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A MULTIVARIATE APPROACH TO IDENTIFY VARIABLES AFFECTING THE CARBON FOOTPRINT OF DAIRY CATTLE FARMS

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Introduction

Carbon footprint (CF) estimations for the dairy cattle sector

from 0.92 (Kristensen et al., 2011) **to 13.78** (Bartl et al., 2011) **kg of CO_2eq/kg of milk**

- **CF = affected by many variables** (ISO, 2006)
- **milk production level is the most important**
- **large variations in CF within the same milk production level have been reported**

Introduction

- **Climate can affect the CF level by modifying several variables within dairy cattle farms:**
  - **more fibrous forages**
  - **high N volatilization from manure and soil**
  - **animal production performances**
  - **energy consumption**

- **Mediterranean area = specific climatic conditions:**
  - hot, dry and often windy summers
  - alternation of drought and rainy periods

- **Little information on the CF of dairy cattle sector of the Mediterranean area is available**

M & M

Partners of the "*Dairy Carbon footprint*" project

• Cooperat		325 farms
• Cooperat		297 farms
• Cooperat	Calabria	153 farms
• Cooperative "Progetto Natura"	Sicily	252 farms

30% = 285 farms

1027 farms

- **Boundaries of the system:** from cradle to farm gate
- **IPCC (2006) Tier 2:** N_2O from on-farm feed production, CH_4 from manure
- **IPCC (2006) Tier 3:** enteric CH_4, N excretion, N volatilization, N_2O from manure, N emissions from N applied to soil, emissions from energy use, secondary emissions

M&M and RESULTS:

Poster in this Congress, section 42: **"Partial life cycle assessment of the greenhouse gases emissions in dairy cattle farms of Southern Italy**

Objectives

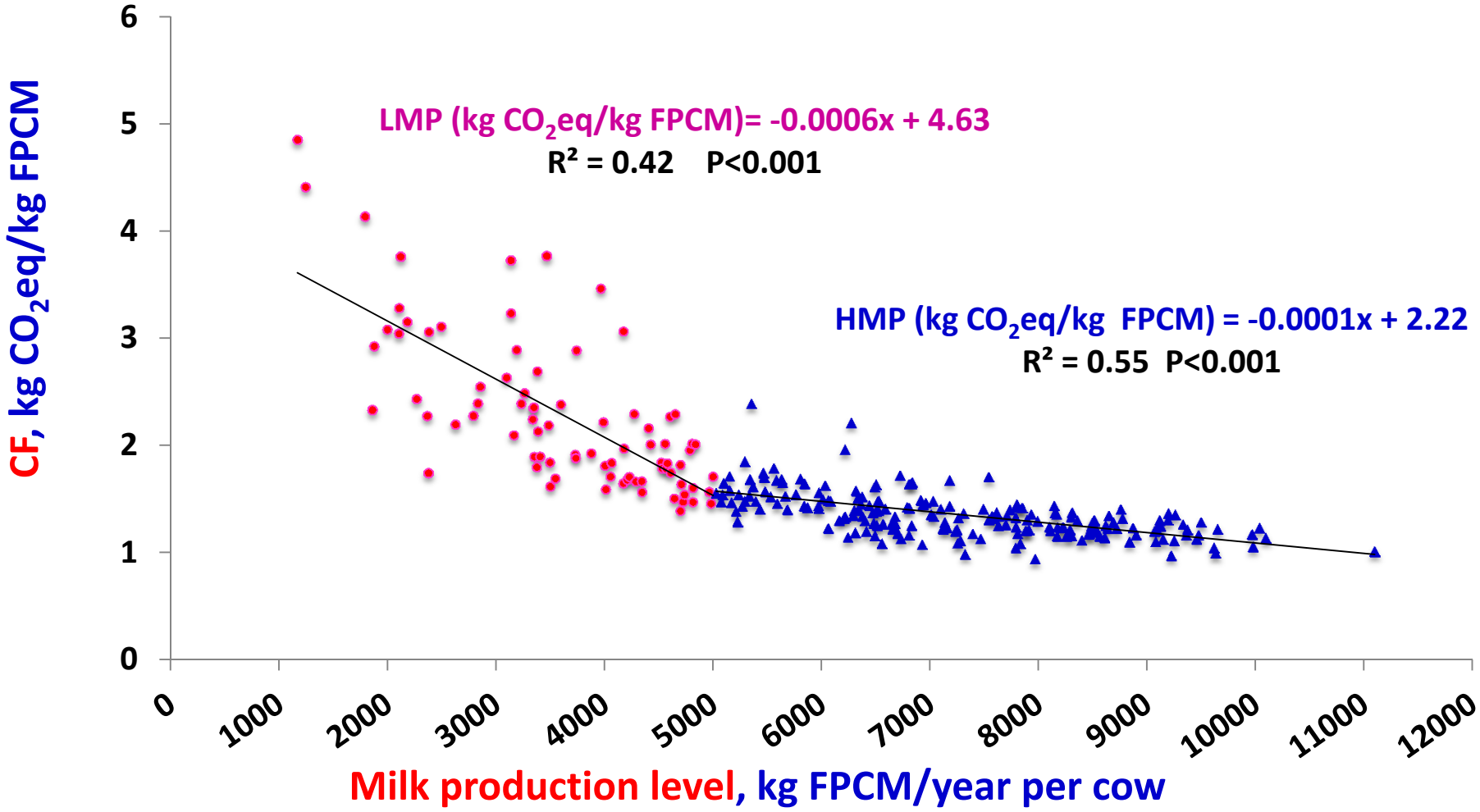
- to test a multivariate approach to identify variables, besides milk production level, which most affect the CF level

