Optimizing concurrently dairy farm profitability and environmental performance

University of Wisconsin-Madison

Di Liang

Advisor: Dr. Victor Cabrera

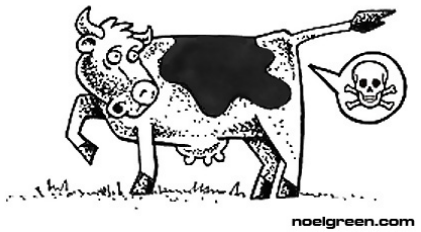
BACKGROUND

- Agricultural greenhouse gas emission (GHG) contributes 8.1% of the total U.S. emissions (EPA, 2014)
- Dairy industry contributes 4% to the global GHG emissions (FAO, 2010)
- Livestock enteric fermentation and manure methane emission accounted for 34.4% of total anthropogenic CH_4 emission (EPA, 2014)

BACKGROUND

- A major goal for dairy cattle farming is to reduce GHG emissions meanwhile increase or keep the farm profit
- Animal performance influences the GHG in dairy farms, including productions and replacement decisions (Crosson, 2011)

BACKGROUND



- Mitigation strategies could affect differently on different farm types (Dutreuil et al., 2014)
- Reducing GHG emission could maintain the profit

OBJECTIVE

- Estimate the environmental and economic effects of **milk production** and **herd structure** on a typical Wisconsin dairy farm

MODEL

- Integrated farm system model (IFSM, version 4.0, USDA, 2013)
- Applied to crop growth, feed storage, machinery usage, and herd management to simulate integrated whole farm performance
- 25-yr daily weather data used in crop growth, tillage, harvest, feed storage, and manure handling modules
- Each year calculated separately, no carry-over effect

FARM CHARACTERISTICS

- Farm located in Dane County, WI
- 100 milking cows, no replacement heifers on farm
- 100 ha rented cropland, 43 ha of alfalfa, and 57 ha of corn
- Economics parameters

Milk price	$ 0.40 per kg
Slaughter price	$1.21 per kg
Replacement heifer price	$1500 per cow
Calf price	$ 150 per calf

MANAGEMENT CHANGES-MILK PRODUCTION

- Target milk production
  - The model optimized the feed allocation to push the actual milk production to approach the target milk production
  - Change from 9,979 to 11,743 kg per cow per year by 279 kg interval

MANAGEMENT CHANGES - REPLACEMENT DECISIONS

- First lactation cow percent
  - Proportion of cows in first lactation
  - Representing the culling and replacement decisions
  - Change from 15% to 45% by 5% interval

