Whole-Farm Simulation of Organic Dairy Farms in Southern Brazil & Northeastern United States

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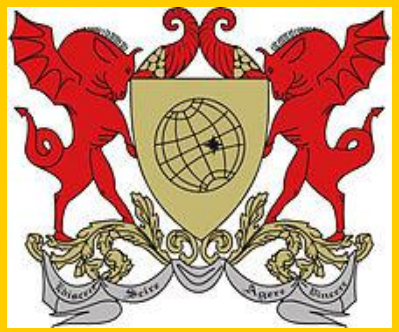


Outline

- **Organic Dairy Background**
- **Integrated Farm System Model (IFSM) Calibration & Assumptions for Brazil**
- **Simulated Forage & Concentrated Feed Crop Output Results**
- **Shifting Climate for Maine?**
- **Conclusions**
- **Future Improvements & Collaboration**

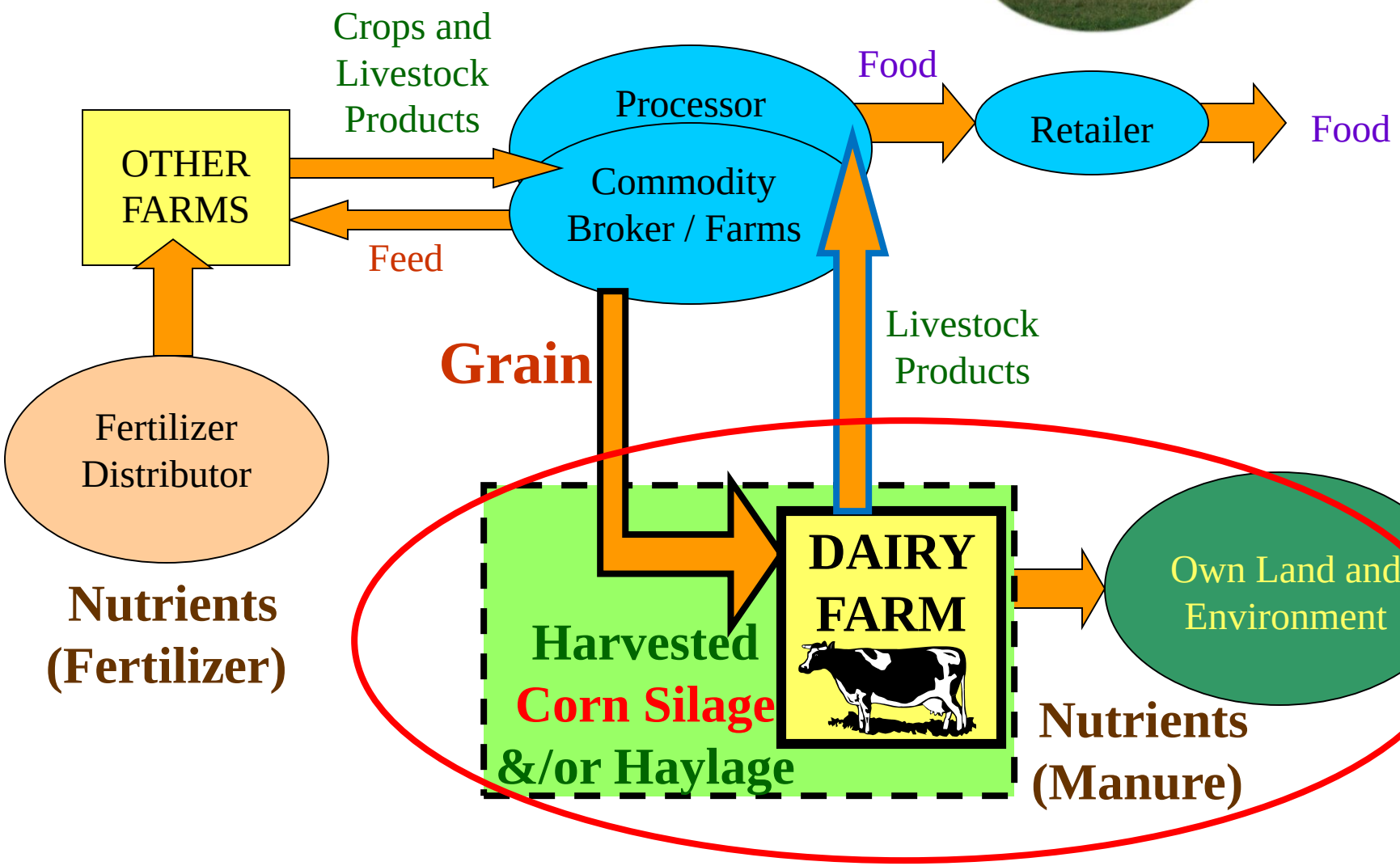
Organic Dairy Background

- **Recent growth of organic crops & dairy in both U.S.**  **& Brazil** 
- **Maine, U.S., has highest percentage of organic dairy farms** (~17% of dairy farms)
  - Transitioned from conventional
  - Some started from scratch

- **Brazil organic dairy throughout country but recent growth concentrated in Santa Catarina** *(Honorato et al. 2014)*