- to find a method to select the most important variables affecting CF to be measured in future CF assessments

M & M

2 subsets on the basis of milk production level:

- *1° subset* (LMP) = 82 farms (< 5000 kg of FPCM/yr per cow)
- *2° subset* (HMP) = 200 farms (> 5000 kg of FPCM/yr per cow)



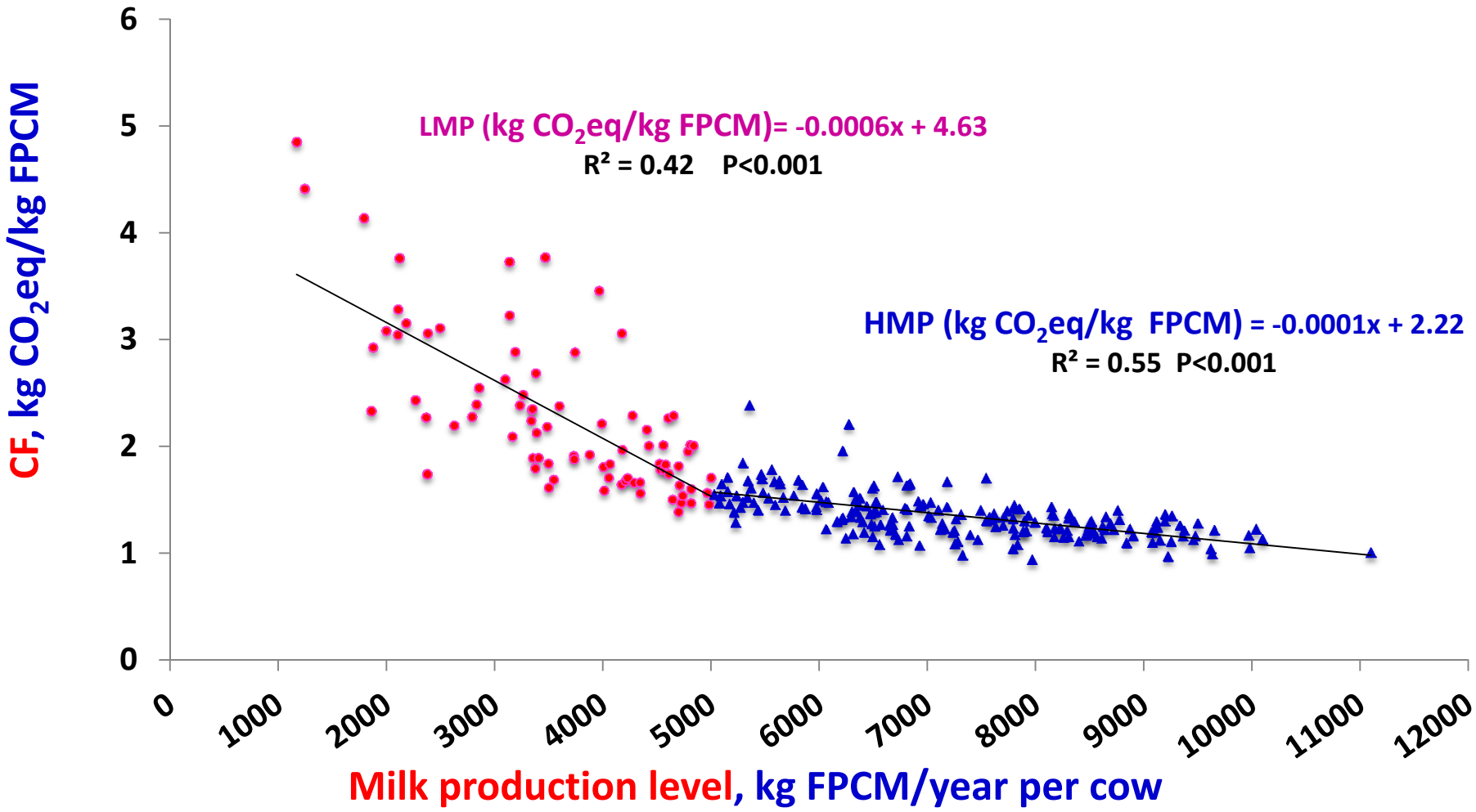
M & M

- We carried out a Linear Discriminant Analysis (LDA) to see if this type of analysis was able to discriminate