DEPARTMENT OF
AGRICULTURAL AND RESOURCE ECONOMICS

Colorado State University

Optimum Stocking Rate: the Significance of Scale and the Link to Profitability

W. Marshall Frasier

Colorado Section Society for Range Management
Strategic Grazing Management for Complex Adaptive Systems
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Western Center for Integrated Resource Management

First, a bit of credit…

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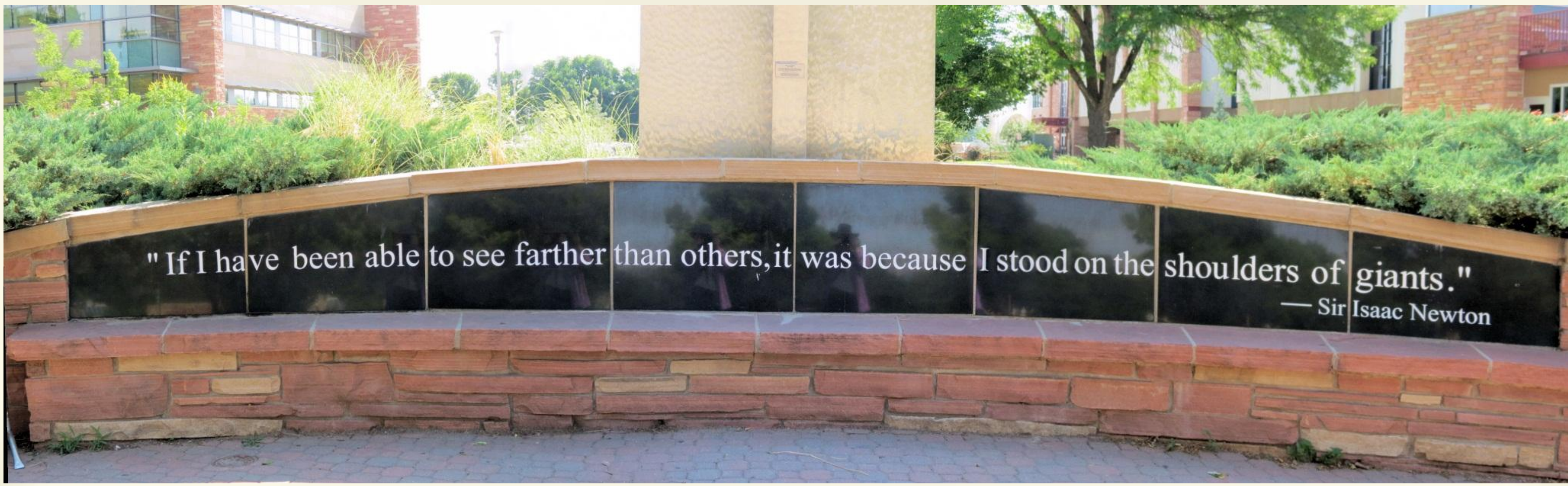


Context and History

- CSU Western Center for Integrated Resource Management (WCIRM)
  - Larry Rittenhouse
  - Roy Roath
  - Tim Steffens
- Lessons of the “early” IRM experience
- Teaching perspective

Nature of our Problem at Hand

According to Webster…

op·ti·mal adjective \ˈäp-tə-məl\

most desirable or satisfactory; best

An optimal decision is the one that generates results that are most consistent with an underlying $\boxed{\text{goal}}$ or objective.

A few words about Goals

- The decision maker is free (and entitled) to assess decision outcomes against their own values
- In a private decision this relatively easy to manage (if not to articulate)
- This can become complicated when we consider decisions that have social implications that deviate from the decision maker’s goals
- “Profit” is a prevalent goal both privately and socially
- ~~Only money matters to an economist.~~

This talk is <u>not</u> about…

- Prescribing the recipe for the “perfect” stocking rate
- Sophisticated research that only I and other economists would care to consider remotely interesting
- Telling you how you can sell more for more from your livestock enterprise

I will talk about…

- How to use abstract representations of the stocking decision to gain insights into the decision problem
- Identify some generalizable results that can help one formulate workable optimal stocking rate decisions
- Discuss a numerical example to illustrate the implications of different management scenarios
- How to use thinking from the context of the simple model to look for “simple” driving relationships in more complex models and reality

