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**Cooperating Producers in Maine: A Summary Report of
the Characteristics of Participants in the Re-Integrating Crop
and Livestock Enterprises in Three Northern States Project**

by
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Cooperating Producers in Maine:
A Summary Report of the Characteristics of Participants in the
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Abstract

The purpose of this report is to document the on-farm collaborators located in Maine that are participating in the Initiative for Future Agriculture and Food Systems (IFAFS) sponsored Re-Integrating Crop and Livestock Enterprises in Three Northern States project. Farmers were selected based upon a purposive sampling structure that emphasized spanning the horizon from farms that are considering integration to those that are integrated through either a diversified on-farm integration or through coupled interactions between livestock and crop producers. Detailed surveys from twenty-seven farms are summarized and the producers classified according to the type and level of integration and the size of their operation. Representative descriptions of different sizes of coupled and on-farm integrators are presented. Future research will focus on generating prototypical enterprise budgets for these systems and developing whole farm models of integrated and specialized production.

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1. INTRODUCTION

Commodities and livestock historically were integrated in Maine, often being produced on the same farm. Farms have become increasingly specialized, focusing exclusively on the production of either crop or livestock products. Recently, some potato, dairy, and beef farms in Maine have experimented with re-integrating crop and livestock systems by coupled interactions between specialized farms or on-farm integration involving crop diversification. This has generated interest in the potential for re-integrating crop and livestock systems to improve profitability and to encourage tighter nutrient cycling. Typical integration involves application of manure on cropland used for production of commodities, livestock feed, or mixed vegetables.

Interviews with cooperating integrated farms in Maine and agronomic results for potato systems amended with manure suggest re-integrating livestock with crops may offer agronomic and socio-economic benefits to farmers. Benefits include reductions in fertilizer, increased crop yields, improved soil quality, options for herd expansion, and enhanced management skills by interaction with another producer. However using such integrated systems may be more costly due to increased management time for coordinating integration with another farmer.

This report documents the Maine on-farm collaborators participating in the Initiative for Future Agriculture and Food Systems (IFAFS) sponsored Re-Integrating Crop and Livestock Enterprises in Three Northern States project. Collaborators provide the basis for examining the economic and agronomic tradeoffs in crop and livestock integration. Producers are aggregated to a level that is broadly “representative” of different types and sizes of integrated farms. This paper documents the aggregated data used in representative models for future economic analyses and bio-economic modeling examining the profitability and feasibility of re-integration in Maine.

Cooperating farmers were selected based upon a purposive sampling structure that emphasized spanning the horizon from farms that were considering integration to those that are integrated through either diversified on-farm integration or through coupled interactions between livestock and crop producers. A purposive sampling structure was used to gather extensive production information from cooperators. Extension educators recommended cooperating farmers involved in the IFAFS project. Farms are generalized to preserve anonymity. Farm acreages and most livestock numbers are rounded.

Maine cooperating farms are categorized as coupled or on-farm integrated. Coupled farms are specialized crop or livestock operations integrating livestock with crops in a complementary relationship with another coupled producer. On-farm integrated farms have both a livestock and diverse crop enterprise on farm and are internally integrated. Diverse crops include commodities like barley, oats, and soybeans as well as mixed vegetables like tomatoes, sweet corn, pumpkins, and winter squash.

Section two provides a background of the Maine potato, dairy, and beef industries to motivate the potential for crop and livestock integration. Re-integrating crop and livestock systems may be limited by the current spatial separation of the potato and dairy industries. Integrated farms cooperating in this project constitute a small percentage of potato (1.2%) and dairy (2.5%) farms. One integrated beef farm is involved in the project. Section three summarizes farm acreages, locations, and livestock numbers for representative integrated farms. Section four describes production characteristics for different sizes of coupled and on-farm integrated potato, dairy, and beef farms.

2. DISTRIBUTION OF MAINE POTATO, DAIRY, AND BEEF FARMS

Potato farms are concentrated in Aroostook County while the bulk of the dairy industry is in the dairy belt in central and south central Maine (Figure 1). Potato farms shown in Figure 1 were geo-coded using a 1998 mailing list obtained from the Resource Economics and Policy (REP) department at the University of Maine. No potato farm addresses are available for 2001. Dairy farm addresses in 2001 are from the Maine Milk Commission. Geo-coded points for both dairy and potato farms are farmer addresses and may not correspond with actual farm centroids.

There are 582 potato farmers provided by the 1998 mailing list. This number of producers is slightly less than the 586 Maine potato farms cited by the 1997 Census of Agriculture. Of the initial 582 farmers, 495 were successfully geo-coded (Figure 1). A total of 437 Maine dairy farms in 2001 were address matched by Aimee Rioux, a former graduate student in REP. These 437 dairy farms are 36% less than the 685 farms surveyed by the 1997 Census.

A. Potato Farms

Potato farms in Maine have declined over the past few decades. From 1964 to 1997, the number of potato farms in Maine decreased from approximately 4052 to 586 according to the 1997 Agricultural Census. Total harvested acreage also decreased from about 131,000 acres to 73,000 acres from 1964 to 1997. During this same time, potato

Table 1: Maine potato farms and acreages (1997 and 1998).