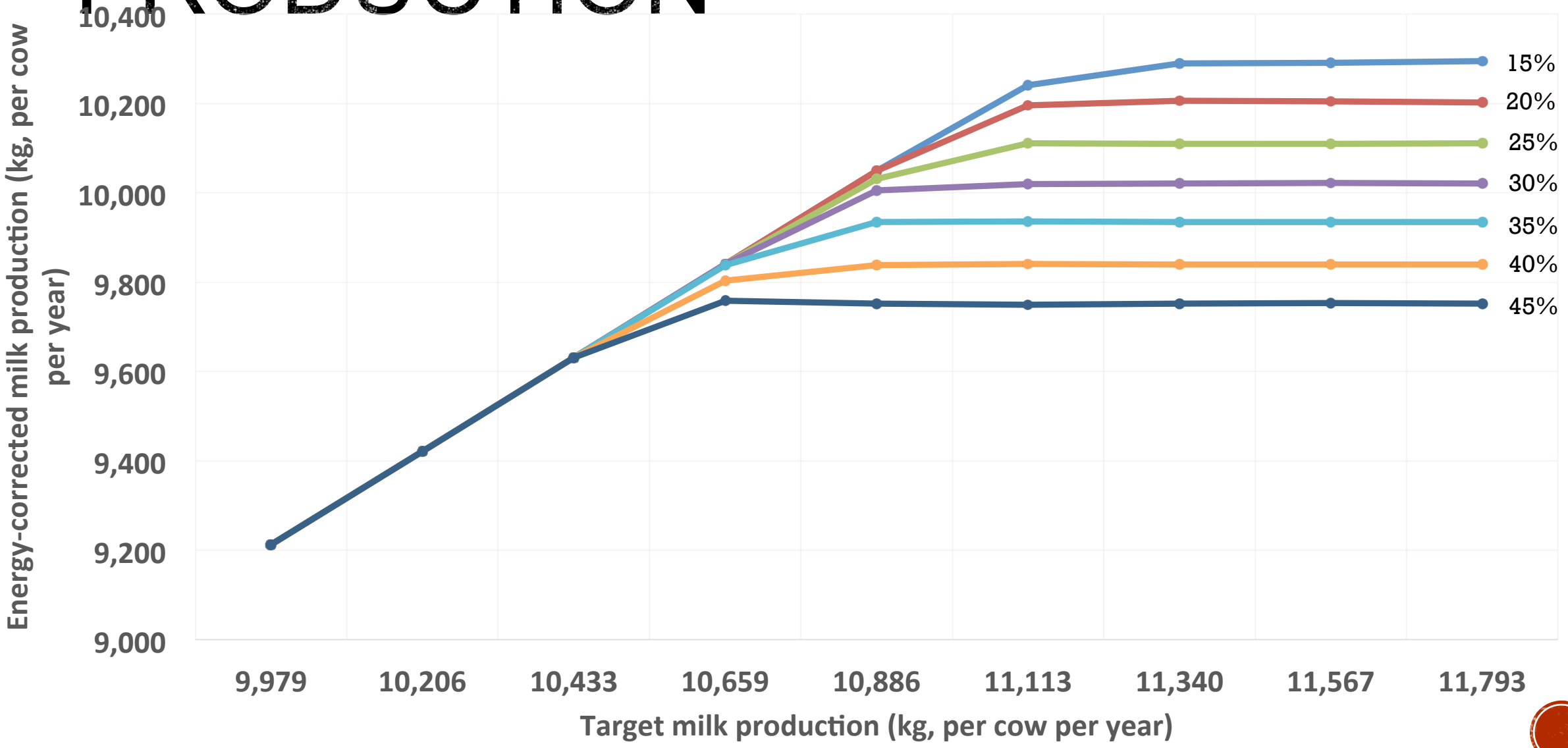
RESULTS

- Farm produced feed
- Energy corrected milk production (4.0% fat, 3.3% protein)
- Net return on management
  - Cost and revenue
- Equivalent CO_2