Evaluating the Tradeoffs in the Stocking Rate Decision

Building Understanding of Complexity through Simplicity

- A **model** is by definition an abstract representation of a given reality
- We use models to help us examine specific aspects of the reality about which we wish to understand
- A “more sophisticated” model can
  - Provide better (more accurate) prediction of expected outcomes
  - Require so much specific data that its becomes to costly to use
  - Generate results that are difficult to generalize
- In general it is a best practice to start simple and add the features that allow you to represent the problem of interest

Extrapolating from a "Budgeting" Approach

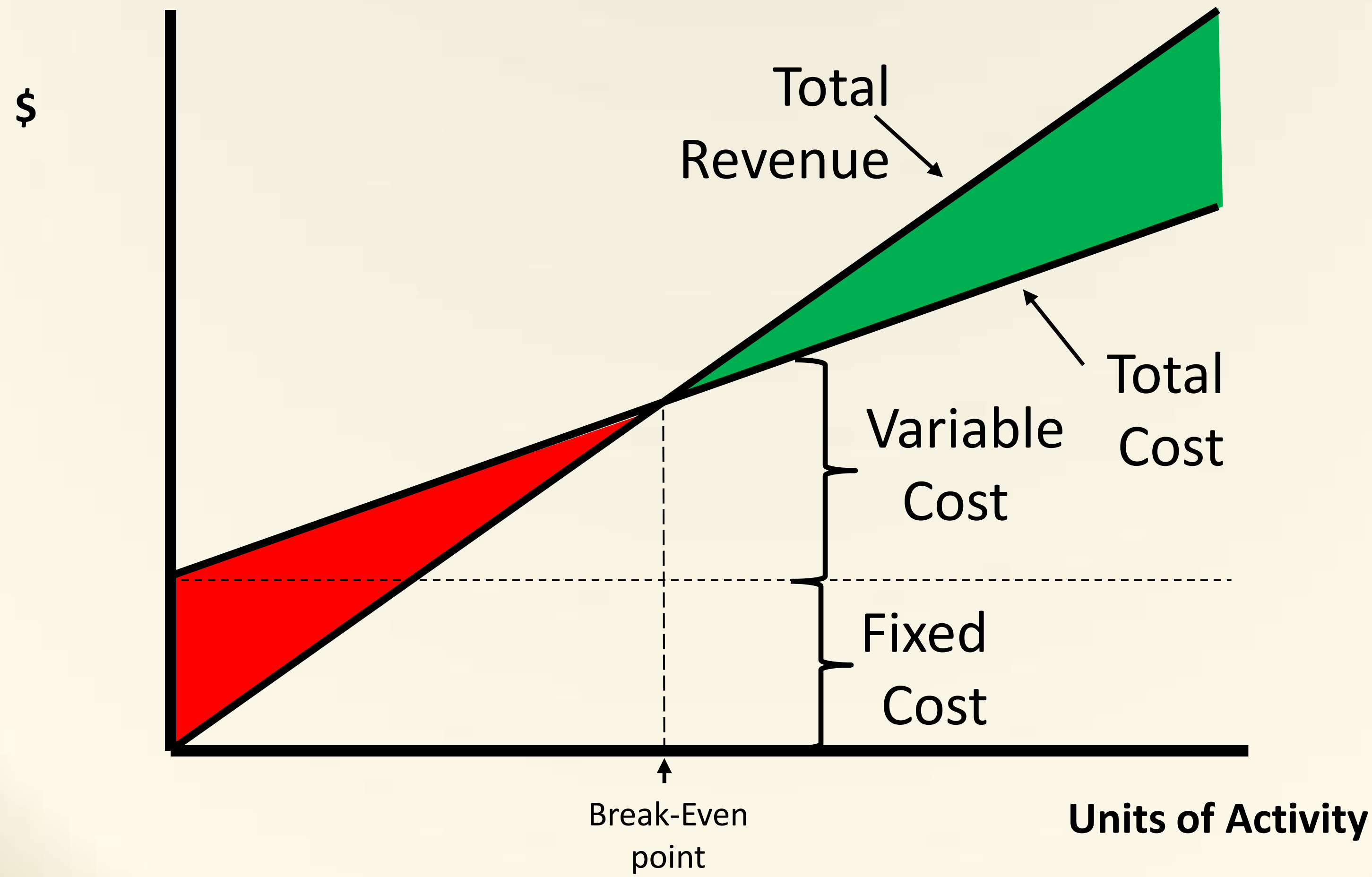
- Revenue – increases directly with production
- Variable costs – increase directly with production
  - Feed
  - Health and medicine
  - Marketing
- Fixed costs – change little with level of production
  - Land costs
  - Permanent labor
  - Machinery and facilities