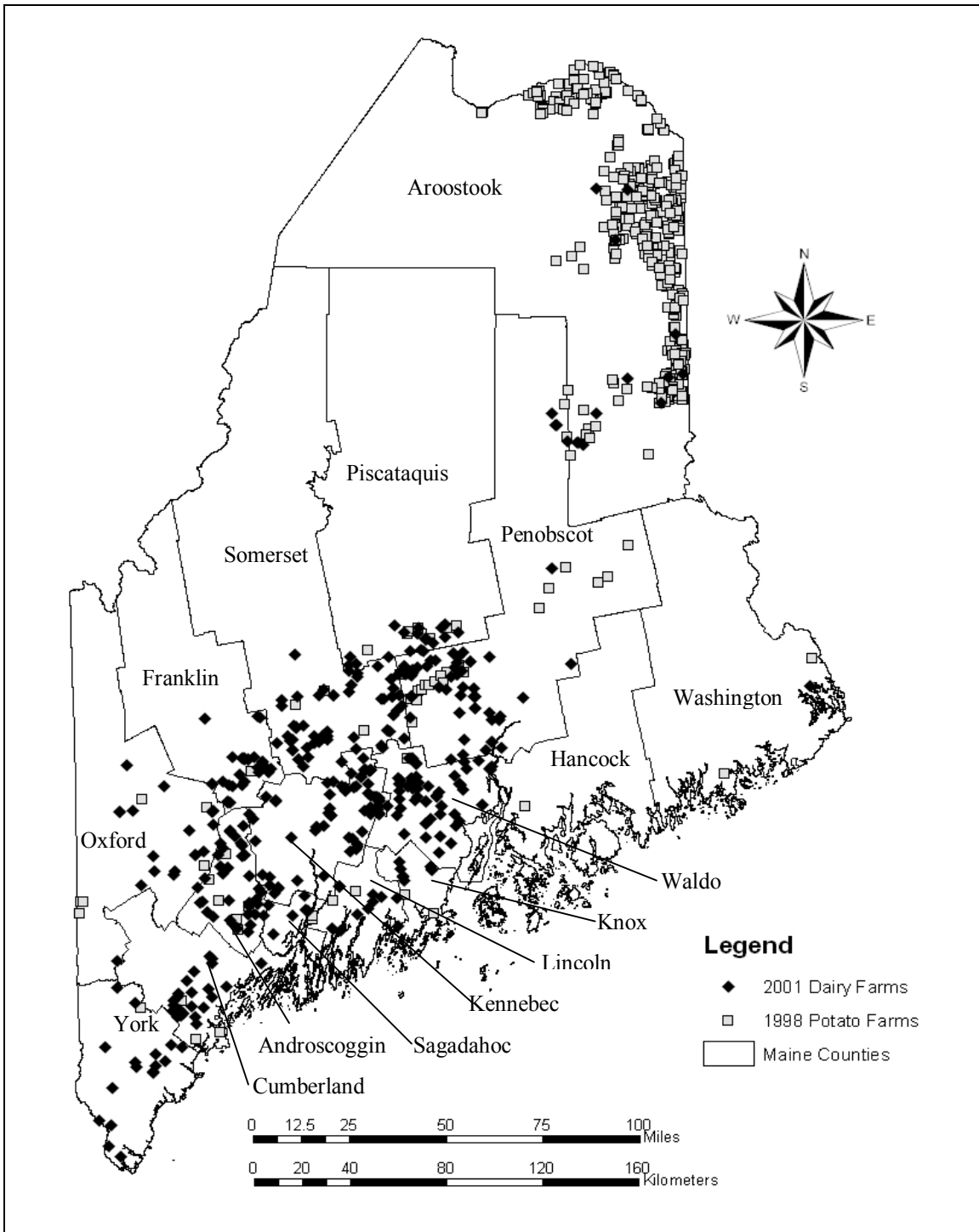
County	Farms ^a (1997)	Farmers ^b (1998)	County Totals		Potatoes ^a (acres)	Potato Farm Averages	
			Geo-coded Farmers (1998)	Potato Farm Cropland ^{ac} (acres)		Cropland ^{ac} (acres)	Potato Acreage ^a
Androscoggin	12	6	6	196	196	16	16
Aroostook	416	514	433	112,864	65,454	271	157
Cumberland	9	4	4	26	(D)	3	(D)
Franklin	5	1	1	22	22	4	4
Hancock	12	1	1	30	11	3	1
Kennebec	14	1	1	691	9	49	1
Knox	4	2	2	(D)	(D)	(D)	(D)
Lincoln	8	3	3	29	7	4	1
Oxford	18	6	6	2,878	1,919	160	107
Penobscot	34	29	23	7,133	4,007	210	118
Piscataquis	12	8	8	543	444	45	37
Sagadahoc	3	--	--	(D)	(D)	(D)	(D)
Somerset	4	3	3	619	(D)	155	(D)
Waldo	9	2	2	16	16	2	2
Washington	11	2	2	28	28	3	3
York	15	--	--	13	(D)	1	(D)
MAINE	586	582	495	127,216	73,085	217	125

^a Data from 1997 Agricultural Census for all surveyed farms (USDA-NEASS, 1997).

^b Data from University of Maine Resource Economics and Policy potato farmer mailing list.

^c Cropland includes potatoes, barley, oats, and grain corn. Wheat and rye grain not included since acreage for these crops are minimal. Some crops not included in sum due to disclosure (D).

Figure 1: Maine potato farms in 1998 and dairy farms in 2001. Farms are geo-coded farmer addresses and may not represent farm centroids.



production dropped from about 35,250,000 to 19,490,000 cwt (USDA-NEASS, 1997). Average potato acreage per farm increased during this time from about 32 to 125 acres. When only those farms with revenues greater than \$10,000 are considered, average acreage for potato farms in Maine in 1997 increases to 145 acres.