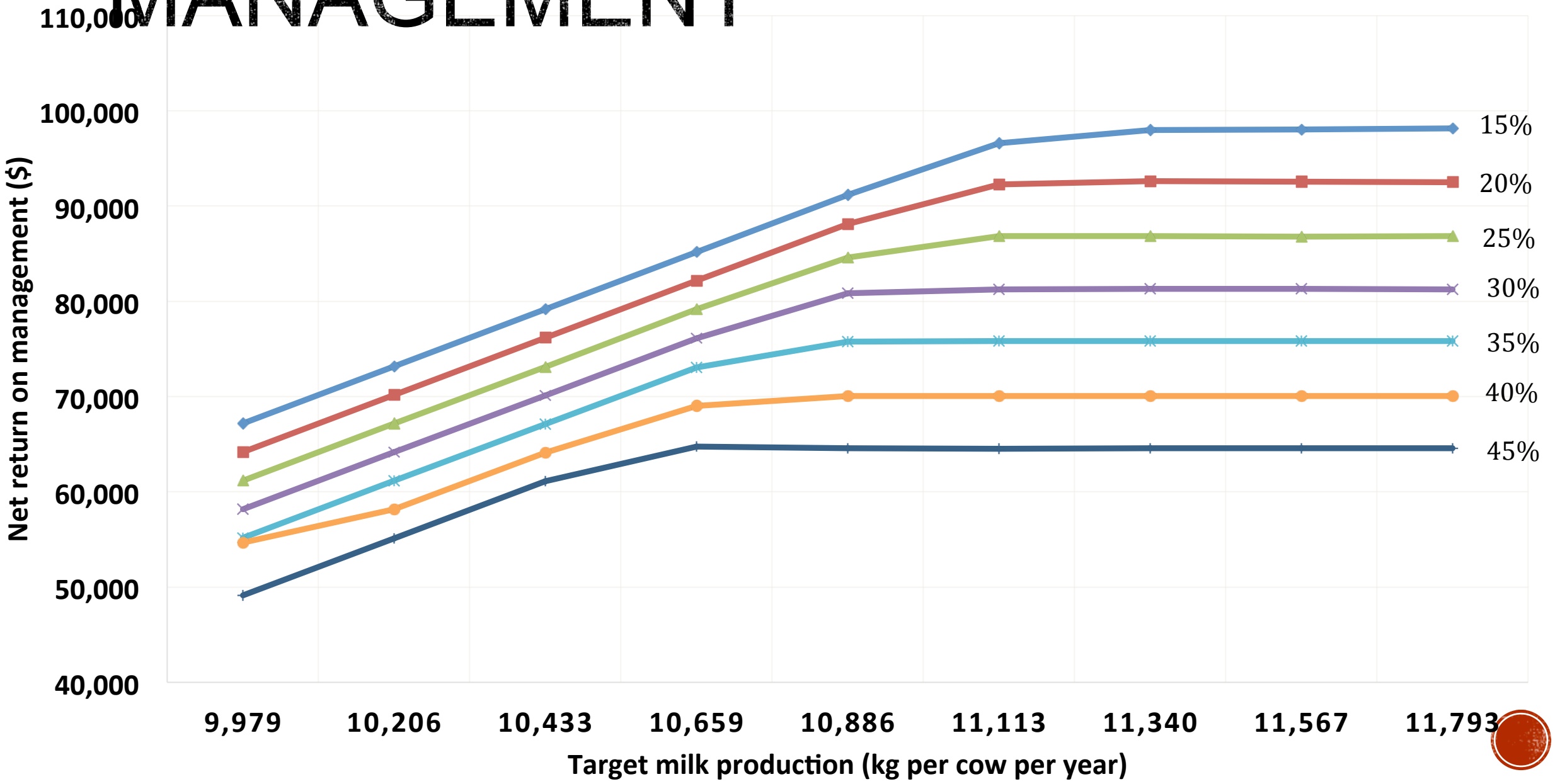
FEED PRODUCED ON FARM

Feed category	Mean ± SD, ton DM
High-quality hay	48 ± 31
Low-quality hay	16 ± 26
High-quality silage	273 ± 48
Grain crop silage	269 ± 2
High-moisture grain	191 ± 64
Dry grain	11 ± 24
Forage	223 ± 65