Some Budgeting Terminology

- **The difference between variable costs and the value of production is GROSS MARGIN.**

- **The difference between gross margin and fixed costs (overhead) is PROFIT.**

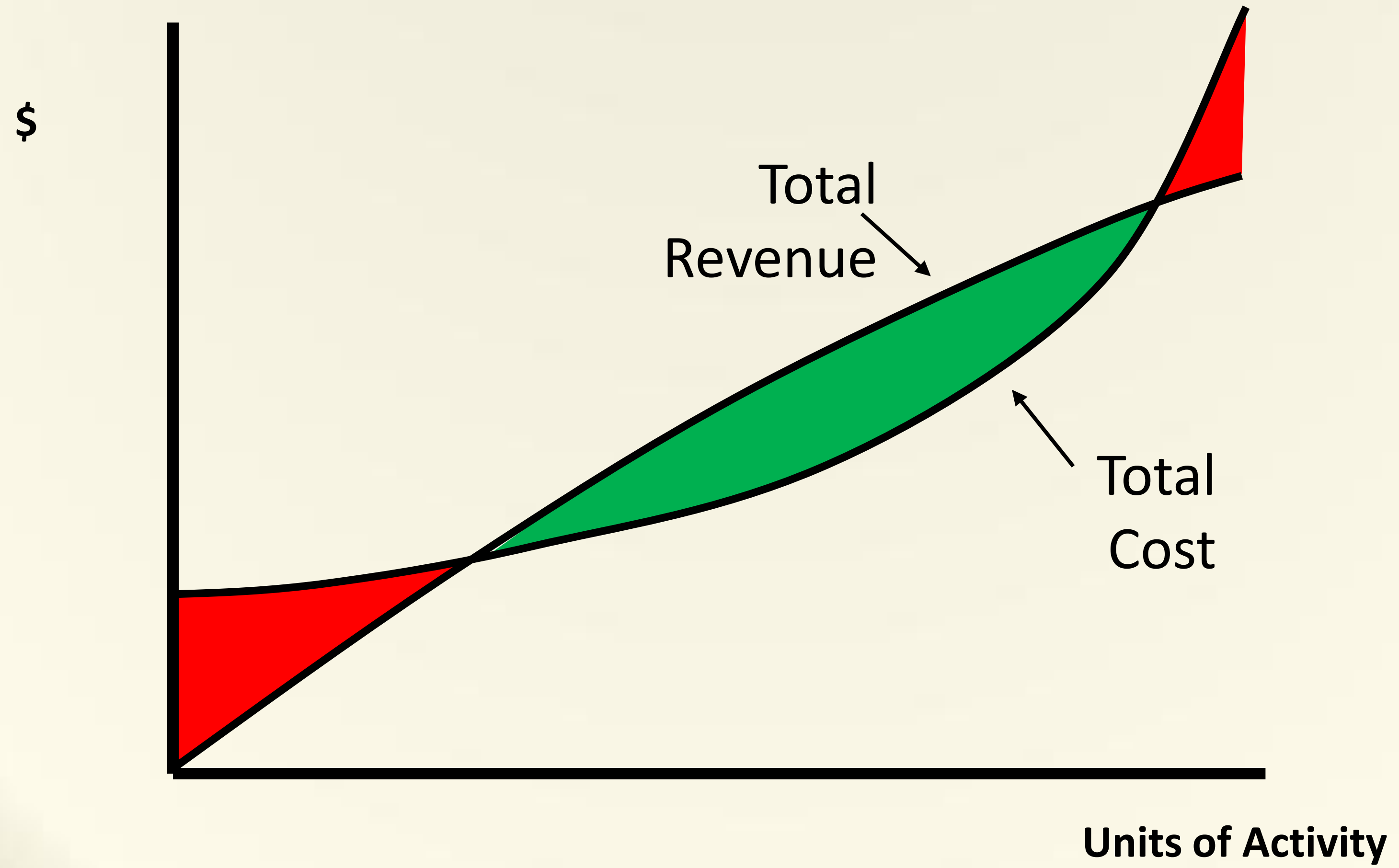
Extrapolation from a “Budgeting” Approach