Potato farms by county from the 1997 Census of Agriculture are compared to potato farmers from the 1998 REP mailing list and those that were successfully geocoded in Table 1. Farmer addresses overestimate the Census numbers in Aroostook County, while underestimating them in all other counties, so the spatial representation of potato farms may not be accurate. Total farm and potato acreages, average farm size, and average potato farm acreages are also shown from the 1997 Census (Table 1). Total potato farmland is estimated by adding acreages for common rotation crops such as barley, oats, and grain corn to potato acres.

According to Census data, about 78% of the potato farms and about 90% of the potato acreage in Maine are in Aroostook County. Penobscot County is second with about 5% of farms and acreage. Farm averages for size and potato acreage are simply estimated by dividing total potato farmland and acreages by the number of farms in each county. Average potato acreages for farms are largest for Aroostook, Penobscot, and Oxford Counties (Table 1).

B. Dairy Farms

Dairy farms in Maine have also declined over the past few decades. From 1964 to 1997, the number of dairy farms in Maine decreased from approximately 5414 to 685 according to the 1997 Agricultural Census. Between 1964 and 1997, the number of milk cows decreased from 75,582 to 40,749 (USDA-NEASS, 1997; Figure 2), while total Maine milk production decreased slightly from approximately 6,600,000 to 6,540,000 cwt from 1965 to 2001 (MSPO, 2003). Average number of cows per farm increased during this time from about 14 to 59. Stable milk production with fewer cows is attributed to higher productivity per cow. Herd averages increased during this time.

Maine dairy farms, milk cows, annual fluid milk output (cwt), and average number of cows and herd averages for all counties in 2001 are shown in Table 2. Maine Milk Commission data from 2001 are used since these data are more detailed than the 1997 Census. Farm numbers decreased in all counties from 1997 to 2001. Dairy farms are concentrated in Kennebec, Somerset, Penobscot, Waldo, and Androscoggin counties. Aggregate milk output corresponds to farm numbers with the exception of Franklin and Piscataquis counties. Piscataquis County with 19 farms has about 45% higher aggregate milk production than Franklin County with 27 farms. This appears to be due to the relatively larger herd average in Piscataquis County compared to Franklin County. Herd averages are highest in Somerset County followed by Piscataquis, Kennebec, and Penobscot counties.

C. Beef Farms

Beef farms in Maine have remained relatively stable over the past few decades. From 1964 to 1997, the number of Maine beef farms decreased from approximately 1295 to 1035 according to the 1997 Census of Agriculture. Over the same time, the number of

Table 2: Dairy farm numbers, milk output, milk cows, average number of cows per farm, and herd average for Maine counties (1997 and 2001).

County	Farms ^a (1997)	Farms ^b (2001)	County Totals		Dairy Farm Averages			
			Dairy Farm Cropland ^c (acres)	Milk Cows ^b	Annual Milk Output ^b (cwt)	Cropland ^c (acres)	Milk Cows ^b	Herd Avg. ^b (cwt)
Androscoggin	67	39	7,282	2,853	579,620	187	73	203
Aroostook	47	12	1,945	762	161,609	162	64	212
Cumberland	42	23	2,851	1,117	220,130	124	49	197
Franklin	44	27	2,757	1,080	188,513	102	40	175
Hancock	2	--	--	--	--	--	--	--
Kennebec	84	73	17,254	6,760	1,535,920	236	93	227
Knox	12	8	707	277	58,765	88	35	212
Lincoln	21	12	1,728	677	116,800	144	56	173
Oxford	37	20	2,453	961	200,069	123	48	208
Penobscot	91	63	14,498	5,680	1,231,636	230	90	217
Piscataquis	31	19	2,889	1,132	273,445	152	60	242
Sagadahoc	15	7	1,059	415	79,935	151	59	193
Somerset	81	60	12,479	4,889	1,224,923	208	81	251
Waldo	76	56	9,947	3,897	809,499	178	70	208
Washington	4	1	153	60	5,475	153	60	91
York	31	17	2,047	802	164,250	120	47	205
MAINE	685	437	80,049	31,292	6,850,589	183	72	218

^a Data is from 1997 Agricultural Census for all surveyed farms (USDA-NEASS, 1997).

^b This is from 2001 Maine Milk Commission data. Milk cows do not include dry cows, heifers, and calves. The herd average is the average annual production of milk per milk cow.

^c County dairy farm cropland and average cropland are estimated assuming a requirement of 2.55 acres of some combination of corn silage, haylage, and hay per milk cow. Numbers of milk cows in 2001 are used.

beef cows increased from 9167 to 11,782 (USDA-NEASS, 1997; Figure 2). Average number of beef cows per farm increased slightly over this period from 7 to 11. Maine county data on beef farms, cows, and estimated cropland are shown in Table 3.

Figure 2: Maine dairy and beef cow numbers from 1964 to 1997 (USDA-NEASS, 1997).