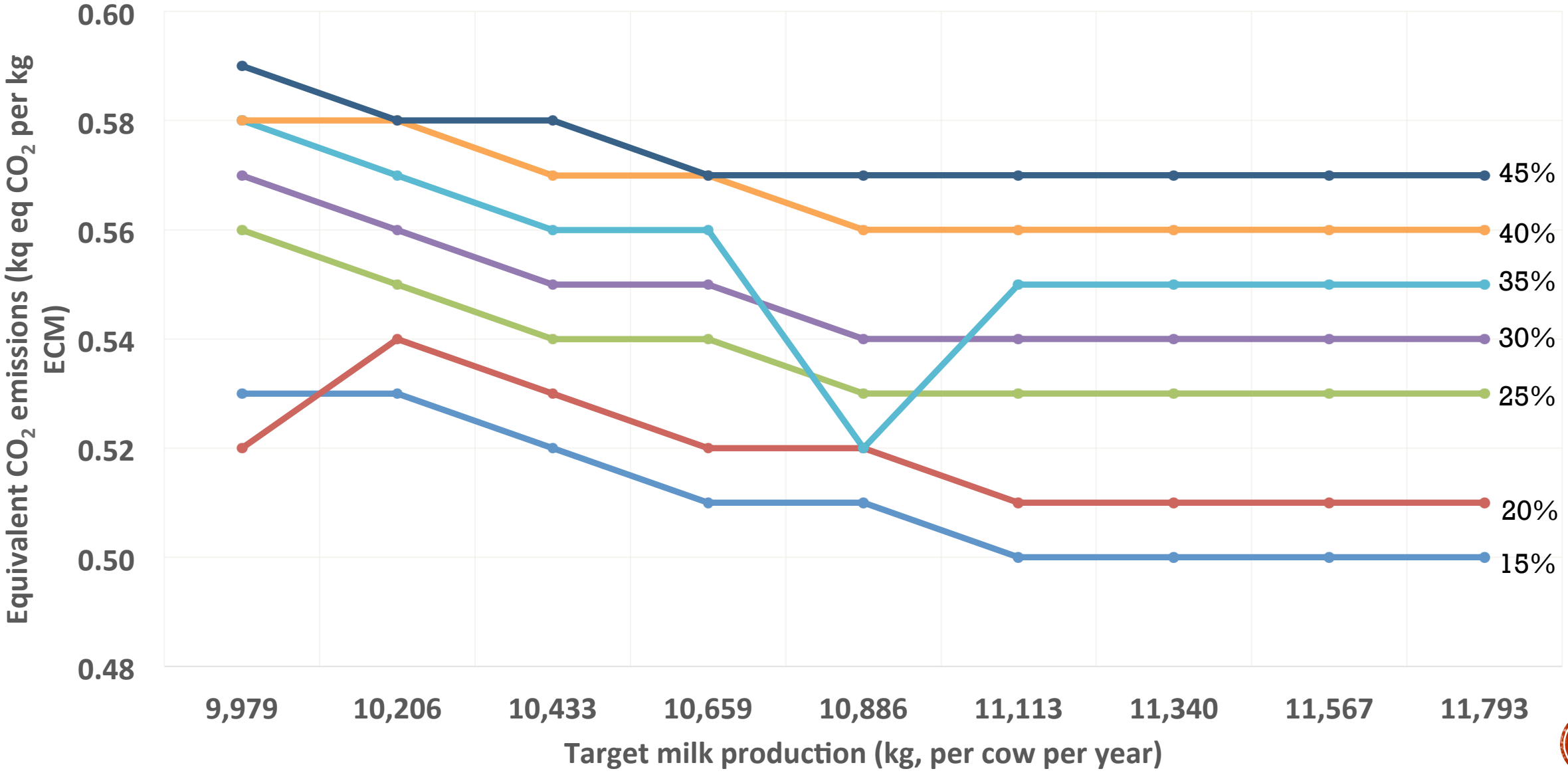
ENERGY CORRECTED MILK PRODUCTION



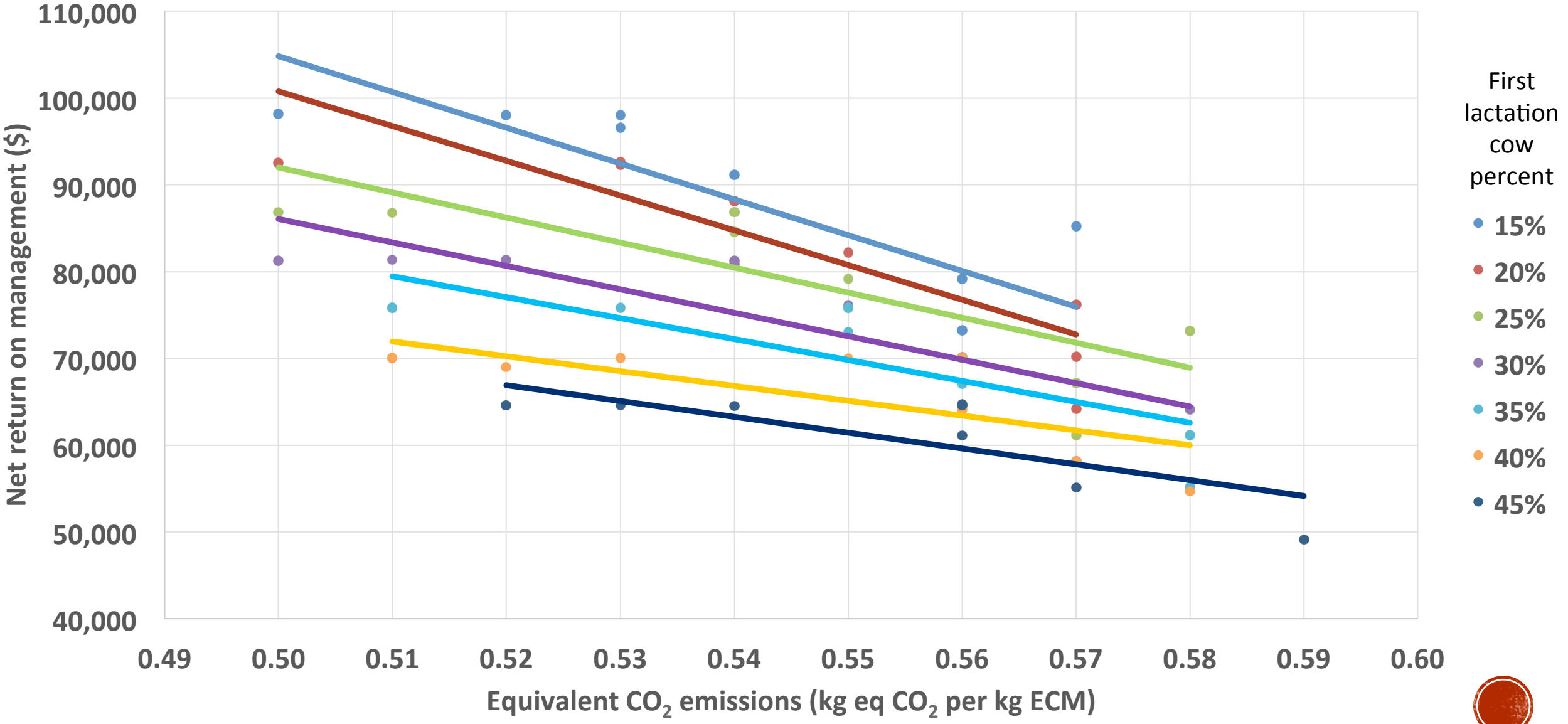
NET RETURN ON MANAGEMENT



EQUIVALENT CO_2 EMISSION



EQUIVALENT CO_2 EMISSION VS. NET RETURN ON MANAGEMENT



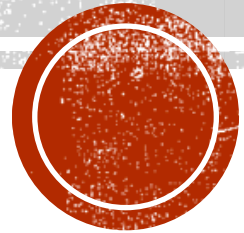
CONCLUSIONS

- Production levels and culling decisions could impact on the farm profit and greenhouse gas emissions
- High production and less culling could increase the farm profit meanwhile decrease the greenhouse gas emissions
- Greenhouse gas mitigation strategies could increase the profit at same time

