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ECONOMIC IMPORTANCE OF FARM PRODUCTION AND AGRICULTURAL RESEARCH IN THE NORTH CENTRAL REGION

by

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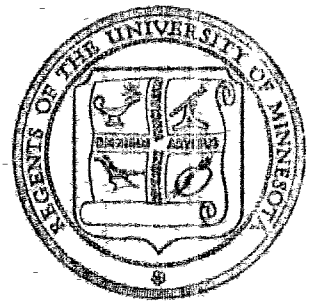

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Economic Importance of Farm Production and Agricultural Research in the North Central Region*

W.B. Sundquist and Shelley Hendrickson**

Introduction

Historically and currently the 12 North Central Region States[1/] (Figure 1) have played a prominent role in U.S. agricultural production. This report provides an inventory of that role for 1979 in terms of the volume of agricultural production, its value and the magnitude of "value added" by the agricultural production sector for individual states. Data presented on "production value" and "value added" are those estimated by Kunz and Purcell (1982) and include all agricultural products with a market value of $10 million or more.

Data are next reported by state, for the "commodity specific" public research investments made for major individual agricultural products by the Agricultural Experiment Stations in the North Central Region. Other research is conducted which is not specific to individual commodities but which also plays a key role in an effective "overall" research and development (R & D) program. The data on Scientists Years

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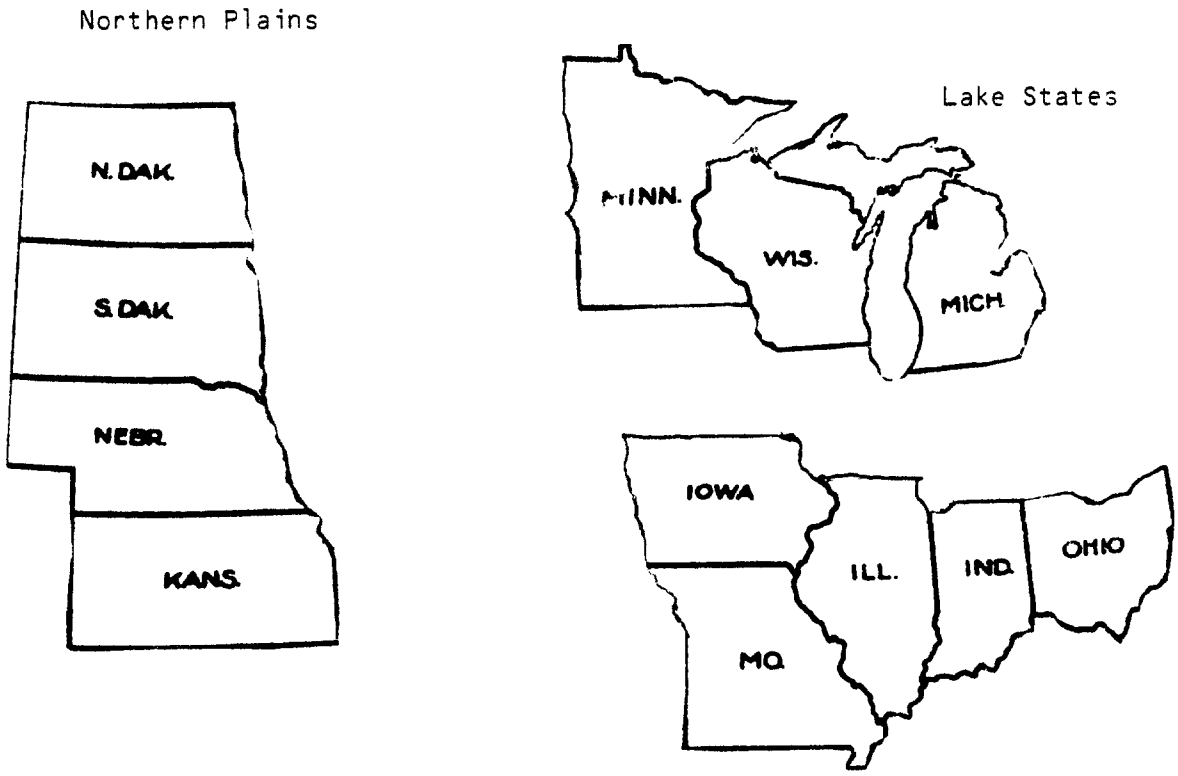
1/ The North Central Region is divided into the Corn Belt, Lake States and Northern Plains Subregions (Figure 1). States included are Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota and Wisconsin.

NORTH CENTRAL REGION

Figure 1



(SY) and budget expenditures are from the National Inventory of Agricultural Research (CRIS).

Finally, we draw on past literature and on analyses which we have conducted specifically for 1979 to assess the recent-year productivity of agricultural research conducted on commodities of major importance in the twelve North Central States. In addition, we provide some perspective on the spillover of research benefits across state boundaries and from producers to consumers. The ultimate pay-off from research is, of course, to the producers who use the results of this research to increase production and/or to reduce costs, to the farm supply and marketing firms servicing the agricultural sector and to consumers who pay lower prices and have enhanced consumer choice because of larger product supplies and/or lower product prices. We have not tried to partition the research benefits between these different groups but have evaluated research benefits at the level of first marketing (farm production value). We do, however, discuss the key factors determining who benefits from agricultural research.

Production Volume, Value and Value Added for Major Agricultural Commodities

Tables 1 through 12 report 1979 production volume, value and value added for major agricultural commodities for each of the North Central Region states. Individual commodities are listed in order of the production value of the commodity.[2/]

[2/] Values for forestry products are not included in these tables but those for fruit and berry products are.

Value added is the difference between the market value of products and the cost of the inputs used up in the production process. The "value added" computations reported in Tables 1 to 12 thus are product values net of those inputs purchased and consumed in the production process. They can be considered as a "residual return" to labor-management, the stock of durable capital and the land base used in agricultural production. One should be careful not to attribute to "value added" normative capabilities which this measure does not possess. For example, value added computations do not provide information about the "resource endowments" of an individual state or region or about the "productivity" of individual resources or inputs. Thus, value added computations do not provide guidelines for maximizing efficiency in the utilization of production resources. They do, however, provide information on the revenue surplus (value in excess of those inputs consumed in the production process) which is generated by individual agricultural commodities. And, it is this surplus in revenue which is available as a payment to the local economy for the land, durable capital and labor-management resources being used in production.

Value added in agricultural production as a percentage of total value varies substantially for different commodities. In general, it tends to be higher for crops than for livestock. One reason is the overriding importance of the land input in crop production. But since good cropland is a resource of limited supply, livestock enterprises, despite their generally lower value added component, play an important economic role in the North Central Region. Among the major field crops

value added as a percent of total value also tends to be higher for soybeans (80 percent plus) than for corn (60 percent plus) because of the higher proportion of purchased inputs, particularly fertilizer, used in corn production. Percent of value added in wheat production is intermediate between that for corn and soybeans. Finally, value added tends to be high, as a percent of total value, for vegetables and specialty crops which require large labor inputs.