farms with higher or lower CF than those predicted by the regression lines

About 200 variables collected with the survey: 87 were selected for the study

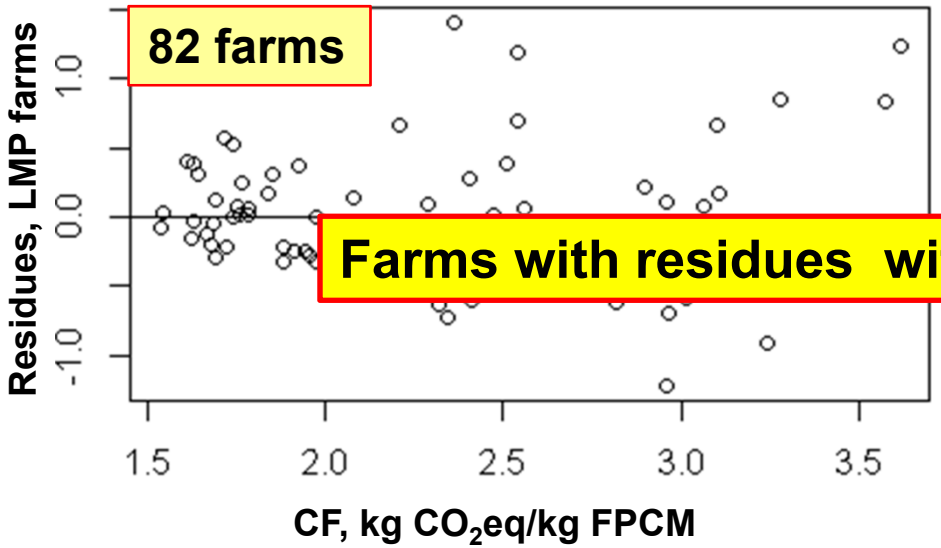
- 25 variables on farms and of the herd characteristics
- 12 variables indicating the average monthly temperature
- 32 variables regarding ration characteristics
- 5 variables regarding energy use of the farms
- 13 variables regarding farm crop cultivations