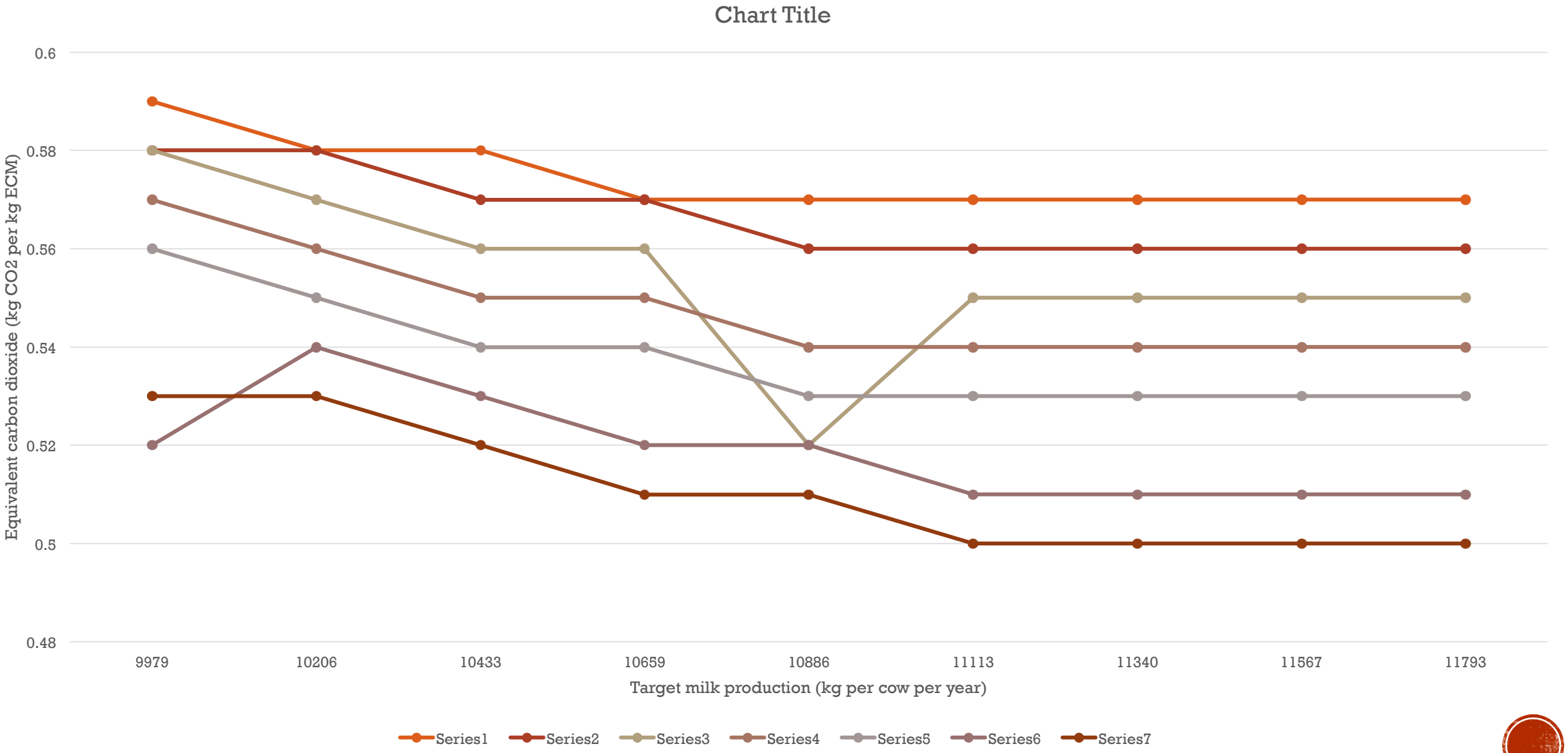
ACKNOWLEDGEMENT

THANK YOU!