Each individual state in the North Central Region has unique resource endowments and agricultural production. Yet, some perspective can be gained by viewing production agriculture in each of the three Subregions. Arrayed in order of the total value added for the six most important agricultural products in each Subregion in 1979 they are as follows:

Corn Belt	Lake States	Northern Plains
Corn	Milk	Cattle
Soybeans	Corn	Wheat
Cattle	Cattle	Corn
Hogs	Soybeans	Hay
Milk	Hay	Sorghum
Hay	Wheat	Soybeans

Thus, there are very substantial differences between subregions (and states) in the importance of individual commodities. These differences become even more pronounced with respect to lesser commodities

such as fruits, vegetables, sugarbeets, sunflower and poultry. Even within the individual states there are major differences between areas as to resource endowments and the economic importance of individual commodities. Such differences constitute one of the major reasons for decentralization of agricultural research, particularly that involving production systems, to regional locations (Branch Stations) within states.

Some agricultural commodities, though of minor economic importance relative to others, do effectively utilize unique resources or capture other dimensions of comparative advantage including location relative to markets. Thus, they may strongly warrant R & D support from the public sector. Generally speaking, however, it is only those commodities which have substantial production volume, or the future potential for such volume, which can carry the costs of major research programs.

Research Expenditures Made by State Agricultural Experiment Stations

The significance of agricultural research is that it is a major source of technical change. It permits the substitution of knowledge for resources and of inexpensive and abundant resources for scarce and expensive resources; and it releases the constraints on growth imposed by inelastic resource supplies. Increasingly production agriculture in the U.S. is a science-based, high-technology economic sector. Thus, the effective development and utilization of research is a key component in keeping it economically competitive.

Table 1, Production Volume, Value and Value Added for Major Agricultural Commodities, State of Illinois

Commodity	Production Units	Production Volume	% of U.S. Production	Value of Production Million $	% of Value of State's Ag Production	Value Added Million $	% of State's Total Value Added
Corn: Grain	1000 bu.	1,358,080	17.5				
Silage	1000 tons	3,520	3.1				
Total				3,465.600	41.0	2,364.021	41.7
Soybeans	1000 bu.	374,220	16.5	2,395.008	28.3	2,056.328	36.2
Hogs & Pigs	1000 lb.	2,606,928	11.5	1,102.633	13.0	340.284	6.0
Cattle & Calves	1000 lb.	965,230	2.5	625.072	7.4	328.614	5.8
Milk	1,000,000 lb.	2,391	1.9	288.222	3.4	191.964	3.4
Wheat	1000 bu.	55,900	2.6	223.600	2.6	166.148	2.9
Hay	1000 tons	3,766	2.6	205.247	2.4	145.498	2.6
Eggs	1,000,000	1,347	1.9	64.207	.8	21.653	.4
Oats	1000 bu.	16,200	3.0	22.680	.3	14.529	.3
Sweet Corn: Fresh	1000 cwt.	348	2.6				
Processing	ton	251,680	10.3				
Total				15.933	.2	12.383	.2
Apples	1,000,000 lb.	110	1.4	13.640	.2	11.111	.2
Sorghum: Grain	1000 bu.	5,100	.1				
Silage	1000 ton	115	1.3				
Total				11.965	.1	7.563	.1
Subtotal				8,433.807	99.40	5,660.096	99.80
Total All Farm Products				8,464.629	100.00	5,674.440	100.00

Table 2, Production Volume, Value and Value Added for Major Agricultural Commodities, State of Indiana

Commodity	Production Units	Production Volume	% of U.S. Production	Value of Production Million $	% of Value of State's Ag Production	Value Added Million $	% of State's Total Value Added
Corn: Grain	1000 bu.	664,160	8.6				
Silage	1000 ton	2,211	1.9				
Total				1,697.920	36.4	1,098.216	38.1
Soybeans	1000 bu.	159,120	7.0	1,002.456	21.5	826.473	28.6
Hogs & Pigs	1000 lb.	1,610,003	7.1	695.659	14.9	212.385	7.4
Cattle & Calves	1000 lb.	567,060	1.5	367,488	7.9	213.436	7.4
Milk	1,000,000 lb.	2,175	1.8	268.830	5.8	166.564	5.8
Wheat	1000 bu.	44,415	2.1	177.660	3.8	130.977	4.5
Eggs	1,000,000	3,536	5.1	171.201	3.7	58.903	2.0
Hay	1000 ton	2,150	1.5	121.475	2.6	87.080	3.0
Turkey	1000 lb.	101,520	3.4	42.638	.9	16.677	.6
Broilers	1000 lb.	59,983	.4	20.819	.4	.629	*
Tobacco	1000 lb.	13,000	.8	19.045	.4	17.466	.6
Popcorn	1000 lb.	147,500	27.5	16.078	.3	12.749	.4
Tomatoes: Fresh	1000 cwt.	266	1.2				
Process	tons	144,550	2.0				
Total				15.164	.3	10.676	.4
Oats	1000 bu.	8,845	1.7	13.710	.3	8.586	.3
Apples	1,000,000 lbs.	75	.9	11.025	.2	10.380	.4
Subtotal				4,641.168	99.40	2,871.197	99.50
Total All Farm Products				4,669.789	100.00	2,885.870	100.00

* Less than .05%

Table 3, Production Volume, Value and Value Added for Major Agricultural Commodities, State of Iowa

Commodity	Production Units	Production Volume	% of U.S. Production	Value of Production Million $	% of Value of State's Ag Production	Value Added Million $	% of State's Total Value Added
Corn: Grain	1000 bu.	1,625,600	20.9				
Silage	1000 tons	11,375	10.0				
Total				3,928.745	36.3	2,690.130	41.2
Hogs & Pigs	1000 lbs.	5,423,276	24.0	3,365.962	20.9	680.378	10.4
Soybeans	1000 bu.	310,460	13.7	1,878.283	17.3	1,631.444	25.0
Cattle & Calves	1000 lbs.	2,461,380	6.4	1,680.796	15.5	835.192	12.8
Milk	1,000,000 lbs.	3,920	3.2	453.936	4.2	293.079	4.5
Hay	1000 tons	8,271	5.7	380.466	3.5	279.763	4.3
Oats	1000 bu.	63,000	11.8	58.691	.9	88.200	.8
Turkeys	1000 lbs.	133,056	4.5	54.553	.5	23.987	.4
Subtotal				10,701.432	99.10	6,522.173	99.40
Total all Farm Products				10,840.423	100.00	6,531.346	100.00