M & M

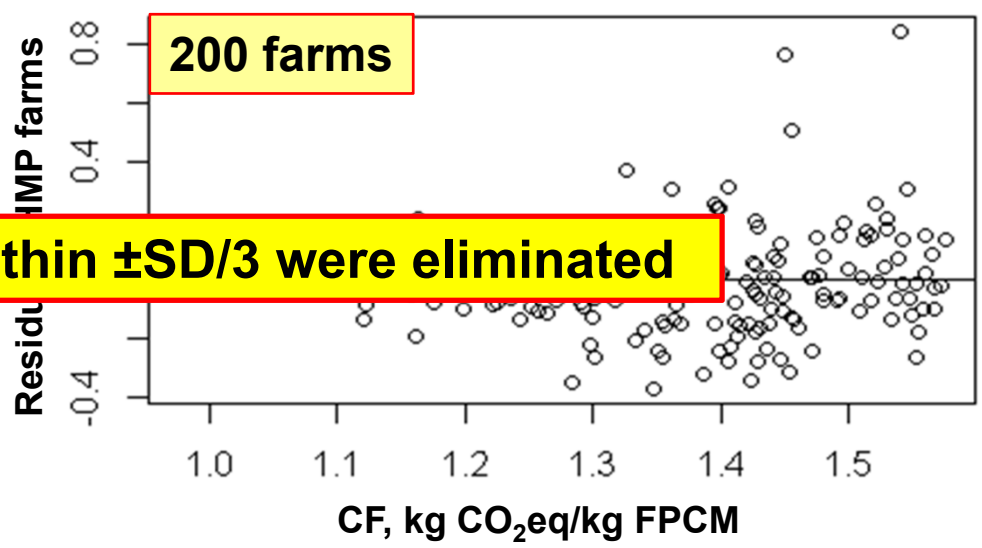

LMP (kg CO2eq/kg FPCM)= -0.0006x + 4.63
R² = 0.42 P<0.001
HMP (kg CO2eq/kg FPCM) = -0.0001x + 2.22
R² = 0.55 P<0.001
CF, kg CO2eq/kg FPCM
Milk production level, kg FPCM/year per cow
0
1
2
3
4
5
6
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000
12000