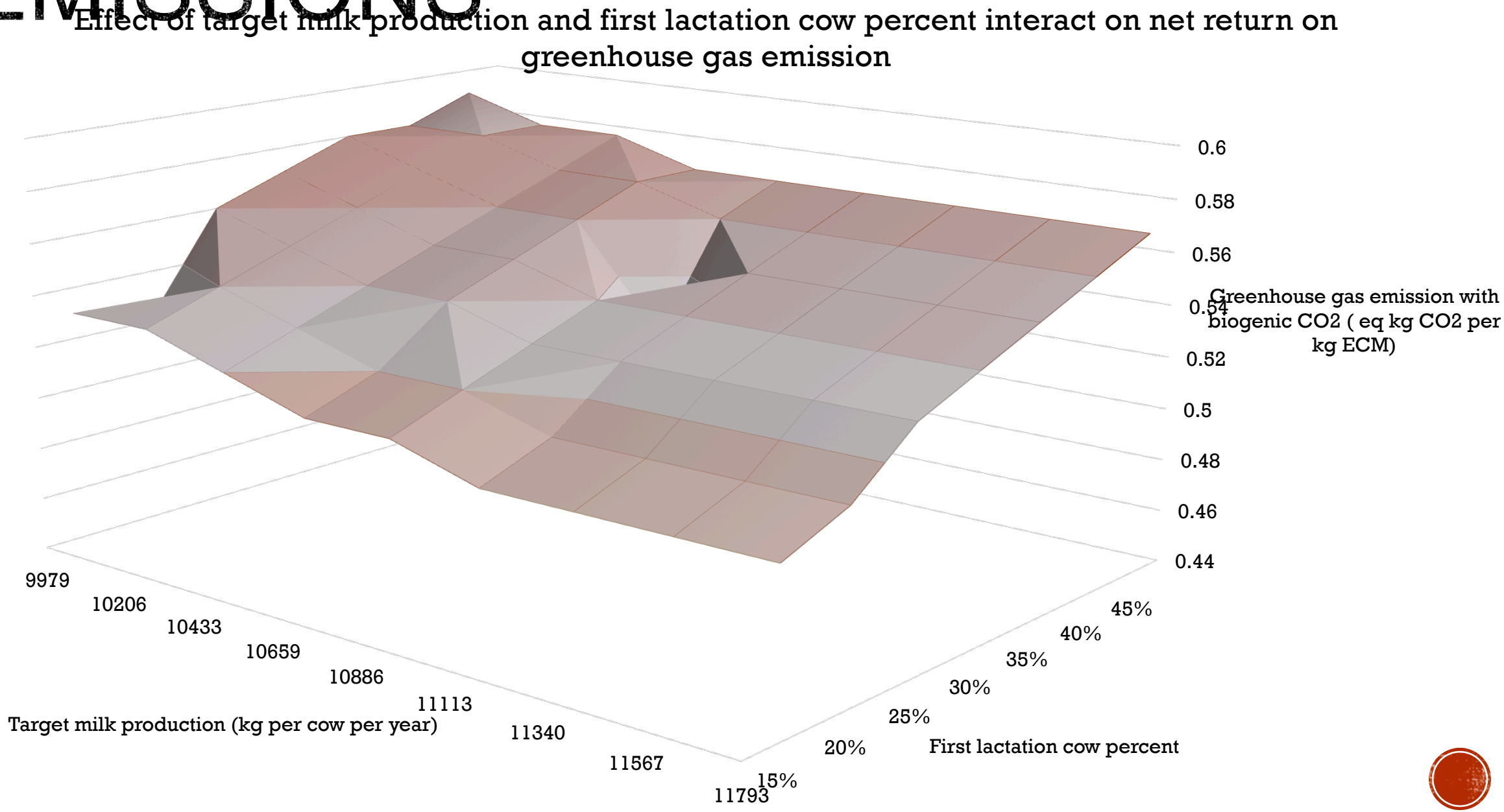
Questions?