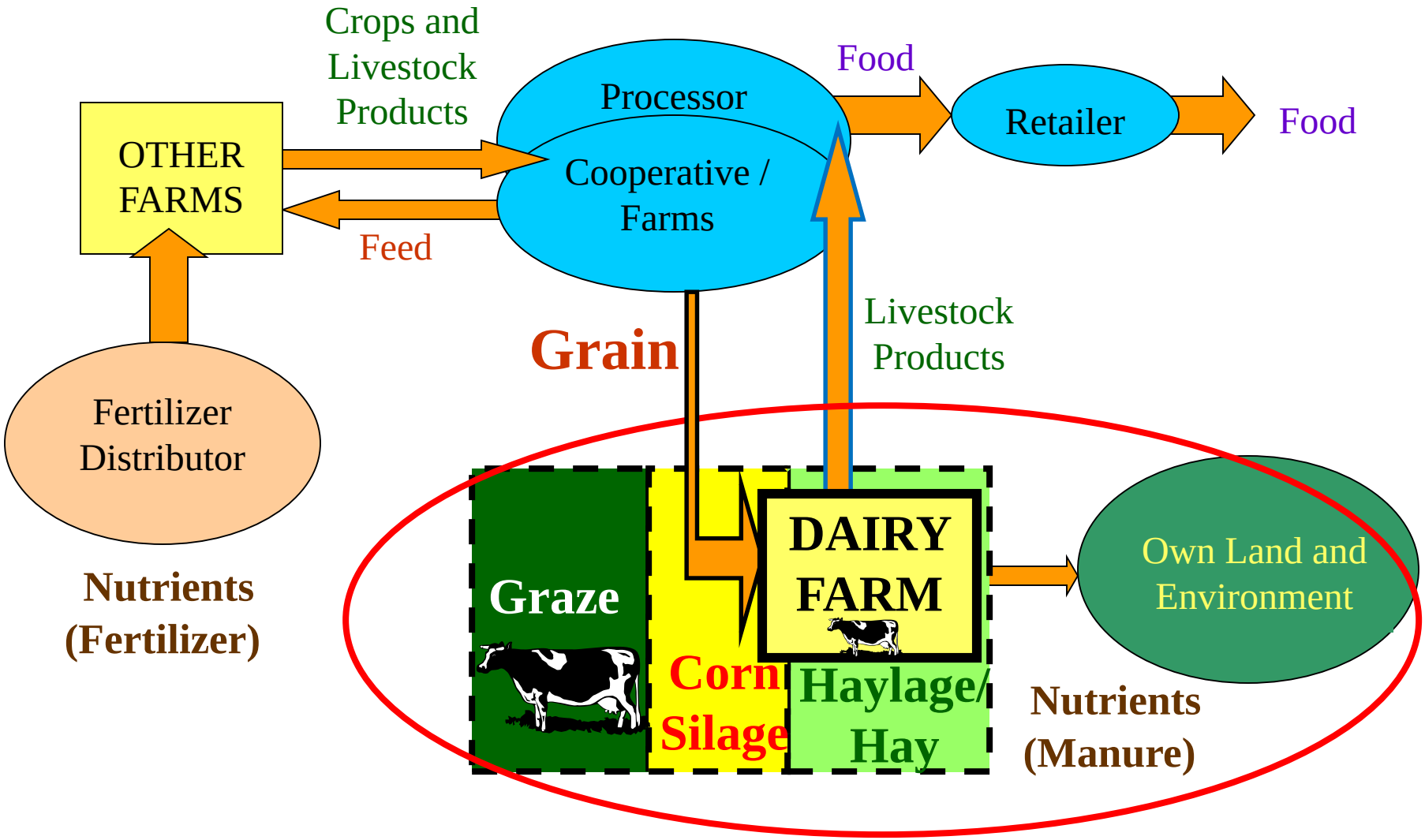
Conventional Dairy Farm

- **Conventional Dairy Farms**



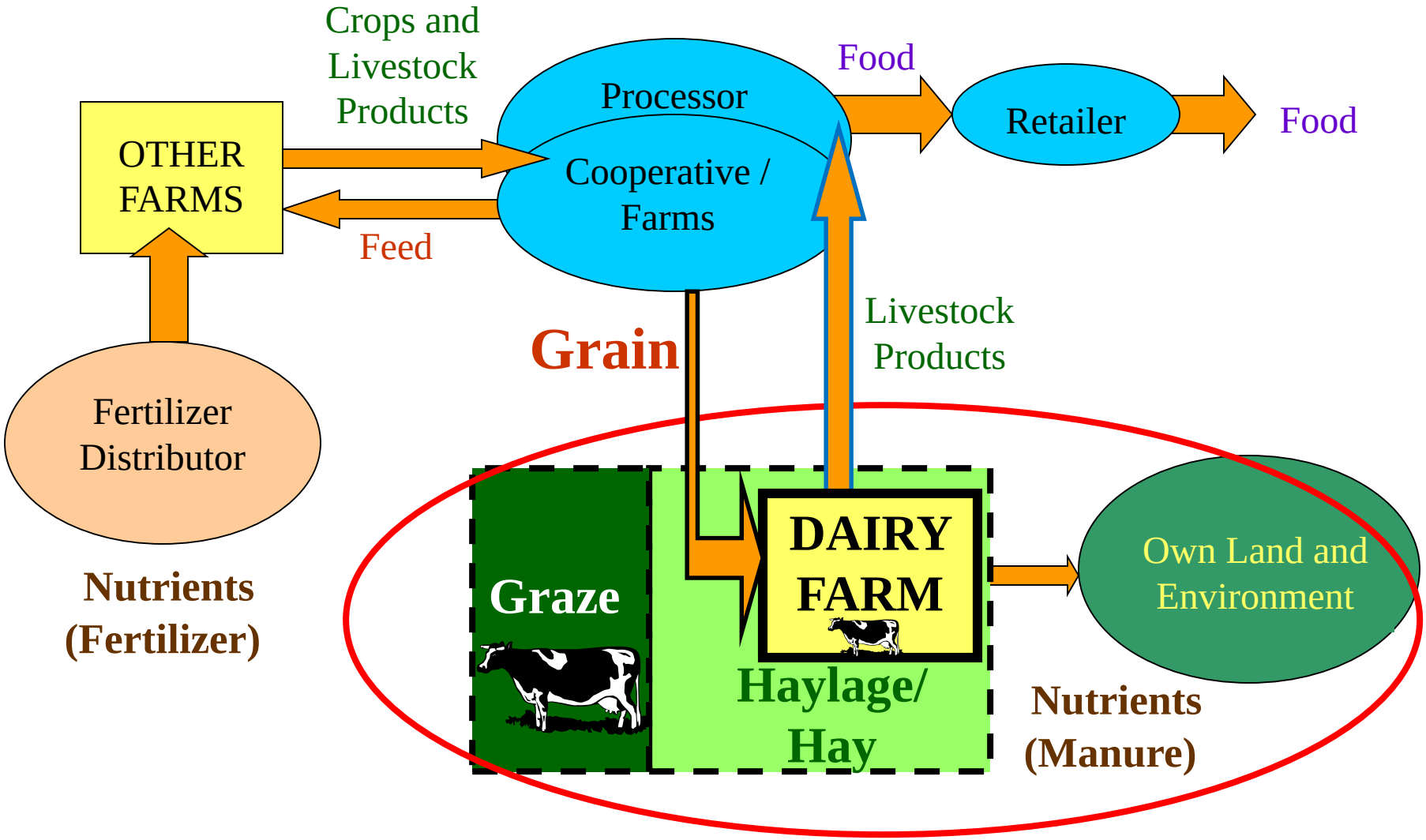
Organic Dairy Farm (Corn)