M & M

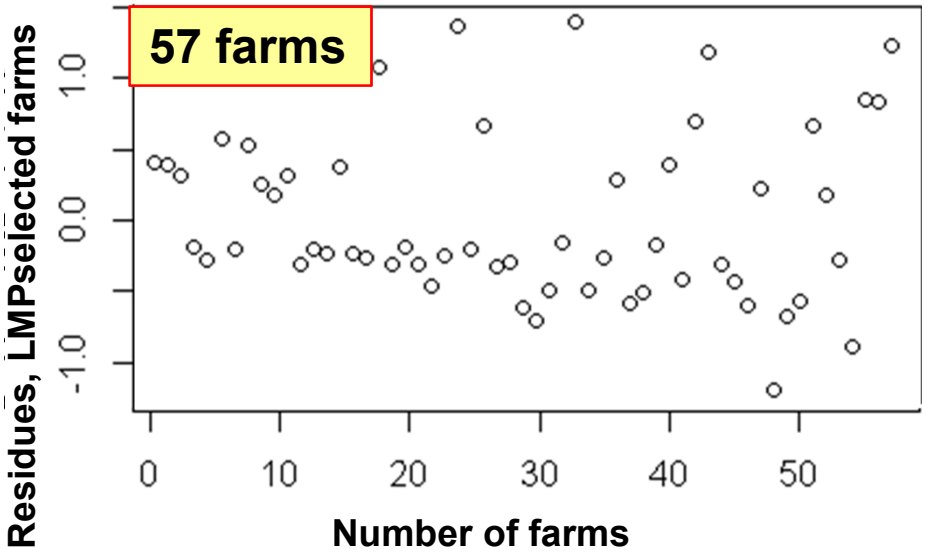
LMP farms

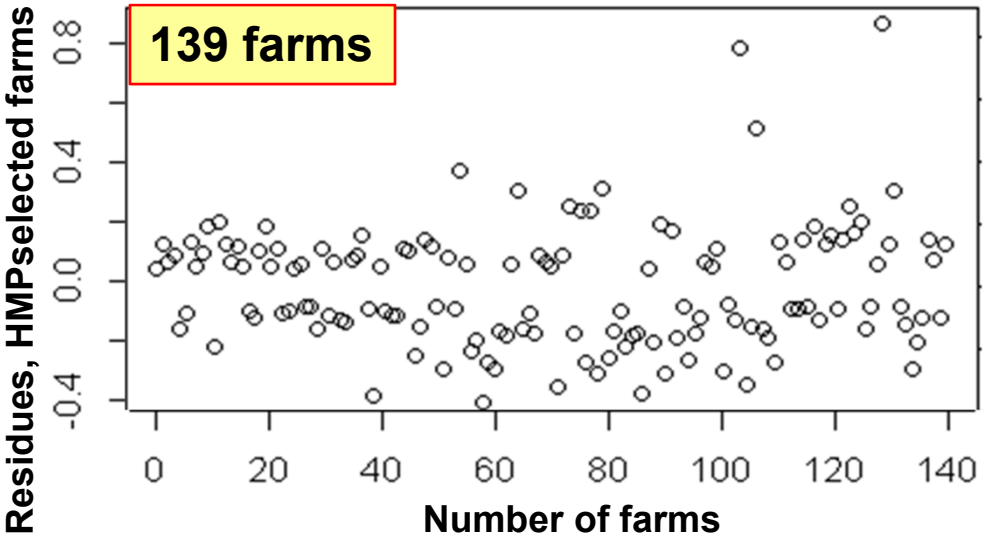


HMP farms



Farms with residues within ±SD/3 were eliminated



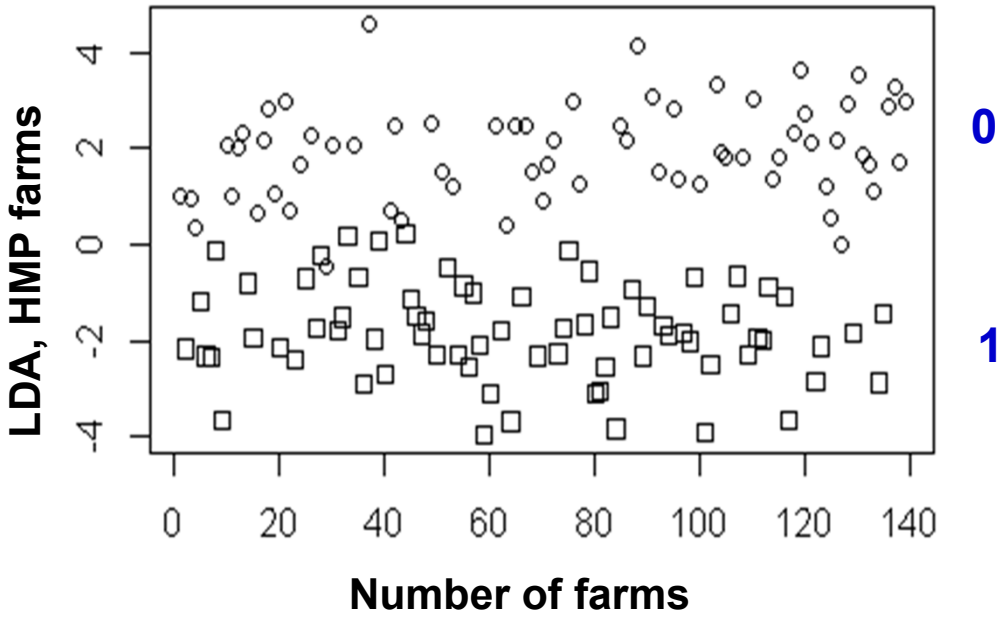


Results

LDA for the HMP farms

- LDA performed on 139 farms with HMP
- **Group 0** = farms with CF values higher than those predicted by regression analysis
- **Group 1** = farms with CF values lower than those predicted by regression analysis