Table 4, Production Volume, Value and Value Added for Major Agricultural Commodities, State of Kansas

Commodity	Production Units	Production Volume	% of U.S. Production	Value of Production Million $	% of Value of State's Ag Production	Value Added Million $	% of State's Total Value Added
Cattle & Calves	1000 lbs.	2,660,520	6.9	1,779.632	32.4	791.604	22.4
Wheat	1000 bu.	410,400	19.2	1,539.000	28.1	1,322.124	37.5
Sorghum: Grain	1000 bu.	256,680	31.5				
Silage	1000 tons	3,984	44.2				
Total				609.502	11.1	466.159	13.2
Corn: Grain	1000 bu.	171,990	2.2				
Silage	1000 tons	3,675	3.2				
Total				501.638	9.1	312.631	8.9
Hogs & Pigs	1000 lbs.	795,985	3.5	316.650	5.8	96.673	2.7
Hay	1000 tons	5,716	3.9	280.084	5.1	240.598	6.8
Soybeans	1000 bu.	41,340	1.8	243.906	4.5	205.159	5.8
Milk	1,000,000 lbs.	1,330	1.1	157.002	2.9	65.018	1.9
Eggs	1,000,000	483	.7	19.723	.4	4.423	.1
Subtotal				5,447.137	99.4	3,504.389	99.3
Total of Farm Products				5,487.379	100.00	3,351.646	100.00

Table 5, Production Volume, Value and Value Added for Major Agricultural Commodities, State of Michigan

Commodity	Production Units	Production Volume	% of U.S. Production	Value of Production Million $	% of Value of State's Ag Production	Value Added Million $	% of State's Total Value Added
Corn: Grain	1000 bu.	237,500	3.1				
Silage	1000 ton	4,995	4.4				
Total				613.462	22.9	395.803	23.4
Milk	1,000,000 lbs.	4,830	3.9	582.498	21.7	365.908	21.6
Cattle & Calves	1000 lbs.	356,865	.9	283.790	10.6	172.322	10.2
Soybeans	1000 bu.	28,615	1.3	170.259	6.4	139.210	8.2
Hay	1000 tons	3,833	2.6	147.571	5.5	51.147	3.0
Hogs & Pigs	1000 lbs.	306,997	1.4	133.106	5.0	42.800	2.5
Wheat	1000 bu.	33,755	1.6	129.957	4.8	93.140	5.5
Dry Edible Beans	1000 cwt.	6,860	33.2	126.910	4.7	102.426	6.1
Eggs	1,000,000	1,491	2.2	62.125	2.3	6.821	.4
Sugarbeets	1000 ton	1,558	7.1	60.295	2.2	49.793	2.9
Cherries: Sweet	tons	27,000	14.8				
Tart	1,000,000 lbs.	100	58.7				
Total				58.496	2.2	51.920	3.1
Apples	1,000,000 lbs.	680	8.4	53.040	2.0	41.745	2.5
Potatoes	1000 cwt.	9,548	2.7	40.979	1.5	26.630	1.6
Oats	1000 bu.	16,470	3.1	23.058	.9	13.039	.8
Cucumbers: Fresh	1000 cwt.	152	2.6				
Process	tons	117,810	17.5				
Total				17.801	.7	13.060	.8
Tomatoes: Fresh	1000 cwt.	370	1.6				
Process	tons	113,520	1.4				
Total				17.040	.6	13.127	.8
Blueberries: Fresh & Process	1000 lbs.	17,600	18.9	16.164	.6	13.546	.8
Turkeys	1000 lbs.	31,200	1.1	14.040	.5	4.845	.3
Grapes: Fresh & Process	ton	58,500	1.2	13.865	.5	12.726	.8
Carrots: Fresh & Process	1000 cwt.	1,713	8.1	13.345	.5	12.135	.7
Asparagus: Fresh & Process	1000 cwt.	221	11.8	12.951	.5	11.133	.7
Onions: Fresh	1000 cwt.	2,414	6.3	12.421	.5	9.955	.6
Celery: Fresh & Process	1000 cwt.	1,153	6.6	10.982	.4	8.469	.5
Subtotal				2,614.155	97.5	1,651.700	97.8
Total All Farm Products				2,680.579	100.00	1,690.148	100.00

Table 6, Production Volume, Value and Value Added for Major Agricultural Commodities, State of Minnesota

Commodity	Production Units	Production Volume	% of U.S. Production	Value of Production Million $	% of Value of State's Ag Production	Value Added Million $	% of State's Total Value Added
Corn: Grain	1000 bu.	606,000	7.8				
Silage	1000 ton	10,125	8.9				
Total				1,362.000	21.1	877.251	21.3
Milk	1,000,000 lb.	9,145	7.4	1,035.214	16.0	682.268	16.5
Soybeans	1000 bu.	167,360	7.4	970.688	15.0	814.514	19.7
Cattle & Calves	1000 lb.	1,259,090	3.3	770.878	11.9	455.855	11.1
Hogs & Pigs	1000 lb.	1,692,992	7.5	708.613	11.0	217.516	5.3
Hay	1000 ton	9,030	6.2	388.290	6.0	309.044	7.5
Wheat	1000 bu.	90,384	4.2	331.308	5.1	235.113	5.7
Turkeys	1000 lb.	414,389	1.5	165.756	2.6	66.004	1.7
Sunflower seeds (oil & non oil)	1000 lb.	1,870,620	25.6	162.104	2.5	113.928	2.8
Sugarbeets	1000 tons	3,782	17.2	120.268	1.9	92.348	2.2
Oats	1000 bu.	84,930	15.9	106.163	1.6	68.004	1.7
Eggs	1,000.000	2,183	3.2	89.685	1.4	24.540	.6
Barley	1000 bu.	40,810	10.8	87.742	1.4	63.047	1.5
Potatoes	1000 cwt.	14,716	4.2	40.883	.6	29.240	.6
Sweet Corn: Process	ton	562,280	23.0	26.258	.4	18.098	.4
Green Beans: Process	ton	111,690	18.4	24.572	.4	21.788	.5
Broilers	1000 lb.	76,500	.5	24.038	.4	5.010	.1
Flaxseed	1000 bu.	2,219	16.4	13.092	.2	9.290	.2
Dry Edible Beans	1000 cwt.	562	2.7	11.633	.2	9.561	.2
Sheep & Lambs	1000 lb.	18,534	2.6	10.690	.2	5.848	.1
Subtotal				6,449.875	99.90	4,118.267	99.70
Total All Farm Products				6,461.031	100.00	4,125.906	100.00

Table 7, Production Volume, Value and Value Added for Major Agricultural Commodities, State of MISSOURI