- **Organic Dairy Farms**



Organic Dairy Farm (Grass)

- **Organic Dairy Farms**



Maine Dairy Farms in the Dairy Belt

363 dairy farms

32,100 dairy cows

55.3 cows/farm

8,426 kg/cow/yr

• Potato Farms

Organic similar distribution w/ 61 dairy farms w/ 3,800 dairy cows & 61.5 cows/farm producing 5,689 kg/cow/yr

Fort Kent

Aroostook County

Presque Isle

Houlton

Waterville

Lewiston-Auburn

Bangor

Portland

Dairy Belt

• Dairy Farms

Legend

2001 Dairy Farms

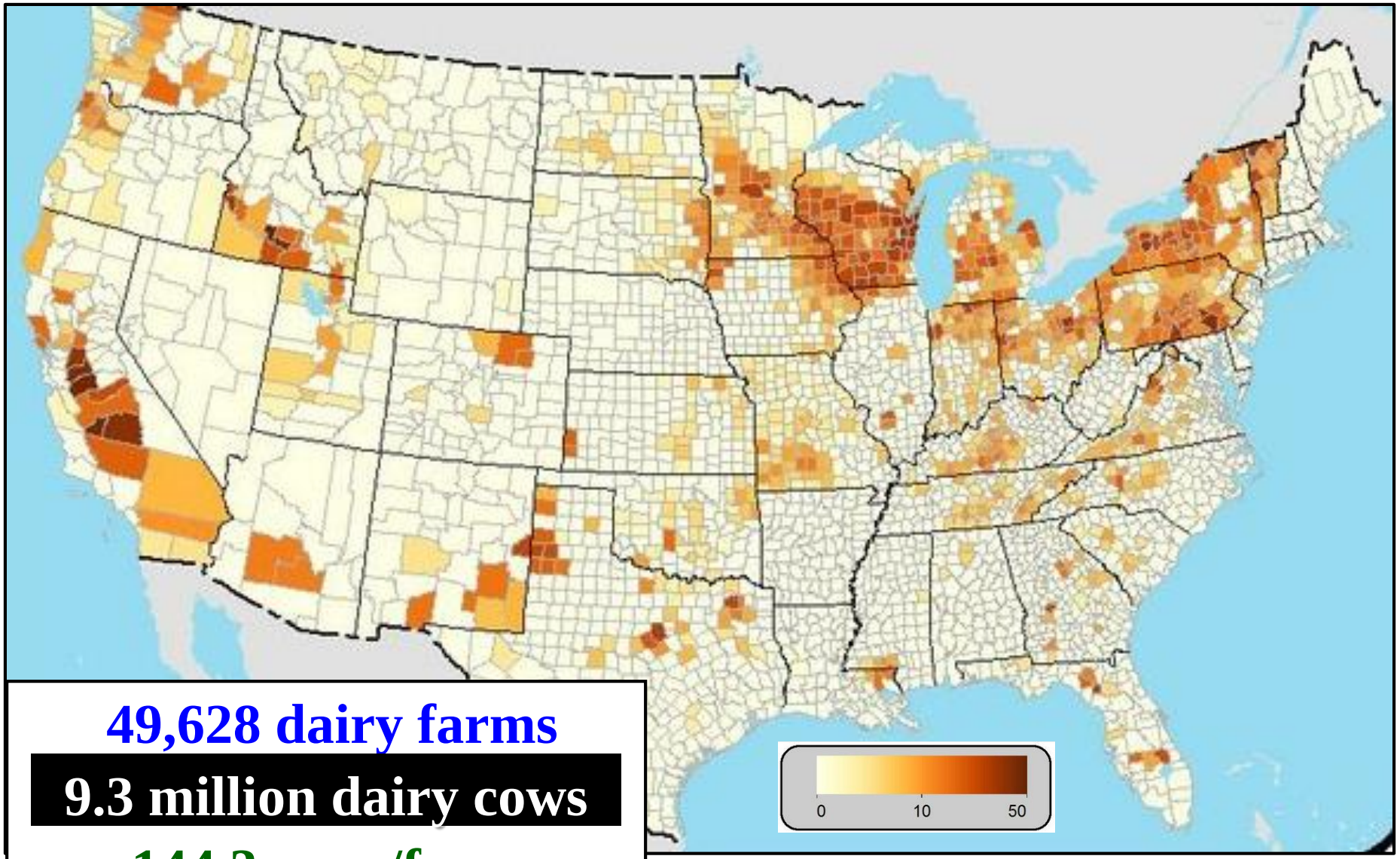
1998 Potato Farms

Maine Counties

0 12.5 25 50 75 100 Miles

0 20 40 80 120 160 Kilometers

U.S. Dairy Cows per Square Kilometer



49,628 dairy farms

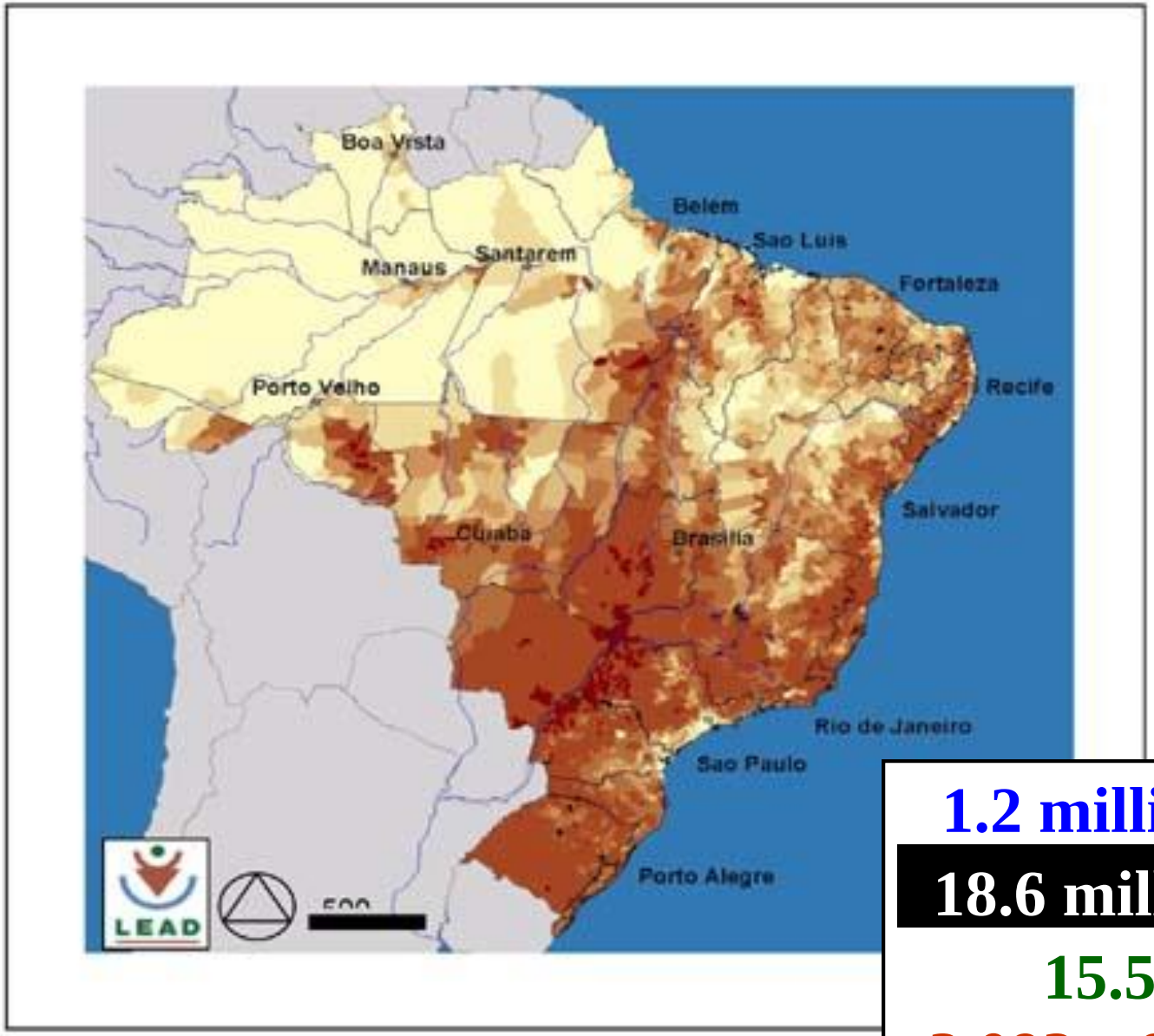
9.3 million dairy cows