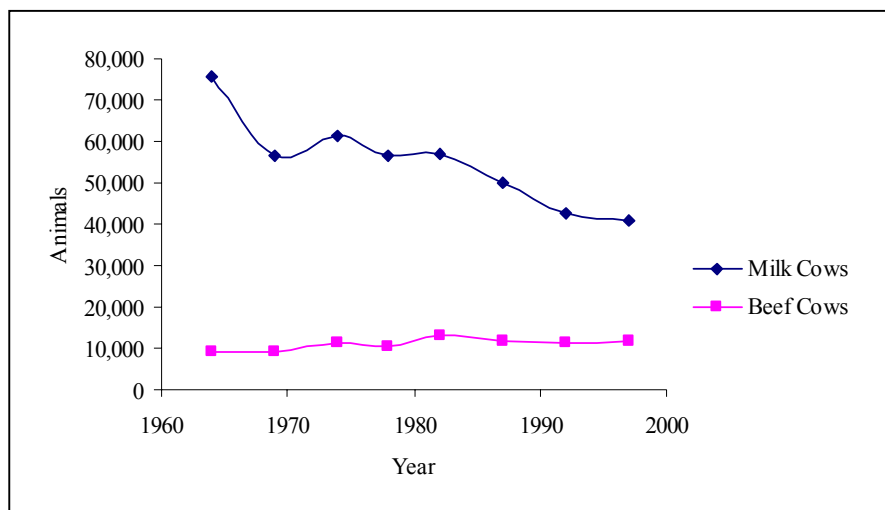


Table 3: Beef farm numbers, cows, and average number of cows per farm for Maine counties in 1997.

County	Farms ^a (1997)	County Totals		Beef Farm Averages	
		Beef Farm Cropland ^b (acres)	Beef Cows ^a	Beef Farm Cropland ^b (acres)	Beef Cows ^a
Androscoggin	58	1,022	511	18	9
Aroostook	147	5,790	2,895	39	20
Cumberland	100	2,864	1,432	29	14
Franklin	52	896	448	17	9
Hancock	34	(D)	(D)	(D)	(D)
Kennebec	103	2,208	1,104	21	11
Knox	31	848	424	27	14
Lincoln	39	728	364	19	9
Oxford	90	1,426	713	16	8
Penobscot	73	1,394	697	19	10
Piscataquis	24	770	385	32	16
Sagadahoc	27	850	425	31	16
Somerset	73	1,676	838	23	11
Waldo	52	984	492	19	9
Washington	22	(D)	(D)	(D)	(D)
York	110	1,536	768	14	7
MAINE	1,035	23,564	11,782	23	11

^a Data from 1997 Agricultural Census for all surveyed farms (USDA-NEASS, 1997).

^b County beef farm cropland and average cropland are estimated assuming a requirement of 2 acres of some combination of haylage, hay, and pasture per beef cow and that no concentrated feeds are grown on farm.

Beef farm numbers are highest in Aroostook, York, Kennebec, and Cumberland counties. However, Aroostook beef farms have the largest number of cows and herd size compared to all other Maine counties (Table 3). Beef farms in Maine can be one of or a combination of three farm types. These types are cow/calf operations, stockers, and finishers (MDA, 2003).

3. INTEGRATION CHARACTERISTICS OF COOPERATING PRODUCERS

Locations of all twenty-six cooperating farms are shown in Figure 3. Farms are categorized as coupled, on-farm integrated, and potential integrators. Coupled farms are either specialized potato or livestock farms that are involved in exchanging manure for forages. This usually involves coupled farms swapping ground. On-farm integrators are dairy operations growing sweet corn and mixed vegetables or a potato farm with a livestock component. Potential potato and dairy farms are interested in integration even though actual implementation has been limited.

Cooperating producers are aggregated into small, medium, and large sized representative farms. Relative acreages and livestock numbers for representative farms with coupled and on-farm integrated categorizations are shown in Table 4. All data are from 2001. The 19 integrated farms in Table 4 do not include four potential integrators and three coupled farms with insufficient data. Manures generated and/or used on farm

Figure 3: Maine cooperating farms classified as coupled, on-farm integrated, or potentially interested in crop and livestock integration. The on-farm integrated classification represents the farm's dominant enterprise.