Commodity	Production Units	Production Volume	% of U.S. Production	Value of Production Million $	% of Value of State's Ag Production	Value Added Million $	% of State's Total Value Added
Cattle & Calves	1000 lbs.	1,686,015	4.4	1,324.974	26.6	896.788	28.2
Soybeans	1000 bu.	186,795	8.2	1,139.450	22.9	937.569	29.5
Hogs & Pigs	1000 lbs.	1,619,092	7.2	653.512	13.1	188.368	5.9
Corn: Grain	1000 bu.	228,660	2.9				
Silage	1000 tons	1,456	1.3				
Total				564.461	11.3	379.947	12.0
Milk	1,000,000 lbs.	2,714	2.2	322.498	6.5	172.227	5.4
Hay	1000 tons	6,070	4.2	294.395	5.9	168.255	5.3
Wheat	1000 bu.	70,400	3.3	267.520	5.4	209.151	6.6
Sorghum: Grain	1000 bu.	59,040	7.3				
Silage	1000 tons	231	2.6				
Total				132.640	2.7	91.414	2.9
Turkeys	1000 lbs.	181,166	6.1	88.761	1.8	34.507	1.1
Eggs	1,000,000	1,376	2.0	61.920	1.2	17.762	.6
Cotton	1000 bales	159	1.1				
Cotton Seed	1000 tons	64	1.1				
Total Cotton and Cotton Seed				55.089	1.1	38.599	1.2
Broilers	1000 cwt.	101,188	.01	32.387	.6	6.101	.2
Rice		1,333	.01	14.263	.3	8.556	.3
Subtotal				4,951.870	99.40	3149.244	99.20
Total All Farm Products				4,983.935	100.00	3174.317	100.00

Table 8, Production Volume, Value and Value Added for Major Agricultural Commodities, State of Nebraska

Commodity	Production Units	Production Volume	% of U.S. Production	Value of Production Million $	% of Value of State's Ag Production	Value Added Million $	% of State's Total Value Added
Corn: Grain	1000 bu	793,500	10.2				
Silage	1000 ton	6,123	5.4				
Total				1,929.528	31.7	1,063.324	30.5
Cattle & Calves	1000 lb	2,815,310	7.3	1,894.752	31.1	913.534	26.2
Hogs & Pigs	1000 lb	1,495,793	.7	632.639	10.4	193.145	5.5
Sorghum: Grain	1000 lb	144,570	17.8				
Silage	1000 ton	735	8.2				
Total				324.216	5.3	257.745	7.4
Hay	1000 ton	7,616	5.2	323.765	5.3	291.129	8.4
Wheat	1000 bu	86,700	4.0	320.790	5.3	272.566	7.8
Soybeans	1000 bu	54,740	2.4	320.229	5.3	282.448	8.1
Milk	1,000,000 lbs	1,260	1.0	153.846	2.5	105.870	3.0
Dry Edible Beans	1000 cwt	2,160	10.5	49.896	.8	29.287	.8
Sugarbeets	1000 ton	1,460	6.6	49.708	.8	36.525	1.1
Eggs	1,000,000	802	1.2	28.872	.5	3.001	.1
Oats	1000 bu	20,140	5.5	26.182	.4	18.875	.5
Popcorn	1000 lb	170,500	31.8	14.152	.2	4.820	.1
Subtotal				6,068.575	99.60	3,472.269	99.50
Total All Farm Products				6,094.666	100.00	3,487.419	100.00

Table 9, Production Volume, Value and Value Added for Major Agricultural Commodities, State of North Dakota

Commodity	Production Units	Production Volume	% of U.S. Production	Value of Production Million $	% of Value of State's Ag Production	Value Added Million $	% of State's Total Value Added
Wheat	1000 bu	252,235	11.8	949.826	34.1	711.448	34.5
Cattle & Calves	1000 lb	741,780	1.9	529.045	19.0	401.794	19.5
Sunflower Seeds, oil & non oil	1000 lb	4,594,080	62.9	403.512	14.5	309.147	15.0
Hay	1000 ton	5,780	4.0	225.420	8.1	168.548	8.2
Barley	1000 bu	75,900	20.1	159.390	5.7	112.637	5.5
Milk	1,000,000 lb	874	.7	95.790	3.4	63.315	3.1
Corn: Grain	1000 bu	22,040	.3				
Silage	1000 ton	1,843	1.6				
Total				83.733	3.0	66.196	3.2
Sugarbeets	1000 ton	2,304	10.5	78.566	2.8	62.012	3.0
Potatoes	1000 cwt	18,240	5.2	51.072	1.8	32.510	1.6
Hogs & Pigs	1000 lb	109,581	.5	44.615	1.6	12.782	.6
Oats	1000 bu	36,960	6.8	40.656	1.5	26.804	1.3
Flaxseed	1000 bu	6,375	47.1	36.975	1.3	29.158	1.4
Dry Edible Beans	1000 cwt	1,418	6.9	33.607	1.2	28.565	1.4
Soybeans	1000 bu	5,562	2.5	30.591	1.1	25.158	1.2
Subtotal				2,762.798	99.10	2,050.074	98.0
Total all Farm Products				2,787.986	100.00	2,060.003	100.00

Table 10, Production Volume, Value and Value Added for Major Agricultural Commodities, State of Ohio

Commodity	Production Units	Production Volume	% of U.S. Production	Value of Production Million $	% of Value of State's Ag Production	Value Added Million $	% of State's Total Value Added
Corn: Grain	1000 bu.	417,450	5.4				
Silage	1000 tons	2,688	2.4				
Total				1,076.848	26.9	726.496	28.0
Soybeans	1000 bu.	145,080	6.4	906.750	22.7	739.007	28.5
Milk	1,000,000 lb.	4,265	3.5	517.345	12.9	311.116	12.0
Cattle & Calves	1000 lb.	592,000	1.5	389.061	9.7	236.272	9.1
Hogs & Pigs	1000 lb.	783,080	3.5	320.877	8.0	103.688	4.0
Wheat	1000 bu.	63,360	3.0	259.776	6.5	194.591	7.5
Hay	1000 ton	3,606	2.5	200.133	5.0	120.176	4.6
Eggs	1,000,000 lb.	2,253	3.3	96.023	2.4	19.039	.7
Oats	1000 bu.	23,800	4.5	34.510	.9	19.517	.8
Tomatoes: Fresh	1000 cwt.	112	.5				
Process	ton	349,320	4.8				
Total				26.730	.7	21.626	.8
Tobacco	1000 lb.	16,405	1.1	22.640	.6	20.416	.8
Turkeys	1000 lb.	53,345	1.8	21.871	.6	7.003	.3
Apples	1,000,000 lb.	105	1.3	16.485	.4	15.581	.6
Sheeps & Lambs	1000 lb.	20,954	3.0	13.463	.3	7.365	.3
Sweet Corn-fresh	1000 cwt.	1,125	8.5	13.388	.3	8.884	.3
Cucumbers - Process	tons	80,200	11.9	12.030	.3	10.631	.4
Potatoes	1000 cwt.	2,694	.8	11.974	.3	6.485	.3
Subtotal				3,939.904	98.50	2,567.893	99.00
Total all Farm Products				3,999.778	100.00	2,595.412	100.00