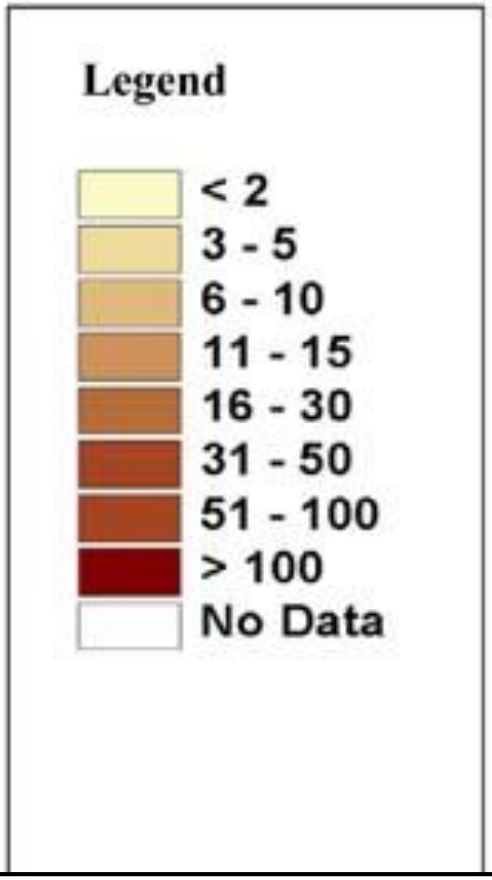
144.3 cows/farm

9,852 kg/cow/yr

Source: http://www.shamskm.com/blogs/wp-content/uploads/2012/07/map_of_dairy_farmers.jpg

Brazil Dairy Cows per Square Kilometer





1.2 million dairy farms

18.6 million dairy cows

15.5 cows/farm

3,092 – 9,244 kg/cow/yr

Source: P. Gerber, Livestock, Environment And Development (LEAD) Secretariat, FAO: http://www.fao.org/wairdocs/lead/x6170e/x6170e0c.htm

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- Integrated Farm System Model (IFSM) Calibration & Assumptions for Brazil
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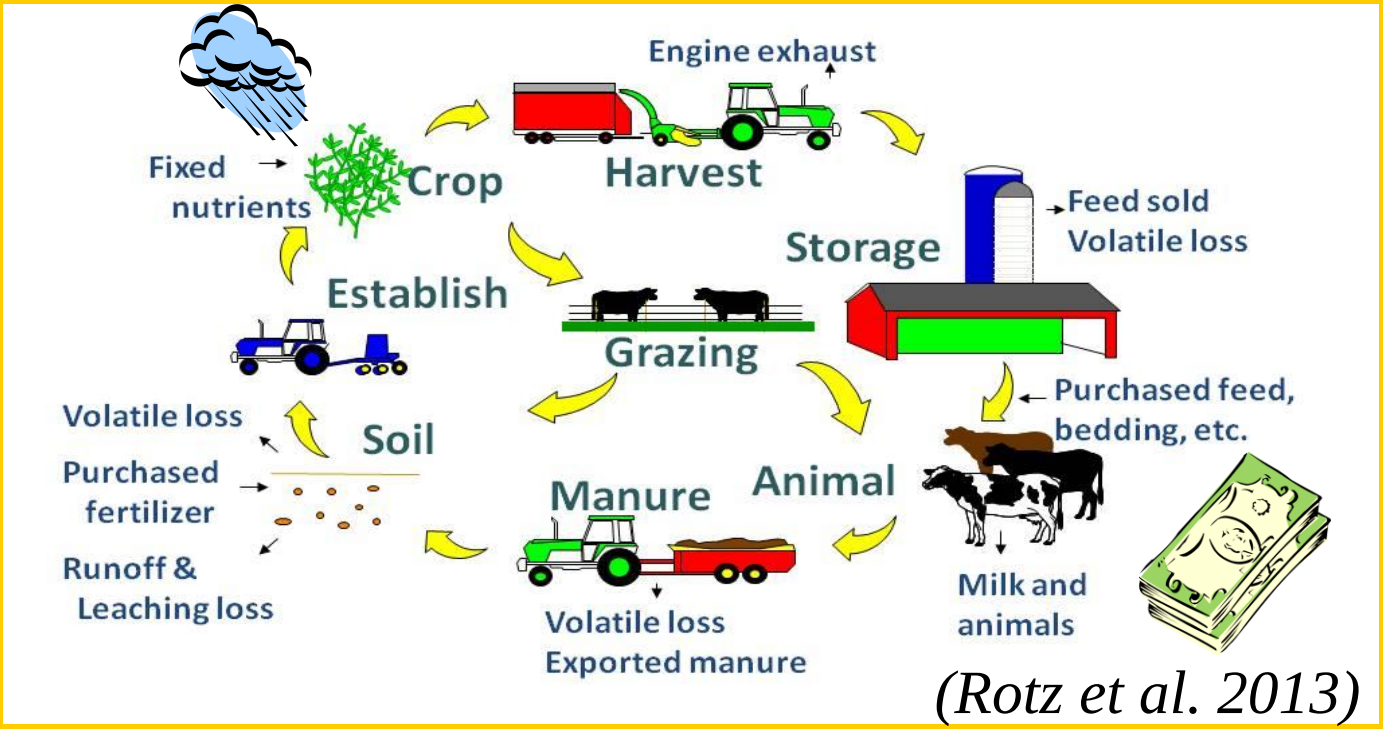
- Shifting Climate for Maine?
- Conclusions
- Future Improvements & Collaboration