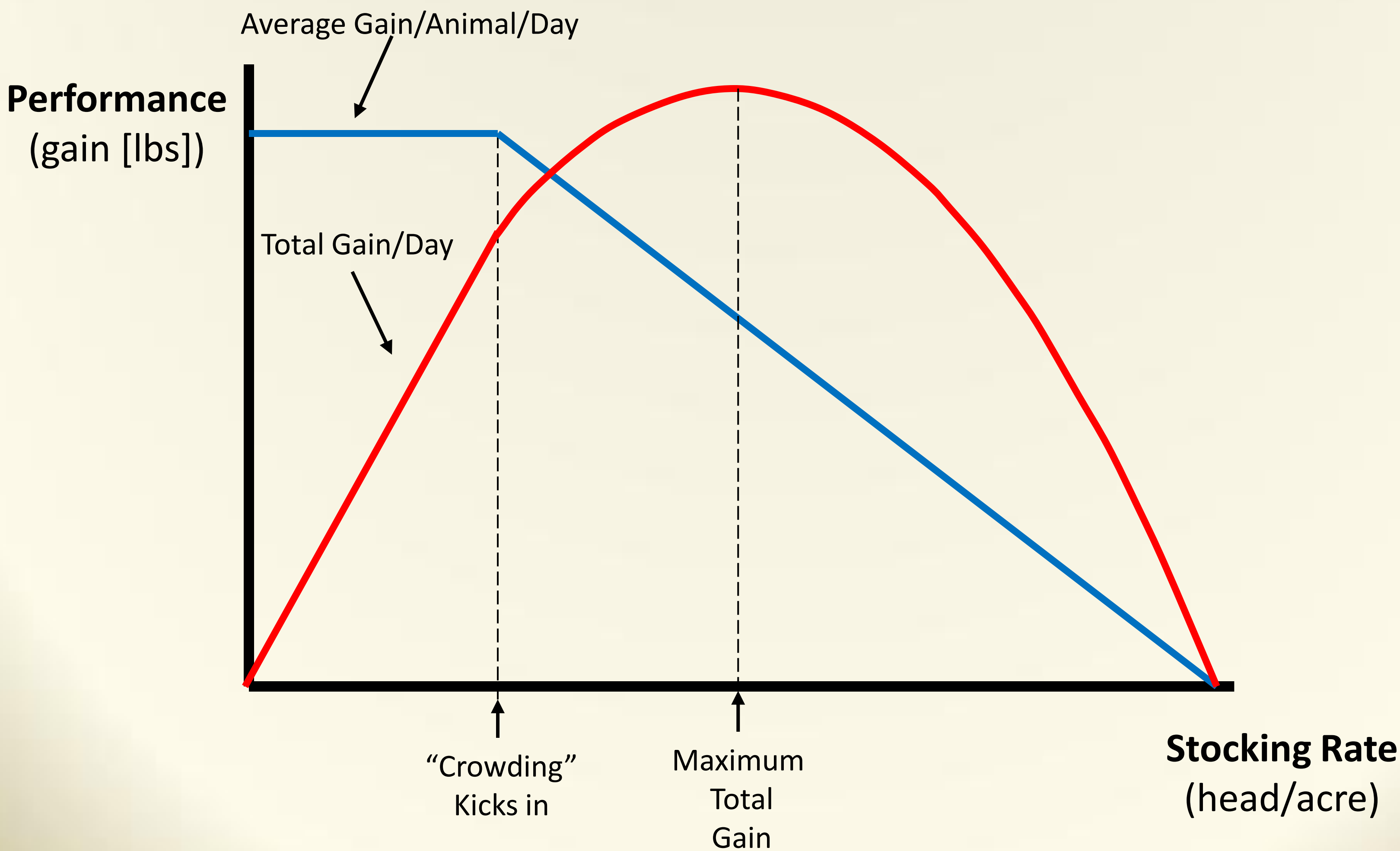
Limitations of the “Budgeting” Approach for Representing Stocking Rate Decision