Table 11, Production Volume, Value and Value Added for Major Agricultural Commodities, State of South Dakota

Commodity	Production Units	Production Volume	% of U.S. Production	Value of Production Million $	% of Value of State's Ag Production	Value Added Million $	% of State's Total Value Added
Cattle & Calves	1000 lb.	1,559,460	4.1	1,143.247	37.4	808.477	38.2
Corn: Grain	1000 bu.	210,900	2.7				
Silage	1000 ton	4,056	3.6				
Total				473.822	15.5	370.344	17.5
Hogs & Pigs	1000 lb.	690,251	3.1	284.299	9.3	83.894	4.0
Hay	1000 ton	7,915	5.4	265.153	8.7	212.735	10.0
Wheat	1000 bu.	60,060	2.8	218.466	7.1	162.711	7.7
Milk	1,000,000 lb.	1,549	1.3	179.404	5.9	119.658	5.7
Sunflower oil & non oil	1000 bu.	756,300	10.4	66.686	2.2	45.621	2.2
Soybeans	1000 bu.	20,955	.92	123.635	4.0	109.963	5.2
Oats	1000 bu.	98,500	18.43	123.125	4.0	85.327	4.0
Barley	1000 bu.	20,000	5.3	43.000	1.4	30.336	1.4
Sheep & Lambs	1000 lb.	61,980	8.7	38.480	1.3	29.357	1.4
Flaxseed	1000 bu.	4,900	36.2	30.380	1.0	24.286	1.1
Sorghum: Grain	1000 bu.	13,590	1.7				
Silage	1000 ton	301	3.3				
Total				27.014	.9	20.563	1.0
Eggs	1,000,000	476	.7	16.218	.5	*	*
Rye	1000 bu.	6,300	25.7				
Subtotal				3,032.854	99.2	2,103.272	99.4
Total all Farm Production				3,058.571	100.00	2,115.837	100.00

*Value is 0 or less

Table 12, Production Volume, Value and Value Added for Major Agricultural Commodities, State of Wisconsin

Commodity	Production Units	Production Volume	% of U.S. Production	Value of Production Million $	% of Value of State's Ag Production	Value Added Million $	% of State's Total Value Added
Milk	1,000,000 lbs.	21,850	17.7	2,579.125	48.6	1,717.800	49.6
Corn: Grain	1000 bu	306,940	4.0				
Silage	1000 ton	10,800	9.5				
total				899.190	17.0	611.991	17.7
Cattle & Calves	1000 lbs.	994,750	2.6	671.663	12.7	448.272	12.9
Hay	1000 ton	12,555	8.6	395.483	7.5	288.655	8.3
Hogs & Pigs	1000 lbs.	605,190	2.7	247.779	4.7	73.558	2.1
Cats	1000 bu	55,860	10.5	72.618	1.4	40.676	1.2
Potatoes		17,010	5.0	68.040	1.3	50.426	1.4
Soybeans	1000 bu	10,030	.4	57.171	1.1	48.152	1.4
Turkeys	1000 lbs.	108,949	3.7	45.759	.9	19.315	.5
Eggs	1,000,000	911	1.3	40.919	.8	13.430	.4
Green Peas-process	ton	177,550	29.2	34.977	.7	23.748	.7
Tobacco	1000 lbs.	25,140	1.6	29.414	.6	26.242	.7
Snap Beans-process	ton	212,520	27.6	29.115	.5	18.360	.5
Sweet Corn-process	ton	556,000	22.7	23.185	.4	16.077	.5
Cranberries-fresh & process	1000 lbs.	901	36.4	22.615	.4	21.213	.6
Broilers	1000 lbs.	47,000	.3	16.081	.3	4.741	.1
Subtotal				5233.134	98.9	3422.656	98.6
Total All Farm Products				5303.730	100.00	3465.543	100.00

In 1979, research funding by the North Central Region State Agricultural Experiment Stations totaled $221.4 million of which about $40 million (18 percent) was federal funding administered by the Cooperative State Research Service (CSRS). Tables 13 through 18 show the levels of research investment made in individual states for each of 15 major plant and animal commodity groups (including trees and forest products) and in total.[3/] In addition to the 15 individual commodities listed, fruit, potatoes and ornamental and turf products, as well as several other commodities, were the recipients of significant research support in some states but not in others.

Along with "commodity specific" research expenditures, a good deal of research was conducted for such varied topical categories as soil and land, water, weeds, seeds, plants, animals, biological cell systems, farm management and marketing. These and other research categories are important components of a comprehensive state-level agricultural research program. In addition, about five percent of the total research expenditures made by Agricultural Experiment Stations in the North Central Region was not classified as to its expected utilization.

In appraising agricultural research investments one should remember that not all research expenditures go for the development of new technology. A substantial portion of the total agricultural research investment must go for maintenance research - to maintain productivity in the face of new pests and pathogens and to maintain the capabilities of the

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[3/] Research expenditures in Tables 13 through 18 include all research funds expended at each location including those from state, federal and other sources.

natural resource base. Moreover, as yield and other measures of agricultural productivity increase, more research is required just to maintain these higher productivity levels.

As might be expected, commodity research expenditures in individual states are generally closely related to the economic importance of the individual commodity in the individual state. For example, in Kansas beef cattle and wheat rank number one and two in both production value and in research support, whereas in Iowa, corn and hogs are the two top commodities in both categories. This verifies the judgement that research administrators in individual states are in a position to give major consideration to the economic importance of individual commodities when making allocations of research resources. It is probably also the case that, at the state level, commodity support groups have influence on research budgets somewhat in proportion to the economic importance of the commodity which they represent. This may, however, result in the underrepresentation of research funding for such non-commodity areas as soil conservation, food safety and community development. In recent years numerous public interest groups have emerged which provide increased support for these "non-commodity" issue areas. To date, however, such support groups have probably been more effective in developing increased public awareness of existing problems than in generating systematic research programs for the issue areas which they represent.