Integrated Farm System Model *(IFSM)*

- **Developed by Dr. Al Rotz, USDA, ARS**
- **Whole-farm ruminant livestock & feed crop computer simulation model**

(Version 3.6 used; Version 4.0 just released)



(Rotz et al. 2013)

IFSM 3.6 Calibration & Assumptions

- **Grazing during growing season**
- **Concentrated feed purchased or grown**
- **3 organic (org.) stored feed systems**
  - ***LOW*** **– Grass silage only**
  - ***MEDIUM*** **– Grass - corn silage/winter wheat silage**
  - ***HIGH*** **– Grass – corn silage/winter wht.silage & soy**

- **Avg. org. milk yield**
  - **Brazil –** 3,153 kg/cow/yr *(Honorato et al. 2014)*
  - **Maine –** 6,531 kg/cow/yr *(Cook et al. 2010)*

IFSM 3.6 Calibration & Assumptions

- **All farms 30 Holsteins w/ 30 young-stock**
- **Modeled 2 locations in Brazil & 1 in ME**
- **Weather Files** – 26 years of daily T_{max}, T_{min}, precipitation & solar radiation
  - ***Chapeco, SC*** **– Created**

  - ***Pelotas, RS*** **– From Al Rotz**

  - ***Waterville, ME*** **– Updated**

- **Missing solar radiation est. w/ RadEst®**

IFSM 3.6 Crop Area for Models

Crop	Type	Chapeco SC (ha)			Pelotas RS (ha)			Waterville ME (ha)		
		Low	*Med.*	*High*	*Low*	*Med.*	*High*	*Low*	*Med.*	*High*
Graze 	Spr./Sum.	30	30	30	30	30	30	14	7.2	7.1
	Fall	30	30	30	30	30	30	28	14.4	14.1
Grass 	Haylage	35	17	17	22	10	10	14	7.2	7.1
Corn 	Silage	-	9.2	2.8	-	4.1	3.3	-	4.6	4.6
	Double Crop	-	6	5.6	-	2.9	2.9	-	3	3
Wheat 	Winter Silage	-	6	5.6	-	2.9	2.9	-	3	3
Soybeans 	Grain	-	-	0.7	-	-	0.7	-	-	2.6

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IFSM 3.6 Crop Yields per Area[a]

Crop	Type	Chapeco SC (t DM/ha)			Pelotas RS (t DM/ha)			Waterville ME (t DM/ha)		
		Low	*Med.*	*High*	*Low*	*Med.*	*High*	*Low*	*Med.*	*High*
Grass	Haylage	2.83	3.11	3.1	5.12	5.47	5.47	7.58	7.72	7.68
Corn	Silage	-	5.71	5.8	-	9.03	9.57	-	8.32	8.61
Wheat	Winter Silage	-	0.98	1.65	-	0.79	1.92	-	3.71	3.64
Soybeans	Grain	-	-	2.48	-	-	2.79	-	-	1.82

[a] Crop yields measured in metric tons (t) of dry matter (DM) per hectare (ha) for the growing season.

IFSM 3.6 Crop Yields per Milk Cow[a]

Crop	Type	Chapeco SC (t DM/cow)			Pelotas RS (t DM/cow)			Waterville ME (tDM/cow)		
		Low	*Med.*	*High*	*Low*	*Med.*	*High*	*Low*	*Med.*	*High*
Grass	Haylage	3.25	1.76	1.76	3.72	1.82	1.82	3.54	1.85	1.8
Corn	Silage	-	2.89	1.62	-	2.11	1.98	-	2.11	2.18
Wheat	Winter Silage	-	0.2	0.31	-	0.08	0.19	-	0.37	0.36
Soybeans	Grain	-	-	0.06	-	-	0.07	-	-	0.16

[a] Crop yields measured in metric tons (t) of dry matter (DM) per milk cow for the growing season.

IFSM 3.6 Graze & Purchased Feed[a]

Graze or Feed	Type	Chapeco SC (t DM) Low	Chapeco SC (t DM) Med.	Chapeco SC (t DM) High	Pelotas RS (t DM) Low	Pelotas RS (t DM) Med.	Pelotas RS (t DM) High	Waterville ME (tDM) Low	Waterville ME (tDM) Med.	Waterville ME (tDM) High
Graze	Season	97	97	97	102	102	102	88	70	68
Purchased Feeds	Grain	40	36	35	27	30	29	56	55	71
	Roast Soy	1	1	-	1	1	-	4	6	-
	Min./Vit.	1	1	1	1	1	1	2	2	2

[a] Grazing and purchased feed measured in metric tons (t) of dry matter (DM) for the year.

