploited by very large enterprises in this area. The average cotton enterprise size is about 3,300 acres. The production concentration is the lowest of the cotton-producing areas studied. The change in production concentration was about a 6-percent increase from 1978 to 1982, or about 2 percent per year. This is very low relative to the other cotton-producing areas, particularly when compared to irrigated cotton. In this area yields are subject to wide variation, owing to climate and the absence of irrigation water. Therefore, producers seem to have adopted a strategy of nonexpansion in the face of size economies for very large enterprises. The future success of this strategy will depend in part on relative yields and land prices compared with those of other cotton-producing areas.