TABLE 13

Scientist Years (SY) and Budget Expenditures for Research ($) on 15 Major Commodities, 1979

ILLINOIS

Commodity	SY	$	Percent of State Total $
Soybeans	19.8	1,848,435	11.6
Dairy Cattle	10.3	1,578,390	10.0
Corn	12.0	1,364,075	8.6
Swine	7.9	1,248,622	7.8
Beef Cattle	6.4	948,828	6.0
Sheep & Wool	3.6	562,043	3.5
Vegetables	5.3	524,397	3.3
Trees&Forest Products	5.0	416,334	2.6
Forage Crops	3.0	348,208	2.2
Poultry	1.3	305,676	1.9
Other Small Grains	1.5	148,348	.9
Wheat	.3	128,232	.8
Sorghum	.7	39,727	.2
Other Oil & Oilseed Crops	---	35,386	.2
Sugar Crops	---	---	---
Total of Above	77.1	9,496,701	59.6
State Total	150.1	15,944,141	

INDIANA

Commodity	SY	$	Percent of State Total $
Swine	12.9	1,848,131	8.7
Beef Cattle	7.3	1,587,147	7.4
Corn	15.3	1,484,546	7.0
Dairy Cattle	5.7	1,029,030	4.8
Soybeans	8.0	848,556	4.8
Trees &Forest Products	9.2	956,003	4.0
Poultry	6.0	696,556	3.3
Vegetables	5.9	542,154	2.5
Wheat	5.4	472,349	2.2
Forage Crops	4.1	387,647	1.8
Sheep & Wool	1.5	190,597	.9
Other Small Grains	.9	79,800	.4
Sorghum	1.7	67,192	.3
Other Oilseed & Oil Crops	---	---	---
Sugar Crops	---	---	---
Total of Above	83.9	10,189,708	47.7
State Total	190.4	21,355,025	

TABLE 14

Scientist Years (SY) and Budget Expenditures for Research ($) on 15 Major Commodities, 1979

IOWA

Commodity	SY	$	Percent of State Total $
Swine	10.4	2,375,589	12.5
Corn	15.2	2,100,772	11.0
Beef Cattle	7.8	1,853,282	9.8
Soybeans	11.6	1,489,999	7.9
Dairy Cattle	6.0	1,147,579	6.1
Poultry	4.5	600,505	3.2
Other Small Gains	3.4	497,262	2.6
Trees &Forest Products	2.9	349,110	1.8
Forage Crops	2.1	299,728	1.6
Sheep	1.2	206,986	1.1
Sorghum	.6	91,953	.5
Vegetables	1.0	72,838	.4
Wheat	.2	19,316	.1
Sugar Crops	---	---	---
Other Oilseed & Oil Crops	---	---	---
Total of Above	66.9	11,104,919	58.5
State Total	117.9	18,966,918	

KANSAS

Commodity	SY	$	Percent of State Total $
Beef Cattle	20.3	3,503,637	20.2
Wheat	24.1	2,253,259	13.0
Corn	11.7	1,040,775	6.0
Sorghum	10.0	938,380	5.4
Dairy Cattle	7.0	783,804	4.5
Poulty	6.3	542,930	3.1
Forage Crops	5.4	510,230	2.9
Other Small Grains	3.4	504,785	2.9
Swine	2.8	445,798	2.6
Soybeans	3.4	392,551	2.3
Trees &Forest Products	3.8	281,416	1.6
Sheep & Wool	2.1	278,131	1.6
Vegetables	2.3	187,033	1.2
Other Oilseed & Oil Crops	1.4	132,067	.8
Sugar Crops	.5	38,440	.2
Total of Above	110.7	11,833,236	68.1
State Total	176.7	17,382,475	

TABLE 15

Scientist Years (SY) and Budget Expenditures for Research ($) on 15 Major Commodities, 1979

MICHIGAN

Commodity	SY	$	Percent of State Total $
Trees	11.8	2,398,327	10.0
Vegetables	10.5	1,716,346	7.1
Dairy Cattle	12.4	1,709,291	7.1
Beef Cattle	3.7	991,167	4.1
Forage Crops	3.7	587,497	2.4
Poultry	6.9	544,375	2.3
Swine	4.5	518,635	2.2
Corn	3.4	507,465	2.1
Wheat	1.3	325,762	1.4
Soybeans	2.1	280,075	1.2
Other Small Grains	3.0	207,010	1.0
Sheep & Wool	.4	99,334	.4
Sugar Crops	.2	58,002	.2
Sorghum	----	----	----
Other Oilseed & Oil Crops	----	----	----
Total of Above	63.9	9,943,286	41.5
State Total	176.5	24,017,249	

MINNESOTA

Commodity	SY	$	Percent of State Total $
Dairy Cattle	12.8	2,697,978	11.4
Corn	10.1	1,661,428	7.0
Trees &Forest Products	13.6	1,615,244	6.7
Beef Cattle	3.9	1,440,703	6.1
Swine	7.9	1,378,643	5.8
Poultry	6.5	1,076,218	4.6
Sheep & Wool	2.8	706,249	3.0
Forage Crops	4.6	654,987	2.8
Other Small Grains	4.5	591,939	2.5
Wheat	3.1	581,926	2.5
Vegetables	2.7	421,581	1.8
Soybeans	2.1	280,075	1.2
Other Oilseed & Oil Crops	.7	47,493	.2
Sorghum	----	----	----
Sugar Crops	----	----	----
Total of Above	75.3	13,155,464	55.8
State Total	152.0	23,570,080	

TABLE 16

Scientist Years (SY) and Budget Expenditures for Research ($) on 15 Major Commodities, 1979

MISSOURI

Commodity	SY	$	Percent of State Total $
Dairy Cattle	7.7	1,144,970	7.8
Corn	6.7	1,143,719	7.8
Beef Cattle	7.1	1,026,460	7.0
Swine	6.3	967,618	6.6
Soybeans	6.0	721,345	4.9
Poultry	6.6	680,602	4.7
Forage Crops	3.7	517,683	3.5
Trees &Forest Products	4.4	486,959	3.3
Sheep & Wool	3.4	423,135	3.0
Vegetables	4.1	333,491	2.3
Sorghum	1.9	248,599	1.7
Wheat	2.3	233,635	1.6
Other Small Grains	.9	90,717	.6
Other Oilseed & Oil Crops	.5	38,324	.3
Sugar Crops	.3	18,268	.1
Total of Above	61.9	8,075,525	55.2
State Total	115.6	14,623,675	

NEBRASKA

Commodity	SY	$	Percent of State Total $
Beef Cattle	15.0	6,463,238	30.0
Swine	11.1	2,233,257	10.4
Corn	11.3	1,226,356	5.7
Sorghum	7.0	888,195	4.1
Dairy Cattle	5.1	791,349	3.7
Wheat	7.5	786,094	3.6
Forage Crops	6.5	710,349	3.3
Soybeans	6.0	569,936	2.6
Poultry	4.6	473,904	2.2
Vegetables	4.4	372,193	1.7
Sheep & Wool	1.0	180,090	.8
Other Small Grains	1.1	102,767	.4
Trees&Forest Products	1.4	94,653	.4
Sugar Crops	.4	46,454	.2
Other Oilseed & Oil Crops	.1	13,101	----
Total of Above	84.0	14,952,776	69.3
State Total	142.6	21,573,869	