IFSM 3.6 Graze & Purchased Feed per Cow[a]

Graze or Feed	Type	Chapeco SC (t DM/cow) Low	Chapeco SC (t DM/cow) Med.	Chapeco SC (t DM/cow) High	Pelotas RS (t DM/cow) Low	Pelotas RS (t DM/cow) Med.	Pelotas RS (t DM/cow) High	Waterville ME (t DM/cow) Low	Waterville ME (t DM/cow) Med.	Waterville ME (t DM/cow) High
Graze	Season 	3.23	3.23	3.23	3.4	3.4	3.4	2.93	2.33	2.27
Purchase Feeds	Grain 	1.33	1.2	1.17	0.9	1.0	0.97	1.87	1.83	2.37
	Roast Soy 	0.03	0.03	-	0.03	0.03	-	0.13	0.2	-
	Min./Vit. 	0.03	0.03	0.03	0.03	0.03	0.03	0.07	0.07	0.07

[a] Grazing and purchased feed measured in metric tons (t) of dry matter (DM) per milk cow for the year.

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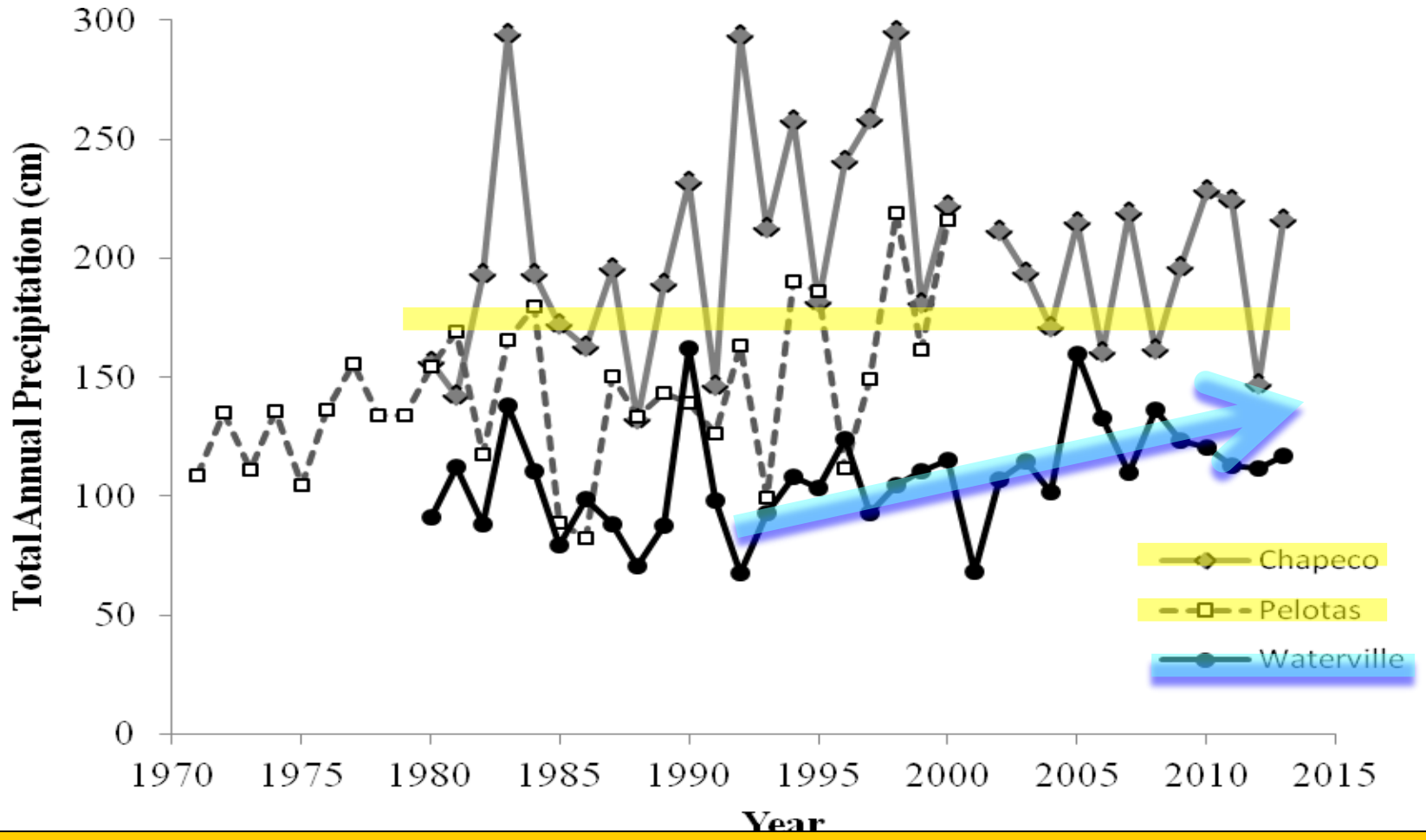
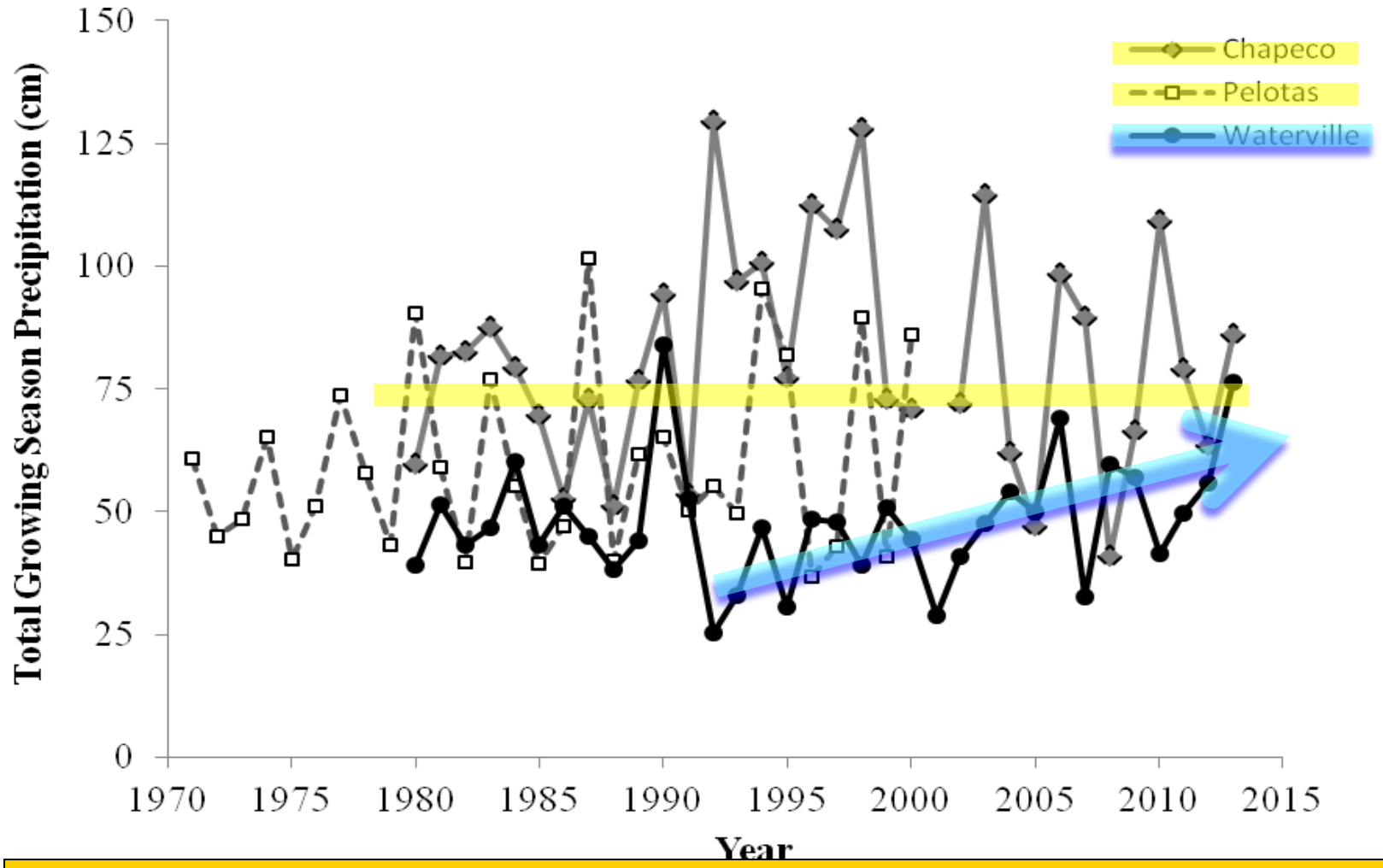
Shifting Climate for Maine?