- Revenue and Costs don’t typically remain constant across the stocking rate decision
- Loss of individual animal performance with increasing stocking rate will result in less revenue as stocking rate increases
- Costs may not vary proportionately as stocking rate varies
- Sometimes “***simple***” is too simple

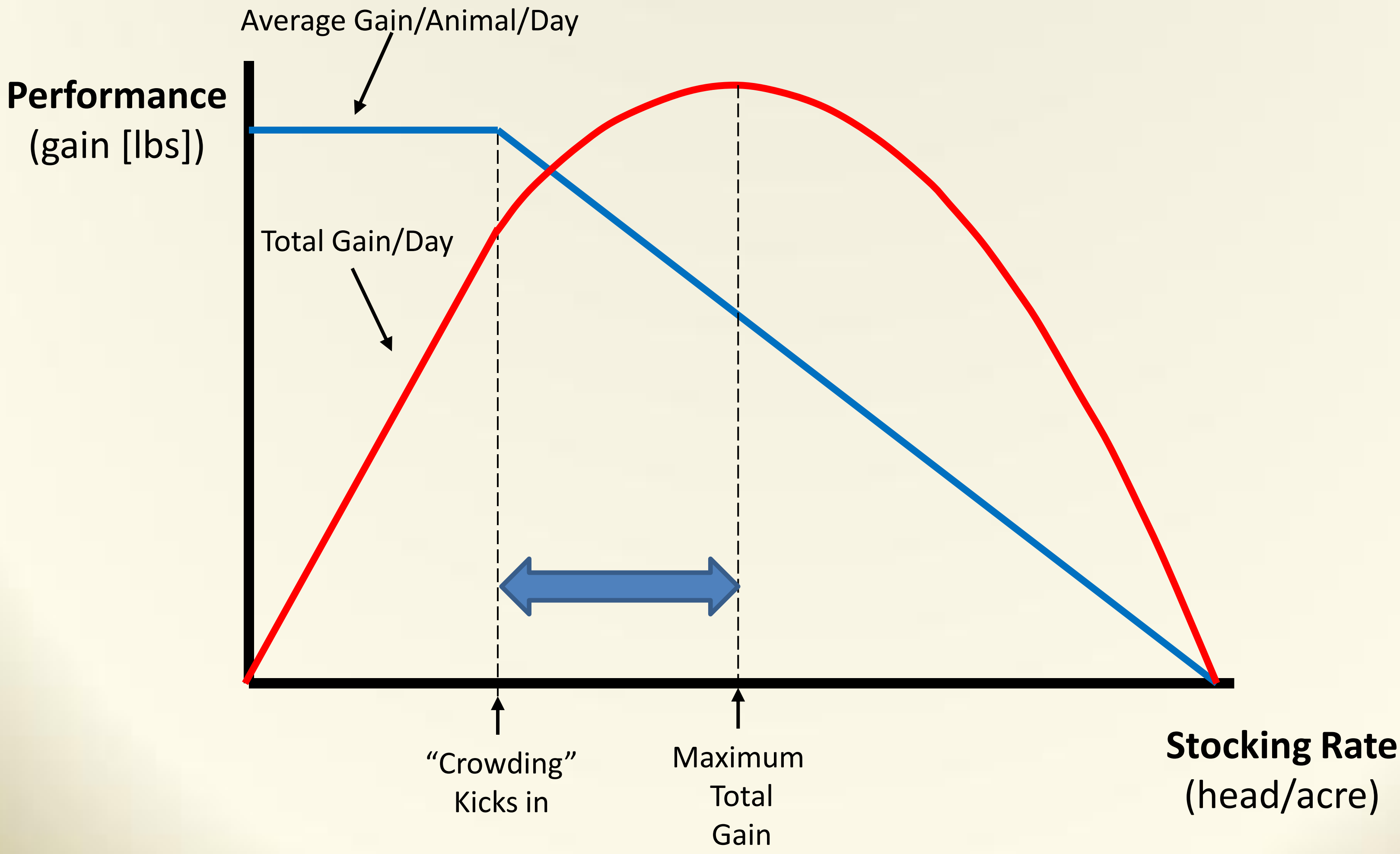
More Realistic Circumstance



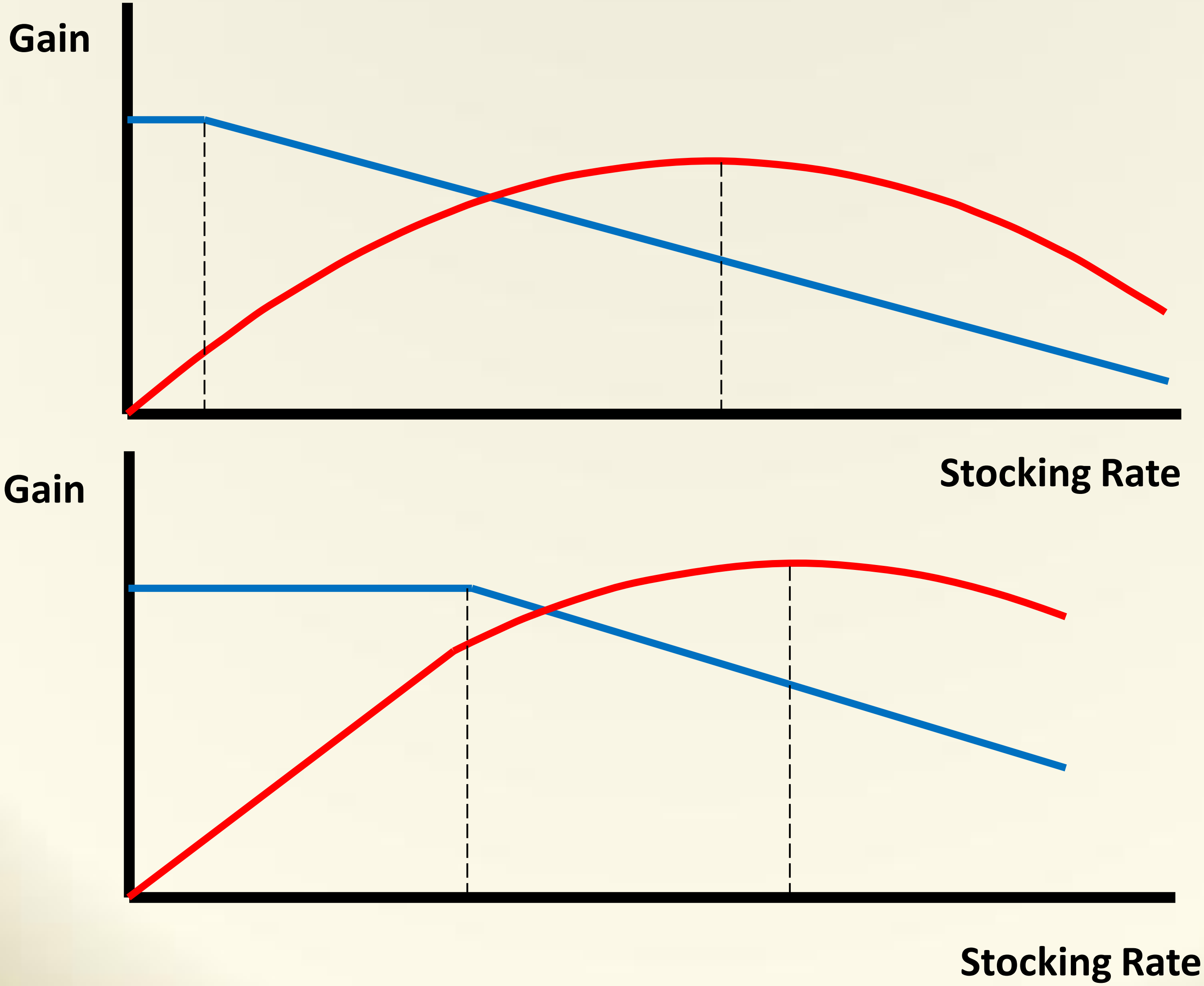
Simplest Representation of Grazing Animal Performance with Feedback