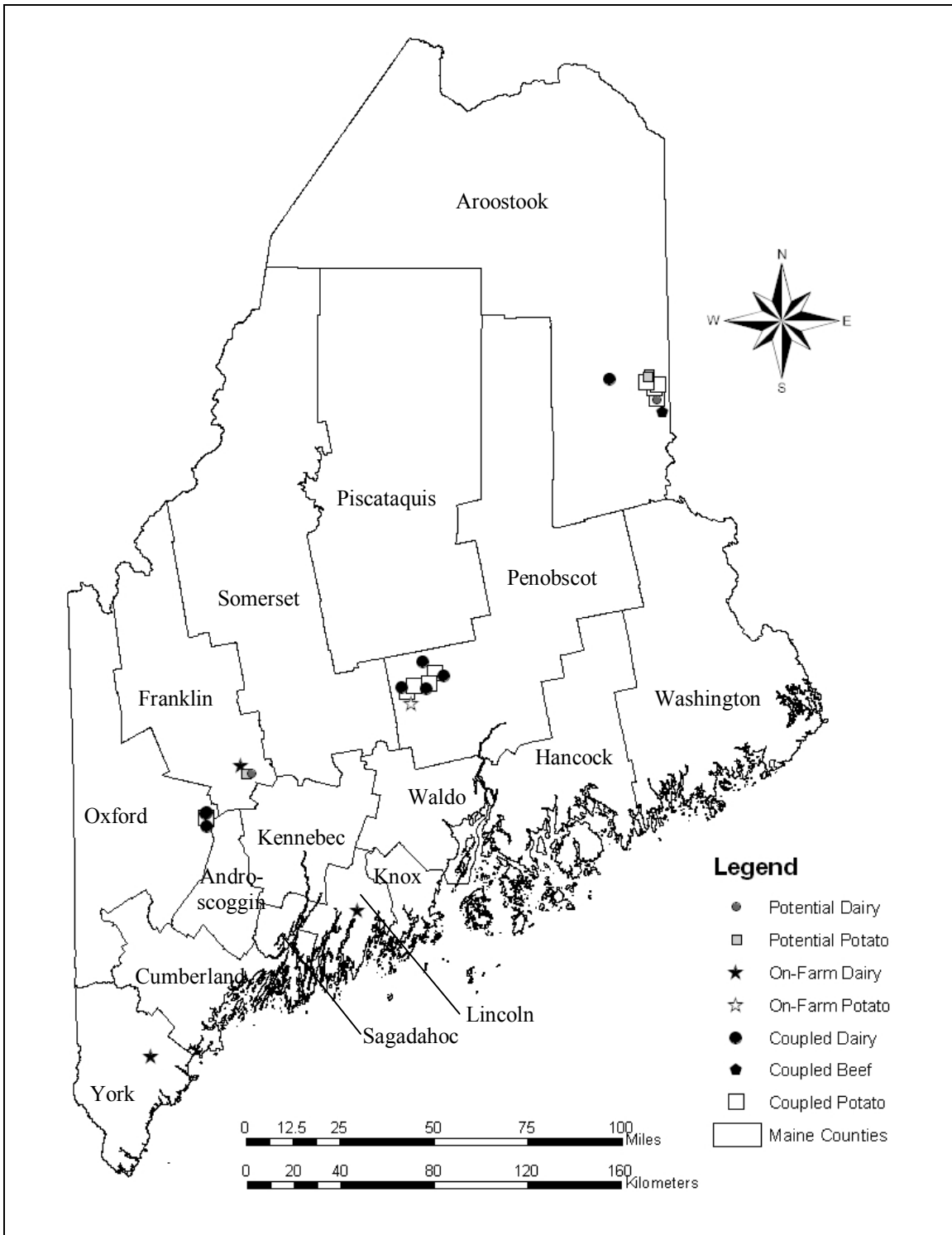


Table 4: Integrated farm categorizations, manure type, milk cows, acreages, and integrated cultivated ground.

Integrated	Type	Size	Manure ^a	Farms	Milk Cows	Average Acreage				Cultiv. Integ.		
						Total	Crops	Cultiv.	Potato			
Coupled	Potato	S	Dairy (L), Beef (S)	2	--	925	763	499	160	321	64%	
		M	Dairy (L/S)	3	--	931	590	501	316	141	28%	
		L	Dairy (L)	1	--	(D)	(D)	(D)	(D)	(D)	19%	
	Dairy	S	Dairy, Hen (S)	3	59	318	184	86	--	57	66%	
		M	Dairy (L/S)	2	127	714	532	322	--	45	14%	
		L	Dairy (L)	3	385	961	584	434	--	180	42%	
	Beef	M	Beef (S)	1	(D) ^b	(D)	(D)	(D)	(D)	(D)	9%	
	On-farm	Pot./Dairy	S/M	Dairy (S)	1	(D)	(D)	(D)	(D)	(D)	(D)	28%
		Dairy/MV ^c	S/M	Dairy (S)	3	73	1142	650	317	--	262	83%
Integrated Total				19	1,805	16,151	11,003	7,672	2,592	3,062	40%	
Integrated Avg.				1	164 ^d	850	579	404	370 ^e	161	40%	

^a Manure is solid (S), liquid (L), or a combination of liquid and solid (L/S).

^b Data cannot be disclosed (D).

^c Includes both dairy and mixed vegetable components.

^d Milk cows averaged only for dairy farms.

^e Potato acreage averaged only for potato farms.

are listed by type. All hen manure is from large egg facilities. Hen and beef manure are solid. Dairy manure is solid, liquid, or a combination of liquid and solid.

Total farm, cultivated, and potato acreages are listed along with the amount and percent of integrated acres on each representative farm (Table 4). Size classes for representative farms are based on cow numbers for dairy farms and potato acreage for potato farms. Representative farms are further described in section four. Total farm acreage includes forested and developed land. Crops include cultivated ground, hay land, and pasture. For coupled dairy and potato farms, the amount and percentage of cultivated acreage that is integrated is the potato acreage involved in the coupled relationship. For one potato farm that grows forages for the dairy farm it is coupled with, the amount and percentage of cultivated land correspond to potato and corn silage acreage involved in rotation. For on-farm integrated farms, the amount and percentage of cultivated land that is integrated is the acreage of tillable crops receiving manure.

Coupled farms have varying amounts of their cultivated land that is integrated. Cultivated land is tilled growing crops like potatoes, corn, and barley. Hay and pasture are not considered cultivated. Nine coupled farms have greater than one-third of their cultivated acreage that is integrated. These farms include three pairs of large coupled potato and dairy farms as well as three small dairy farms. The small dairy farms have most of their cultivated ground coupled with a potato farm. This potato farm is integrated on less than one-third of its potatoes and is also integrated with a large dairy farm.

Six coupled farms are integrated on less than one-third of tillable acreage. One is a dairy farm that is integrated with a potato farm integrated on more than a third of its potatoes. A potato and dairy farm are coupled on another farm's land. There is only one cooperating beef farm and it is integrated with two potato farms. There are four on-farm integrators. One of these is a potato farm with a dairy component. The other three farms

in the on-farm integrated category all have dairy components and grow varying amounts of sweet corn and mixed vegetables in addition to forages. Potential integrated farms have had limited past integration or have expressed interest in integration. Two farms experimented with this at a plot level a few years ago. Two other farms have never been integrated but have discussed this possibility.