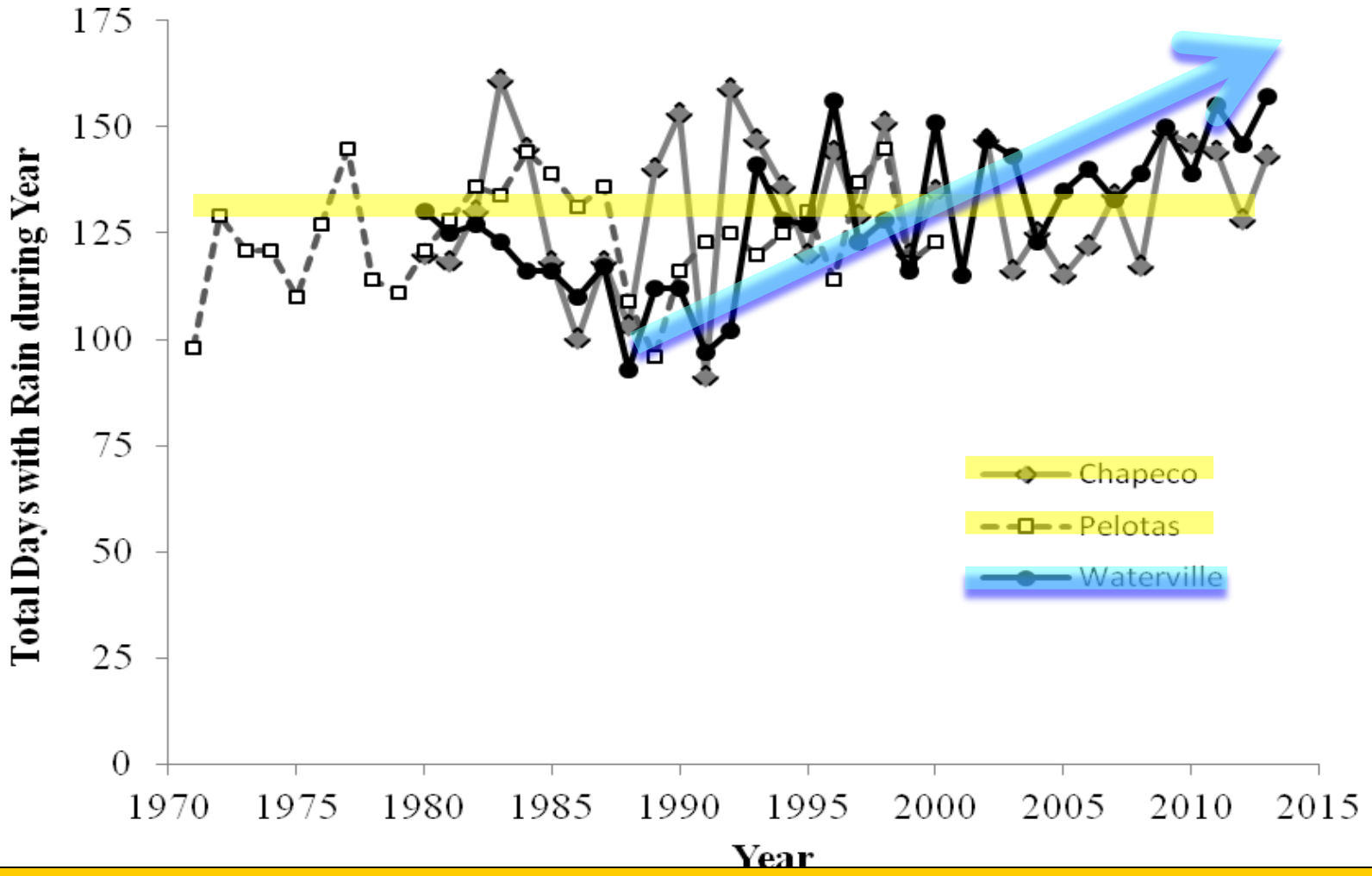
➢ **Total <u>ANNUAL</u> precipitation (cm)**

Shifting Climate for Maine?