HMP Farms (n=139), LDA with 87 variables		
	0	**1**
0	72	2
1	0	65



Results

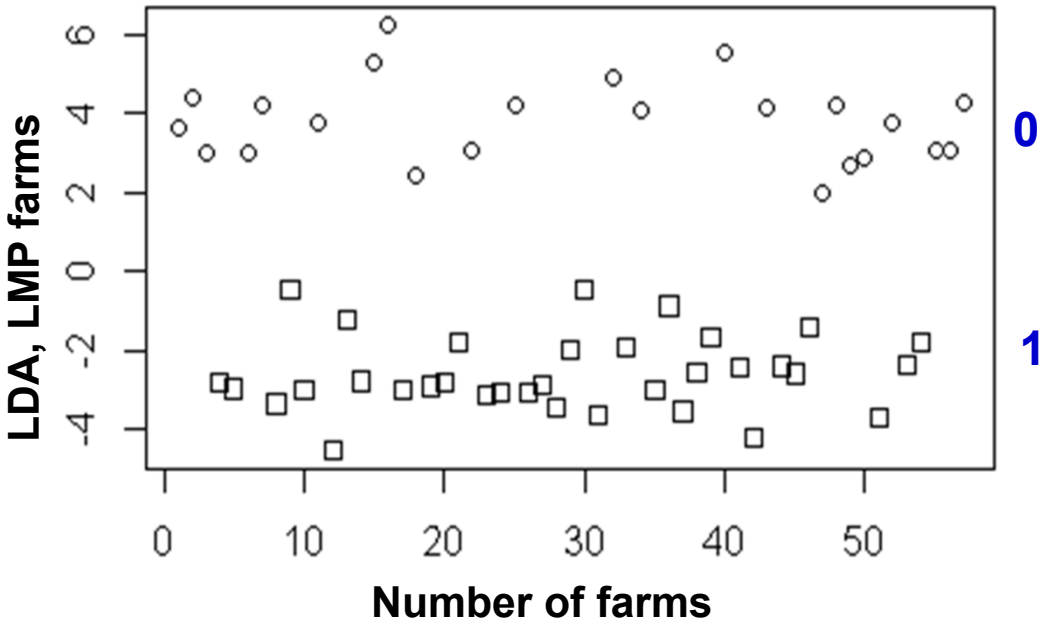
LDA for the LMP farms

- LDA performed on 57 farms with LMP

- Group 0 = farms with CF values higher than those predicted by regression analysis

- Group 1 = farms with CF values lower than those predicted by regression analysis

LMP Farms (n=57), LDA with 87 variables		
	0	**1**
0	34	0
1	0	23



New selection of variables for the 2nd LDA for the HMP farms

name	Coefficient	name	Coefficient
1- mean Temp, Sept	14.3039	16- corn cultiv	1.9001
2- mean Temp, Jul	13.8864	17- GEin, dry cows	1.5732
3- F:C, dry cows	8.9966	18- F:C, unweaned calves	1.5552
4- mean Temp, Jun	8.9493	19- mean Temp, May	0.8391
5- F:C, bred			0.7526
6- mean Ter			0.7517
7- mean Ter			0.3857
8- mean Temp, Oct	4.7088	23- farm localization	0.3241
9- mean Temp, Nov	4.6369	24- consump min fert	0.2284
10- mean Temp, Aug	4.2862	25- GEin, lact cows	0.2245
11- mean Temp, Apr	2.7942	26- dry cows	0.1694
12- mean Temp, Feb	2.7895	27- corn silage cultiv	0.0888
13- F:C, lactating cows	2.6975	28- age first calving	0.0883
14- Neff, corn grain	2.6259	29- mean Temp, Jan	0.0681

58 variables with coefficients included within ±SD/10 were eliminated

New selection of variables for the 2nd LDA for the LMP farms

name	coefficient	name	coefficient
1- F:C, open heifers	11.2867	18- mean Temp, Feb	0.5722
2- F:C, bred heifers	11.0767	19- mean Temp, Jul	0.5412
3- F:C, dry cows	5.9421	20- GEin, open heifers	0.5304
4- F:C, lactating cows	5.1571	21- mean Temp, Apr	0.3972
5- corn cultiv	2.8098	22- mean Temp, Jun	0.3701
6- mean Temp, Sept	2.2270	23- dry cows	0.3521
7- mean Te			0.2745
8- mean Te			0.2720
9- housing type	1.0950	26- on-farm feeds	0.2404
10- GEin, dry cows	1.0803	27- mean Temp, Mar	0.1738
11- mean Temp, Oct	1.0601	28- consump min fert	0.1728
12- F:C, unweaned calves	1.0016	29- irrigation service	0.0747
13- GEin, bred heifers	0.7362	30- surplus cows	0.0674
14- mean Temp, Nov	0.7312	31- beef calves	0.0532
15- mean Temp, Jan	0.7039	32- mean Temp, Dec	0.0503
16- farming system	0.6791	33- Neff, corn grain	0.0448
17- corn silage cultiv.	0.6674		