4. MAINE REPRESENTATIVE FARMS

Representative descriptions of production characteristics for different types of integrated farms are provided in this section. Representative farms illustrate the current production characteristics of different types and scales of integrated producers in Maine. These different integrated farm types included coupled dairy and potato farms categorized as small, medium, and large. Farm size classifications are based on number of milk cows for dairy farms and potato acreage for potato farms. On-farm integrated dairy farms have more diverse crop components to their operations. These diverse crop components include concentrates grown for farm milk cows or direct-marketed mixed vegetables. There is also an on-farm integrated potato farm with a dairy component.

Model farm representations are based on the integration classifications shown in Table 4. Production information for farms falling into each category are averaged or generalized and do not represent specific cooperating farms. Farms with only one farm falling in a classification category are described in a generalized fashion so as not to disclose confidential production data about that specific farm. The integrated farm types representing only one cooperating farm are coupled beef, large coupled potato, and on-farm integrated potato/dairy (Table 4). Cows milked by dairy farms include dry cows.

A. COUPLED POTATO FARMS

1) Small

Cooperating potato farms growing less than 200 acres of potatoes are classified as small. The representative small, coupled potato farm grows potatoes in rotation with either barley or corn silage. Corn silage is grown under a coupling arrangement with a nearby dairy farm. One farm raises forage for sale to a dairy farm with which it is coupled. Total farm acreage is about 925 acres, of which 30% are owned. Crops take up about 763 acres, while average cultivated ground is 499 acres. About 160 acres of potatoes are grown. Other crops include forages such as haylage and alfalfa.

Non-irrigated potato yields for different cultivars range from 158 to 262 cwt acre⁻¹. Irrigated yields range from 250 to 320 cwt acre⁻¹. Average barley and corn silage yields are about 50 bu acre⁻¹ and 15 tons acre⁻¹ respectively. Haylage yields are normally 9 tons acre⁻¹ off of two cuts. Alfalfa yields are about 4 tons acre⁻¹ for one cut off a newly established stand and about 9 tons acre⁻¹ for three cuts off a mature crop.

The typical small, coupled farm is integrated in either a potato-corn rotation with a dairy farm or a potato-barley-clover rotation with a feeder beef farm. Manure is not applied during the potato year. Typical liquid manure applications are about 5000 gallons acre⁻¹ on corn and about 4000 gallons acre⁻¹ on grass using spreader trucks. Manure on corn may be spring or fall applied, while manure on forage grass is applied during the fall. Beef manure is applied early during the clover year.

Integration with the dairy or beef farm has happened for a couple of years and involves land swapping. About 321 acres, or 64% of the representative farm's cultivated ground is integrated. More acres are devoted to integration for the small representative potato farm compared to larger coupled potato farms since more forages are grown that are integrated with potatoes. Forage acres are classified as integrated in addition to potatoes for one of the farms used to derive the representative small, coupled potato farm.

2) Medium

Potato farms growing between 200 and 450 acres of potatoes are categorized as medium in size. The medium-sized, coupled potato farm's acreage is about 931 acres, of which 61% is owned. Crops take up 590 acres and cultivated ground is 501 acres. About 316 acres of potatoes are grown. Smaller amounts of sweet corn, winter squash, and pumpkins are also grown. Non-irrigated potato yields for cultivars range from 215 to 230 cwt acre⁻¹. Irrigated yields range from 250 to 275 cwt acre⁻¹.

The potato farm has been integrated with a dairy farm from two to more than ten years. About 141 acres, or 28% of the farm's cultivated ground is integrated. The medium-sized potato farm is integrated in a potato-corn or a potato-corn-barley rotation. Manure is not applied during the potato year. Typical liquid manure applications are 4000 to 7000 gallons acre⁻¹ on corn and 4500 gallons acre⁻¹ on green chop barley. Manure on corn may be spring or fall applied, while manure on barley is applied during mid-summer.

3) Large

There is one large cooperating potato producer raising more than 450 acres of potatoes. The large, coupled representative potato farm grows various potato cultivars for processing and grain corn. Rotation is two-year potato-corn. Irrigation is used on most of the potato ground. Typical non-irrigated potato yields range from 215 to 250 cwt acre⁻¹, while irrigated yields vary between 250 to 320 cwt acre⁻¹. Typical grain corn yields are about 90 bu acre⁻¹. Recently, the farm has started to grow corn silage for a large dairy farm's expanding herd.

The coupled relationship with the large dairy farm involves exchanges of land and corn silage production for revenue and manure. The potato farm has also been coupled with three small dairy farms for a few years. These relationships involve land swapping and explicit trades of operations for manure. Liquid dairy manure is spring applied at rates of 7000 gallons acre⁻¹ for the corn year of the rotation. Solid dairy and hen manure are both applied between 5 to 11 tons acre⁻¹. About 19% of the large, coupled farm's acreage is integrated.

B. COUPLED DAIRY FARMS

1) Small

Cooperating producers milking less than 100 cows are classified as small. The representative small, coupled dairy farm milks about 59 Holsteins in either a tie stall or a small herringbone parlor. There are on average about 8 dry cows. Average milk production per cow, or the herd average, is about 206 cwt year⁻¹. There are a combined total of 64 heifers and calves. All forages are grown on-farm and concentrates are imported as a pellet grain mix. Total farm acreage is about 318 acres, with about 71% of

those acres owned. Average crop acreage is 184 acres, while average cultivated acreage is 86 acres. Crops include forages such as corn silage, haylage, and dry hay. Average corn silage yields are 18 tons acre⁻¹. Grass yields are typically a total of 8 tons acre⁻¹ of hay. Hay is harvested as 15 first cut round bales acre⁻¹ with a second crop of 100 square bales acre⁻¹ weighing 40 lb bale⁻¹.