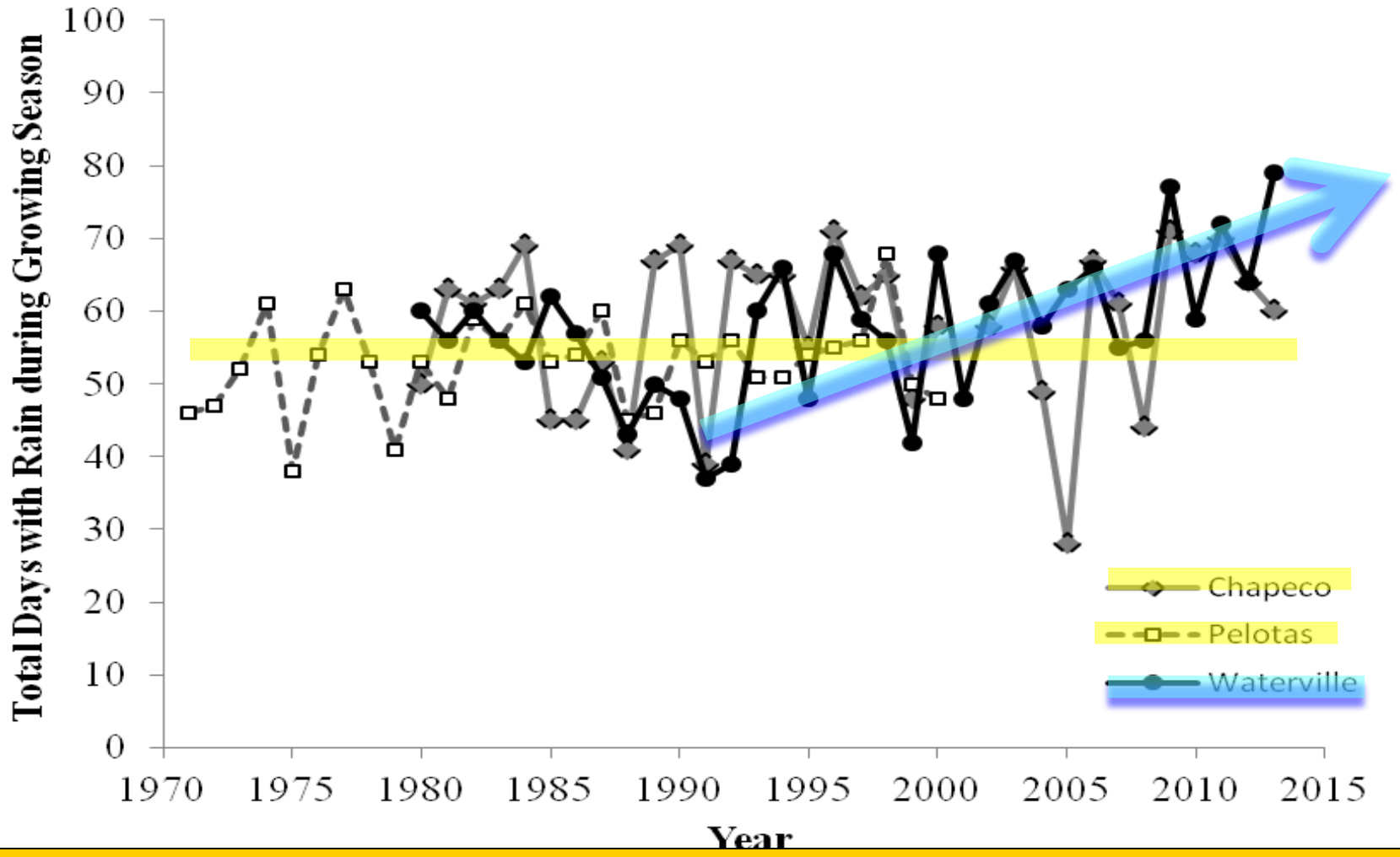
- **Total <u>GROWING SEASON</u> precipitation (cm) for 5 months (*May-Sept.* for Maine; *Nov.-March* for Brazil)**

Shifting Climate for Maine?



- **Total <u>DAYS WITH RAIN</u> during the year**

Shifting Climate for Maine?



- **Total <u>DAYS W/ RAIN</u> during growing season for 5 months (*May-Sept.* for Maine; *Nov.-March* for Brazil)**

Shifting Climate for Maine?

- **More rain days during growing season in Waterville, Maine**
  - ❖ Delayed planting of corn & soy *(May/June)*
  - ❖ Wet & not dry hay bales for first cut *(June)*
  - ❖ Extended harvest for corn silage *(September)*
- **Supports prior research** *(Hoshide et al. 2011)* **suggesting <u>smaller</u> organic dairy farms use <u>grass-based</u> systems & scale economies for corn-based ones**

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Conclusions

- **Higher crop (esp. corn) productivity in Pelotas RG compared to Chapeco SC explains small organic dairy growth in Santa Catarina**
- **Western SC more hilly w/ landscape more suitable to grass-based dairy**
- **Similar ME comparative advant-ages for *Waterville* (corn) compared to *Eastport* (grass) & *Presque Isle***

Conclusions

Recent organic dairy outside of dairy belt challenging for corn:

- **Fall frost damage**
  Presque Isle
- **Cool & poor soils**
  Eastport

More plant & harvest rain days:

1) **Grass-based en-sile early cuts**
2) **Corn-based more slack.**

Dairy Belt

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Future Improvements/Collaboration

- **More weather stations w/ same yrs**
- **Analyze clustering of rain days**
- **IFSM input data files for Brazil**

  (this analysis used IFSM defaults)

  - **Soils** 
  - **Grass** species in temp./trop. stands 
  - **Input costs**  
  - **Conventional** in addition to **organic**

Future Improvements/Collaboration

- **Adjust for other factors impacting milk yield using IFSM adjustments** *(this analysis did not)* **even though these are not functionally in model**
  - Shade, water, ticks, parasites, cross-breeding, genetic database → **milk yield**
  - Spoiled silage → **harvest yield**
  - Time to breed back → **calving**

(Pasetti et al. 2012, Costa et al. 2013, Bernardes & do Rêgo 2014)

Future Collaboration

- **Crop & livestock simulation modeling can complement research & on-farm experiments in Brazil & U.S.**
- ***Conventional & organic dairy IFSM models throughout Brazil***
- **Tropical forage & Zebu / Zebu cross updates in IFSM** *(Oliveira et al. 2013)*
- **Use Environmental Policy Integrated Climate (EPIC) crop model**

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Comments and Questions?