TABLE 17

Scientist Years (SY) and Budget Expenditures for Research ($) on 15 Major Commodities, 1979

NORTH DAKOTA

Commodity	SY	$	Percent of State Total $
Wheat	15.7	1,440,702	14.4
Beef Cattle	9.0	699,986	7.0
Other Small Grains	9.1	664,389	6.6
Other Oilseed & Oil Crops	5.9	436,540	4.4
Swine	2.9	321,015	3.2
Forage Crops	4.0	295,824	3.0
Sheep & Wool	3.2	292,145	2.9
Sugar Crops	1.9	211,417	2.1
Dairy Cattle	1.8	193,706	1.9
Vegetables	1.6	150,133	1.5
Corn	1.8	130,698	1.3
Trees &Forest Products	1.0	100,891	1.0
Poultry	.4	88,682	.9
Soybeans	.8	51,950	.5
Sorghum	----	----	----
Total of Above	59.1	5,078,078	50.7
State Total	102.4	10,007,248	

OHIO

Commodity	SY	$	Percent of State Total $
Dairy Cattle	9.9	1,688,666	8.6
Beef Cattle	6.7	1,644,169	8.4
Soybeans	9.9	1,378,167	7.1
Swine	8.4	1,356,972	7.0
Vegetables	10.4	1,282,020	6.7
Corn	8.6	1,228,756	6.3
Poultry	6.6	1,022,270	5.3
Trees &Forest Products	8.4	730,526	3.8
Sheep & Wool	2.9	599,206	3.1
Forage Crops	2.3	371,146	1.9
Wheat	1.3	313,392	1.6
Sugar Crops	1.1	133,811	.7
Other Small Grains	.2	52,407	.3
Sorghum	---	----	---
Other Oilseed & Oil Crops	---	----	---
Total of Above	76.7	11,801,508	60.6
State Total	123.7	19,458,587	

TABLE 18

Scientist Years (SY) and Budget Expenditures for Research ($) on 15 Major Commodities, 1979

SOUTH DAKOTA

Commodity	SY	$	Percent of State Total $
Beef Cattle	16.7	873,257	13.5
Swine	6.5	396,449	6.1
Forage Crops	6.0	349,033	5.4
Other Small Grains	3.1	303,309	4.7
Dairy Cattle	4.1	274,834	4.3
Wheat	4.5	260,937	4.0
Corn	2.7	205,554	3.2
Sheep & Wool	2.6	143,248	2.2
Trees &Forest Products	2.8	140,021	2.2
Poultry	2.8	122,219	1.9
Other Oilseed & Oil Crops	1.7	92,395	1.4
Soybeans	.8	75,797	1.2
Vegetables	.7	57,420	.9
Sorghum	.1	5,044	.1
Sugar Crops	----	----	---
Total of Above	55.1	3,299,517	51.2
State Total	104.9	6,449,010	

WISCONSIN

Commodity	SY	$	Percent of State Total $
Dairy Cattle	10.9	2,797,514	11.4
Vegetables	11.2	1,183,095	4.8
Trees &Forest Products	11.4	957,669	4.0
Forage Crops	6.2	904,972	3.7
Beef Cattle	3.5	722,749	2.9
Swine	3.8	670,582	2.7
Poultry	4.0	669,620	2.7
Corn	3.2	518,033	2.1
Other Small Grains	1.9	339,657	1.4
Sheep & Wool	.7	234,804	1.0
Soybeans	2.0	233,218	.9
Wheat	.4	68,750	.3
Sorghum	---	----	---
Sugar Crops	---	----	---
Other Oilseed & Oil Crops	---	----	---
Total of Above	59.2	9,300,663	37.8
State Total	148.4	24,618,318	

Economic Returns to Agricultural Research

A lag of several years occurs typically between the time that research expenditures are incurred and their payoff occurs in the form of increased output, reduced costs or other forms of benefits to producers and/or consumers. Thus, in estimating the rates of economic returns to agricultural research, analysts must incorporate some lag-time structure between research costs and benefits. And, returns for research must be high enough to cover the time related costs of these lags between investment and the accrual of research benefits. For other research investments, the linkage between research investments and the benefits which they generate are not easily quantified. Examples of this are community development -,natural resource -, human nutrition - and even maintenance - related research. In the section which follows our measure of benefits is the increase in productivity which results from the research.

Annual Rates of Return

Numerous studies have estimated the annual rates of return for agricultural research in the U.S. to be high and well in excess of the returns available in alternative market investments. In fact, the large majority fall in the range of 35 percent or more and a number are in the rage of 75 percent plus.[4/] These high returns testify to the economic viability of agricultural research programs even in times of rapid inflation when high opportunity costs must logically be charged to funds allocated to such

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4/ For a comprehensive summary of historical rates-of-returns from agricultural research see Chapter 10. "The Economic Benefits from Agricultural Research" in Vernon W. Ruttan, Agricultural Research Policy, University of Minnesota Press, Minneapolis, 1982.

research. Also, several analysts have concluded that agricultural experiment station research support is being allocated reasonably efficiently at least over such major commodity categories as cash grains, dairy, livestock, and poultry.[5/]

Table 19 illustrates the annual percentage rates of returns estimated for research conducted over the past two decades for cash grains, dairy and livestock, all of which are of major economic importance in the North Central Region. These estimates represent conservative appraisals of rates of return for Experiment Station research since they are discounted by two-thirds to allow for unestimated contributions from private sector research and from extension education inputs. More disaggregative analysis by Miner (1982) estimates returns for soybean research to be in the 55 to 60 percent range.

Table 19. Internal Rates of Return to Experiment Station Research

Commodity Category	Internal Rate of Return %* 1969	1974
Cash Grains	47	69
Dairy	42	51
Livestock	89	106

*Calculated with constant prices and with an estimated average time lag between research expenditures and pay-off of 6 years. A longer time lag results in lower rates of return and a shorter time lag in higher rates.

Source: George W. Norton, "The Productivity and Allocation of Research: U.S. Agricultural Experiment Stations Revisited". North Central Journal of Agricultural Economics, Vol. 3, No. 1, January, 1981.

5/ See particularily the work by M. Bredahl and W. Peterson reported in "Experiment Station Research Productivity" American Journal of Agricultural Economics, Vol. 58, No. 4, Novermber, 1976. These conclusions are supported by the work of Norton (1981).