Solid manure is bedded with sawdust. Manure storage includes either a pit or stacking pad. Solid dairy manure is spread with solid spreaders at a rate of 5 to 10 tons acre⁻¹ on corn and 5 to 7 tons acre⁻¹ on forage grass. The typical small, coupled dairy farm also uses hen manure from large egg facilities. Hen manure is applied at rates of 5 to 11 tons acre⁻¹ for corn and up to 5 tons acre⁻¹ for grass. Hen manure is delivered without charge to field stacking sites. Limited conventional fertilizers are used on crops.

The representative farm is integrated in a potato-corn rotation with a nearby potato farm. Manure is either spring or fall applied for corn and is not applied during the potato year. Land swapping is involved. Integration with the potato farm has occurred for a few years and prior to the current arrangement, the representative farm was integrated with a former potato farm that sold its land to the current potato grower. About 57 acres, or 66% of the representative farm's cultivated ground is integrated.

2) Medium

Dairy farms milking between 100 and 200 cows are classified as medium. The representative medium, coupled dairy farm milks about 127 Holsteins in a medium sized herringbone parlor. Farm herd average is about 208 cwt year⁻¹. There are 18 dry cows and a combined total of 107 heifers and calves. All forages are grown on-farm. Concentrates are imported as grain or are grown on-farm. Concentrates grown on-farm include barley and soybeans. Barley is crushed on-farm. Soybeans are trucked to a processor where they are crushed for oil with the meal returned to the farm for feed.

Total farm acreage is 714 acres, with 62% of those acres owned. Average crop acreage is 532 acres, while average cultivated ground is 322 acres. Major crops include forages such as corn silage, haylage, and alfalfa, in addition to the concentrates mentioned above. Average corn silage yields are about 16 tons acre⁻¹. Forage grass yields are about 6 tons acre⁻¹ for two cuts harvested as haylage. Alfalfa yields are about 13 tons acre⁻¹ for three cuts and both barley and soybeans yield about 76 bu acre⁻¹.

Manure is bedded with either sand or sawdust depending on the season. Liquid manure is primarily stored in pits, while solid manure is stored on a stacking pad. Typical liquid manure applications range from 4000 to 7000 gallons acre⁻¹ on corn and are applied at about 4000 gallons acre⁻¹ on forage grass using spreader trucks. Manure is fall or spring applied on corn, while it is applied during the mid-summer on grass. Solid dairy manure is spread on corn and grass with solid spreaders at rates ranging from 4 to 25 tons acre⁻¹. Application rates depend on soil tests. Conventional fertilizer use is reduced for manured crops. Fertilizer is also reduced if manure is spring applied.

The typical medium coupled dairy farm is integrated in a potato-corn rotation with a potato farm. Manure is spread for corn and not during the potato year. Integration may involve land swapping or land rental from a common owner. Integration with the potato farm has occurred for a couple of years. About 45 acres, or 14% of the representative farm's cultivated ground is integrated. Less acreage is devoted to integration for medium compared to other sizes of coupled dairy farms. One reason for

this is that the rest of the potato farmer's fields are beyond a feasible spreading and harvesting distance. Another reason is a lack of available potato acreage for integration since the potato farmer involved in coupling is integrated with a second dairy farmer.

3) Large

Cooperating dairy farms milking more than 200 cows are classified as large. The large representative, coupled dairy farm milks about 385 Holsteins in a large herringbone or parallel parlor. Farm herd average is about 229 cwt year⁻¹. There are about 49 dry cows and a combined total of 270 heifers and calves. All forages are grown on-farm and concentrates are imported as grain mixes. Total farm acreage is 961 acres, with 76% of these acres owned. Crops take up about 584 acres, while average cultivated ground is 434 acres. Crops include forages such as corn silage, haylage, green chop barley, and alfalfa. Typical corn silage and haylage yields are about 15 and 9 tons acre⁻¹ respectively. Green chop barley yields average about 6 tons acre⁻¹. Alfalfa yields are about 4 tons acre⁻¹ for one cut off a newly established crop and about 9 tons acre⁻¹ for three cuts off a mature stand.

Manure is primarily bedded with sand but sawdust is used for young stock. Most manure is stored in liquid pits. Typical liquid manure applications range from 5000 to 7000 gallons acre⁻¹ on corn and are applied at about 4000 to 6000 gallons acre⁻¹ on forage grass using spreader trucks. Manure on corn may be spring or fall applied, while manure on forage grass is either applied during the fall or in two summer applications. Liquid manure is spread on green chop barley in mid-summer at about 4500 gallons acre⁻¹. Spring applied manure on alfalfa is spread at rates ranging from 3000 to 4000 gallons acre⁻¹. Conventional fertilizer applications are reduced on crops receiving manure. Inorganic fertilizer applications are reduced for spring compared to fall manure.

The typical large coupled farm is integrated in either a potato-corn or a potato-corn-barley rotation with a potato farm. Manure is not applied during the potato year. Integration may involve land swapping. Integration with the potato farm has occurred from a couple of years to over a decade. About 180 acres, or 42% of the representative farm's cultivated ground is integrated. Less acreage is devoted to integration for large compared to small, coupled dairy farms since more crops involved in the rotation are grown for forage.