54 variables with coefficients included within ±SD/10 were eliminated

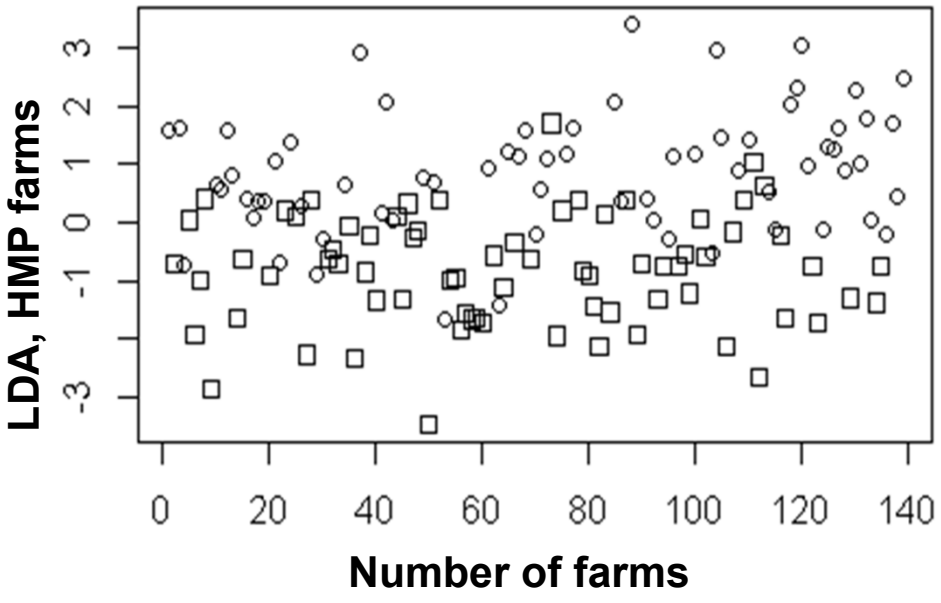
Objectives

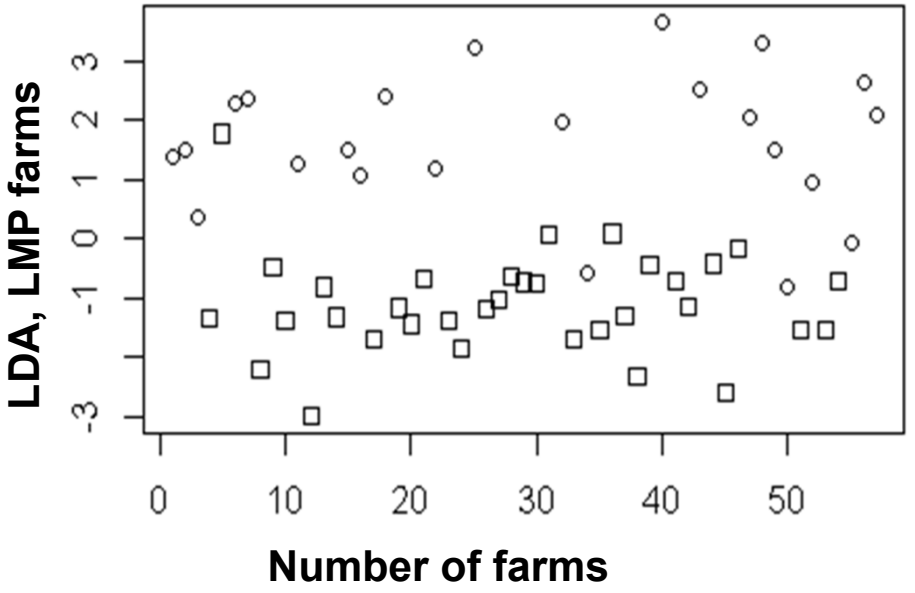
- **Based on these results, we wanted to see if it was possible to further reduce the number of variables needed to predict the CF**

Results

Results of the 2nd LDA for the HMP and LMP farms

HMP Farms (n=139), LDA with 29 variables			LMP Farms (n=57), LDA with 33 variables		
	0	**1**		**0**	**1**
0	57	15	**0**	33	4
1	15	52	**1**	1	19





Discussion & Conclusions

- **CF in LMP farms was more affected by dietary quality and crop cultivation techniques**
  - **high variability** was observed for these variables in LMP farms, which did not present standardized management compared to HMP farms

- **CF in HMP farms was more affected by climatic conditions and dietary F:C ratio**
  - **low variability** in feed and crop cultivation management was observed for these farms, because of their standardized farm management techniques

Conclusions

- **LDA was useful to identify the variables with the higher impact on the CF of the farms**

- **The elimination of the variables realized to perform the 2nd LDA was appropriate for the LMP farms but it was not for the HMP farms**

  - the small variability of CF of the HMP farms needs to be investigated considering more factors than those selected by the 1st LDA

Acknowledgments

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- Colleagues of the **Sections of Agronomy, Agriculture Engineering and Animal Science** of the Department of Agraria of the University of Sassari


Thank you for your attention
556
Did you hear??
Cow 558 is producing only 0.35 kg of CO_2eq per liter of milk!!!!
Of course, it's easy for her! She just had a ruminal plastic surgery !!!!