Clearly, the economic returns for the above listed categories of agricultural research are high both absolutely and relative to alternative market investment opportunities for funds. Also, assuming equally productive research programs between states, Norton's analysis indicates that the returns for research on cash grains are higher, for example, in Illinois and North Dakota than in Wisconsin and Michigan reflecting the greater importance of cash grains in the agricultural sectors of the two former states. On the other hand, returns to dairy research in Wisconsin and Minnesota are higher than in Illinois and Nebraska, again reflecting the relative importance of dairy in these several states. These findings represent another indication that large, productive research programs can generate high economic returns if they are directed to high-volume commodities.

Marginal Products from Corn, Soybeans and Wheat Research

Among the cash grain crops grown in the North Central Region, three are dominant: Corn, soybeans and wheat. In order to evaluate the productivity to research directed specifically for each of these three crops, we have estimated, for 1979, the level of output value of these crops as a function of the inputs used in their production including land, labor, machinery, fertilizer, pesticides and research expenditures, the latter lagged by six years.[6/] In addition, we have included a variable to measure the research expenditures made for each of these three crops in neighboring states within the same general production region. The latter topic will be discussed in more detail later under the heading of "spillover".

6/ The results of this analysis are presented in Hendrickson and Sundquist, 1982.

In brief, we estimated the marginal product (value of commodity output in 1979 associated with the last dollar of research expenditures for that commodity in 1973) to be about $150, $180 and $360, respectively for corn, wheat, and soybeans. A major expansion in export demand for food grains, feed grains and oil seed crops in the 1970's clearly helped to generate the extremely high productivity rates for public research expenditures for these crops. And, other basic and non-commodity-specific research undergirded the commodity-specific research. The major conclusion is, however, clear. Big gains in crop output and value are attributable to public research investments.

Distribution of Research Benefits

Both the high rates of return from past agricultural research and the large marginal products associated with recent research expenditures suggest a substantial underfunding of agricultural research in the North Central Region. This underfunding probably results mainly from three factors:

1) the spillover of research benefits beyond the boundaries of states in which the research is financed and conducted
2) the spillover of benefits from producers to consumers and
3) the large volume and wide variety of projects and programs which compete for public sector funding.

Spillover Between States

A high portion of the research conducted in an individual State Agricultural Experiment Station has productivity impacts in other states as well. This is particularily true for scientific research, but also for technology - oriented research relating to crop and livestock commodities.

Some credible estimates indicate that only about one-third of the productivity from science - oriented research and perhaps up to two-thirds of the productivity from technology - related research is realized within the state undertaking the research.[7/] Our own analysis for corn and soybeans suggests that, in very general terms, three-fifths and four-fifths, respectively, of the research related productivity for these crops comes from research conducted within the state where utilized and the balance is spilled in from research conducted in other states.

The spillover (spill out and spill in) of research benefits between states is a complex phenomenon and complicates the process of research planning and funding for individual states. And, it contributes to a hesitancy by states to fund research (1) in the expectation of losing some of the benefits of this research to other states and (2) in the hope that other states might provide the needed research. But, it also points up the importance of research related planning, coordination and communication on an interstate basis if the total pay-off from agricultural research is to be as great as possible.

7/ See, for example, Robert E. Evenson, Paul E. Waggoner, and Vernon W. Ruttan, "Economic Benefits from Research: An Example from Agriculture", Science 205 (September 14, 1979). Recent unpublished analysis by Garren and White also indicates that nationally about two-thirds of the total marginal product from research on cash grains is associated with research within the state where research is done and about one-third from research in other states. They found a smaller portion of spillover, however, for dairy research.

Spillover from Producers to Consumers

One of the most common misperceptions regarding agricultural research is that the producers are the only, or at least the main, beneficiaries of this research. In a free and competitive market and in the presence of both an inelastic demand for agricultural products and a slow growth in this demand, much of the research - based productivity gain in agriculture is quickly transferred to consumers in the form of lower product prices. And, only in the cases of an elastic demand and/or of rapid increases in demand, are the benefits of these productivity gains (in the form of reduced production costs and higher production volume) retained mainly by producers. Otherwise, increased production volume results mainly in consumer benefits in the form of a more-than-proportional decline in product prices.

The experience of recent years with respect to the incidence of benefits from research - induced productivity gains in agriculture is mixed. Clearly consumers have benefited greatly from efficiency gains in food production. Their gains have been both in the form of lower prices and broadened consumer choice. Innovative producers, the early adopters of new technology, have generally been able to capture a portion of the benefits of research - related productivity gains. And, most cash grain producers captured substantial benefits during the period of rapid growth in export demand during the 1970s. But with the low current grain prices, consumers are the major current economic beneficiaries of increased productivity in agriculture. Meanwhile, some government programs, such as the dairy price support program, have slowed the transfer of productivity related benefits to consumers and permitted producers to capture a significant portion of these benefits at least in the short run.

Of critical importance to our discussion is the fact that, although consumers have been major beneficiaries of productivity gains from agricultural research, they have not been a significant or effective voice in the support of financing this research. And, despite the fact that surplus production can depress producer prices in the short term, agricultural research is a continuous process which cannot be turned off and on without destroying its long-term effectiveness.

Competing Uses for Public Sector Funds

At both the state and federal levels of public sector financial appropriations, decision makers are faced with evaluating a broad set of programs and projects for financial support. Many of these activities such as transportation, housing, food aid, health services, education, national defense, R & D for alternative energy sources and many others are of very high social priority. And, most are strongly advocated by active support groups. Individually, and in the aggregate, these competing public sector activities probably contribute substantially to the underfunding of agricultural research. And at the federal level, farm price support and soil conservation programs are examples of activities which compete even more directly with agricultural research for financial support. It is virtually impossible to analyze the economic benefits from a broad range of competing public sector activities and compare them with the benefits from agricultural research. But, it may be feasible to broaden the evaluation base for agricultural research. Such a broadening beyond the estimation of marginal products and rates of return can include consideration of the impacts of agricultural research on consumer food costs, the distribution of benefits to

different income groups and the external impacts (particularily environmental impacts) of the agricultural technology generated by agricultural research. Evaluation of agricultural research is now moving in these directions. For example, recent assessment has been made of the impacts of agricultural research on consumer food expenditures (White, Eddleman and Purcell, 1980) this assessment indicates, for example, that agricultural research benefits all income groups of consumers through lower food prices. Absolute benefits are greatest for higher income groups who spend more for food, but, relative to family income, benefits are several times higher for low income families.

In Conclusion

Funding competition for alternative public sector projects in the North Central Region, as elsewhere, will be even higher in the future than in the past. Clearly, however, publicly funded agricultural research continues to exhibit high marginal earnings (both in terms of large marginal products and high rates-of-return) and the overall economic diagnosis still is one of severe "underfunding". Improved priority setting and effective coordination of research can help to minimize the impacts of this underfunding. But, increased "real" levels of research funding are strongly justified and needed if future productivity gains in production agriculture are to keep pace with future demand for farm products.

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