C. COUPLED BEEF FARM

The representative coupled beef farm is integrated with a nearby potato farm. The farm's herd is split fairly evenly between Angus and Hereford/Charolais cows and calves. The beef farm grows its own hay and haylage with some haylage sold to a local deer farm. Hay is baled as 800 lb round bales or 40 lb square bales. Haylage is baled as 1100 lb wet round wrapped bales. Cows are pastured during the growing season.

Solid beef manure is bedded with cedar shavings. Manure storage is a stacking pile. Solid manure is spread on most grass ground using a solid spreader at an average rate of about 10 tons acre⁻¹. Recently, the beef farm has been involved in a three-year rotation of potato-barley-clover with the potato farm. Manure is spread during the spring of the mammoth red clover year. The coupling arrangement involves land swapping. The coupled beef farm is integrated on only about 9% of its acreage.

D. ON-FARM INTEGRATED FARMS

1) Dairy/Mixed Vegetables

The representative on-farm integrated dairy and mixed vegetable farm is based on two small and one medium-sized dairy farms. These farms grow a diversified set of crops and have a livestock enterprise. The representative farm milks 73 cows in either a medium-sized herringbone parlor or a pipeline system in a tie stall barn. Farm herd average is about 188 cwt year⁻¹. There are about 15 dry cows and a combined total of 67 heifers and calves. All forages are grown on farm. Concentrates are both purchased and grown on-farm. Concentrates include soybeans, which are processed cooperatively with local farmers.

Total farm acreage is about 1142 acres, with about 71% of those acres owned. Average crop and cultivated acreage are 650 and 317 acres respectively. Major crops include forages such as corn silage, haylage, and alfalfa, in addition to concentrates previously mentioned. Average corn silage yields are 16 tons acre⁻¹. Haylage yields are about 5 to 8 tons acre⁻¹ for first cut. Second cut yields either 15 wet wrapped bales or 50 square bales acre⁻¹. Alfalfa yields are about 16 tons acre⁻¹ for three cuts, while soybeans yield about 70 bu acre⁻¹.

Other commodities grown include grain corn and oats, yielding about 144 and 60 bu acre⁻¹ respectively. Additionally, the representative on-farm integrated dairy farm grows sweet corn, winter squash, pumpkins, tomatoes, and various mixed vegetables. Mixed vegetables can include potatoes, peas, green beans, cucumbers, summer squash, zucchini, onions, lettuce, beet greens, broccoli, cauliflower, and peppers. Vegetables are sold on-farm, at farmer's markets, and at local stores. Diversification may also include enterprise as well as crop diversification.

About 262 acres, or 83% of the representative farm's cultivated ground is integrated. Manure is bedded with either sand or sawdust. Liquid manure is primarily stored in pits, while solid manure is stored on a stacking pad. Hen manure from large egg facilities may also be used on corn. Manure is either spring or fall-applied. Conventional fertilizer applications are reduced for manured crops.

If liquid dairy manure is used, it is applied at 5000 gallons acre⁻¹ on silage corn and forage grass using a spreader truck. Solid dairy manure applications on grain and silage corn are 5 tons acre⁻¹ with an additional 3 tons acre⁻¹ of hen manure. Solid spreaders are used. Solid manure is spread on forage grass and mixed vegetables at 10 tons acre⁻¹. Sweet corn receives either of the two previous types and amounts of manure. Manure is applied on alfalfa at rates of 8 tons acre⁻¹ respectively. Soybeans and oats are not manured.

2) Potato/Dairy

The representative on-farm integrated potato farm raises dairy replacements. It is classified as a medium-sized potato farm since it grows between 200 and 450 acres of potatoes. However, it is categorized as a small dairy farm since it raises less than 100 replacements. Several varieties of potatoes are raised for processing and forages are grown for the livestock. Some potato ground is irrigated. Non-irrigated yields range from 230 to 250 cwt acre⁻¹. Other crops include silage and grain corn, forage grass, rye, and barley. Typical silage and grain corn yields are 18 tons acre⁻¹ and 95 bu acre⁻¹.

respectively. Haylage is harvested in one cut of about 3 tons acre⁻¹. Rye and barley yield about 60 bu acre⁻¹.

This representative farm is on-farm integrated on about 28% of its acreage. Solid manure is bedded with sawdust and is stored on a stacking pad. Manure is usually spread on corn silage at a rate of about 20 tons acre⁻¹ during the spring using a solid spreader. Corn silage that gets manure gets spring-applied urea cut back from 100 to 50 lb acre⁻¹, while corn starter applications remain unchanged. The livestock component of the farm is managed as a separate operation.

5. SUMMARY

This report has documented representative production data for cooperating producers participating in the Maine activities of the Re-Integrating Crop and Livestock Enterprises in Three Northern States project. This information will be supplemented with existing data on dairy production (Dalton and Bragg, 2003) to complete the spectrum of non-integrated to integrated production. Additionally, information on the cost of producing potatoes in both a non-integrated and integrated situation will be derived from existing studies (Dalton, Porter and Winslow, 2003a; Dalton, Porter and Winslow, 2003b) and from data collected from cooperating potato farms.

This information will be used to create representative models of enterprise production budgets and will be aggregated and combined to produce whole farm models. Budgets are under construction and will be completed in the second half of 2003. Based upon the economic and biophysical characteristics of the models, the EPIC simulation model will be used to compare the long-run productivity of integrated and non-integrated production. The EPIC model will be used to develop ex-ante estimates of the long-run productivity of these systems. Economic performance of these systems will be evaluated based upon the dynamic evolution of farm production conditions.

6. REFERENCES

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