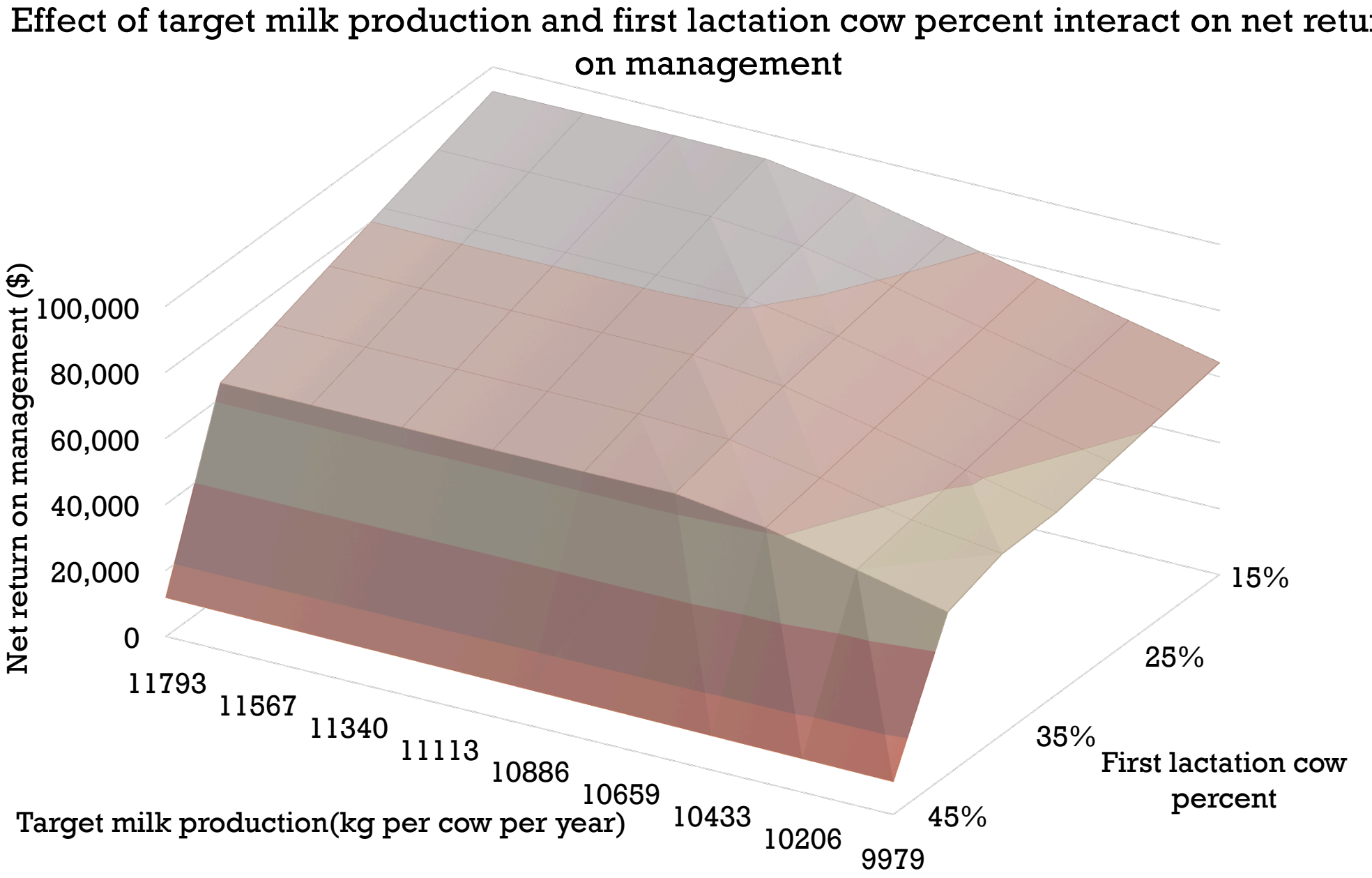
GREENHOUSE GAS EMISSIONS



GREENHOUSE GAS EMISSIONS



NET RETURN


Effect of target milk production and first lactation cow percent interact on net return on management
Net return on management ($)
100,000
80,000
60,000
40,000
20,000
0
11793
11567
11340
11113
10886
10659
10433
10206
9979
Target milk production(kg per cow per year)
15%
25%
35%
45%
First lactation cow percent

ENERGY CORRECTED MILK PRODUCTION