“Optimality” in this Situation



Differences in Scenarios



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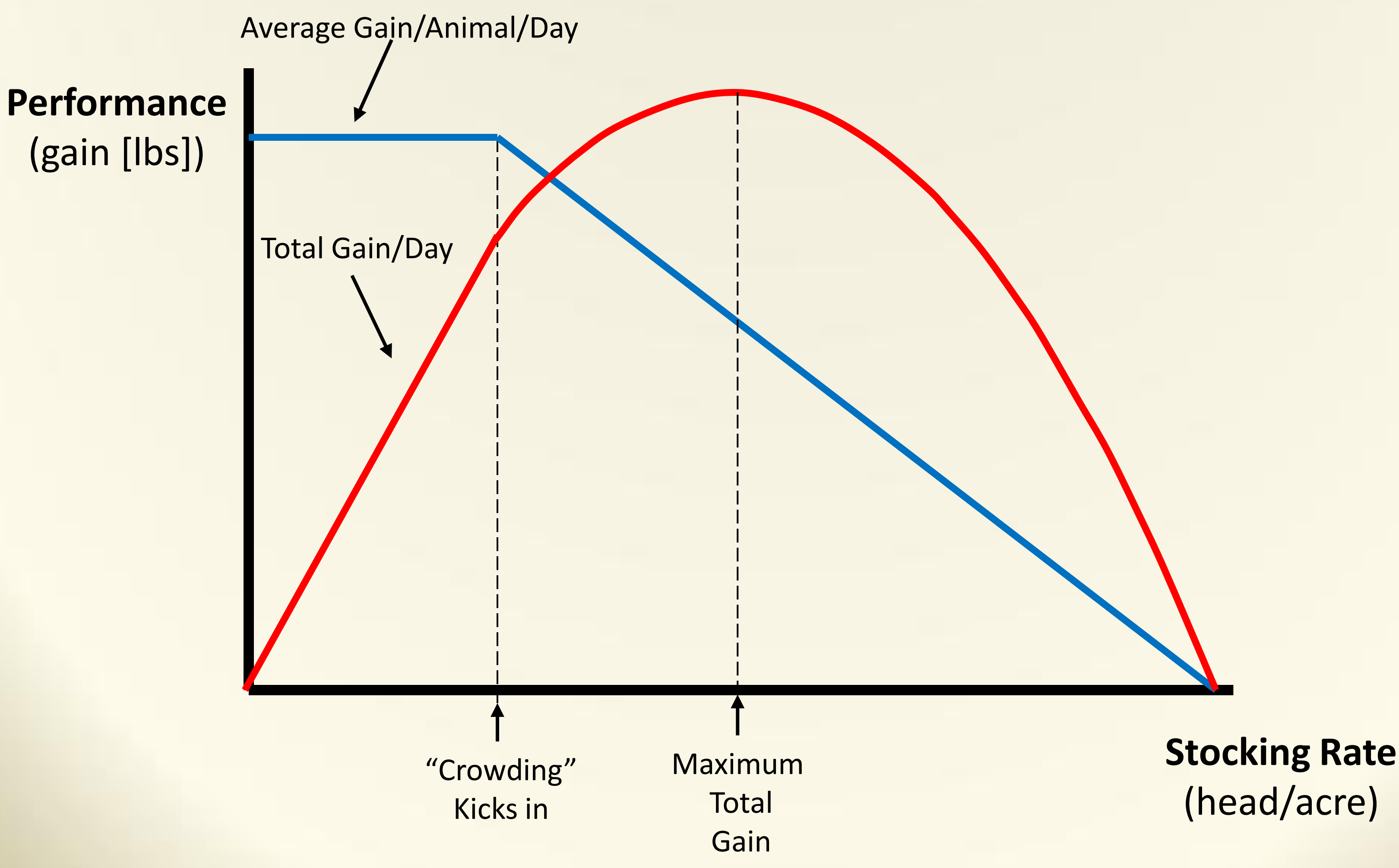
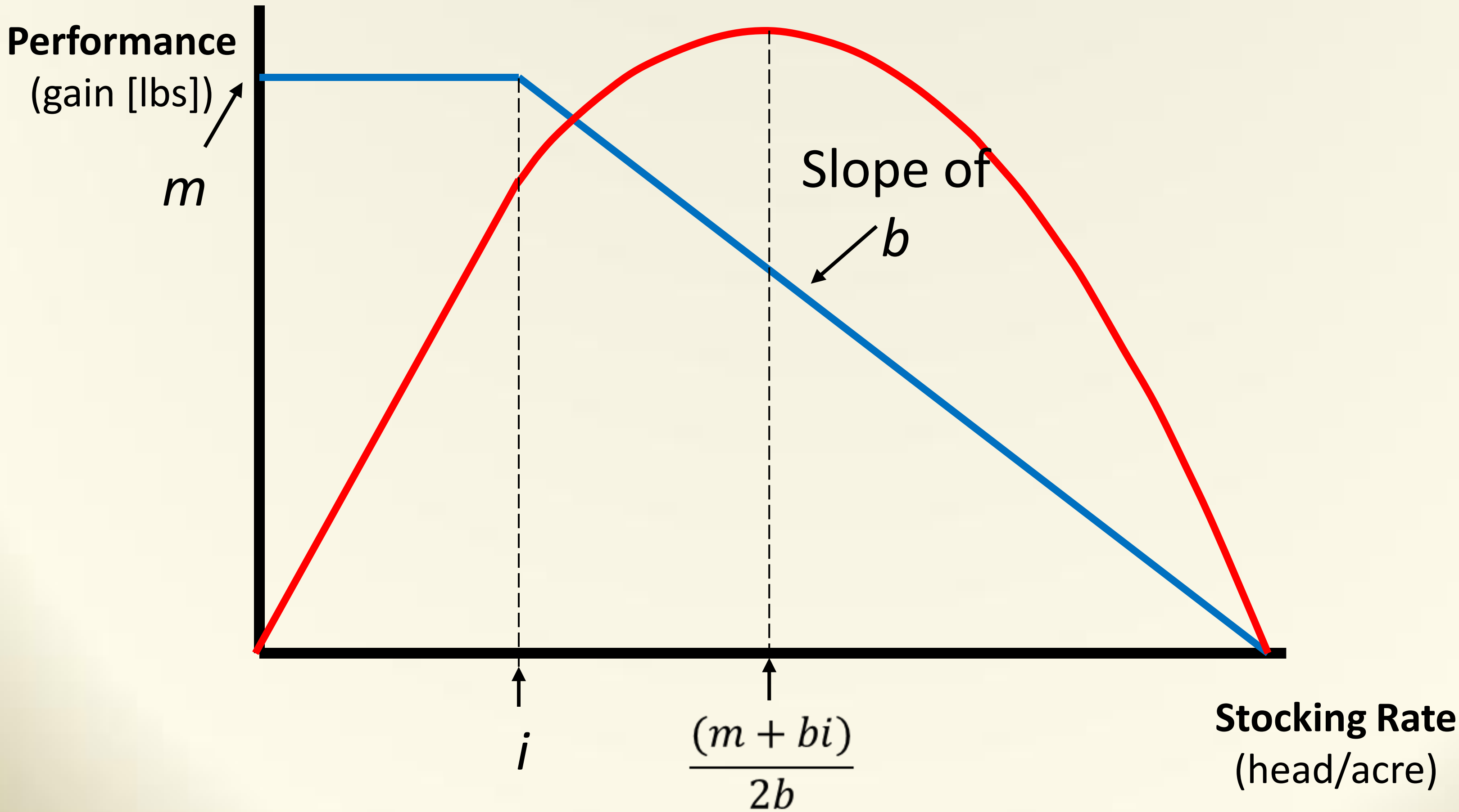


Fun with Math



Fun with Math

- Profit = Total Revenue – Total Cost

  $= [VS(m + bi - bS)] - (cS + F)$

  where:

  V = Value of gain ($/lb)

  S = Stocking Rate (Number of animals/acre)

  m = maximum individual performance (lb)

  b = slope of the individual performance curve

  c = variable costs/ head

  i = max. no. of head with max. individual perf.

  F = Fixed costs or overhead costs ($)

Fun with Math

Production max.

- Profit maximized where:

$$S^* = \boxed{\frac{(m + bi)}{2b}} - \boxed{\frac{c}{2Vb}}$$

where:

V = Value of gain ($/lb)

S = Stocking Rate (Number of animals/acre)

m = maximum individual performance (lb)

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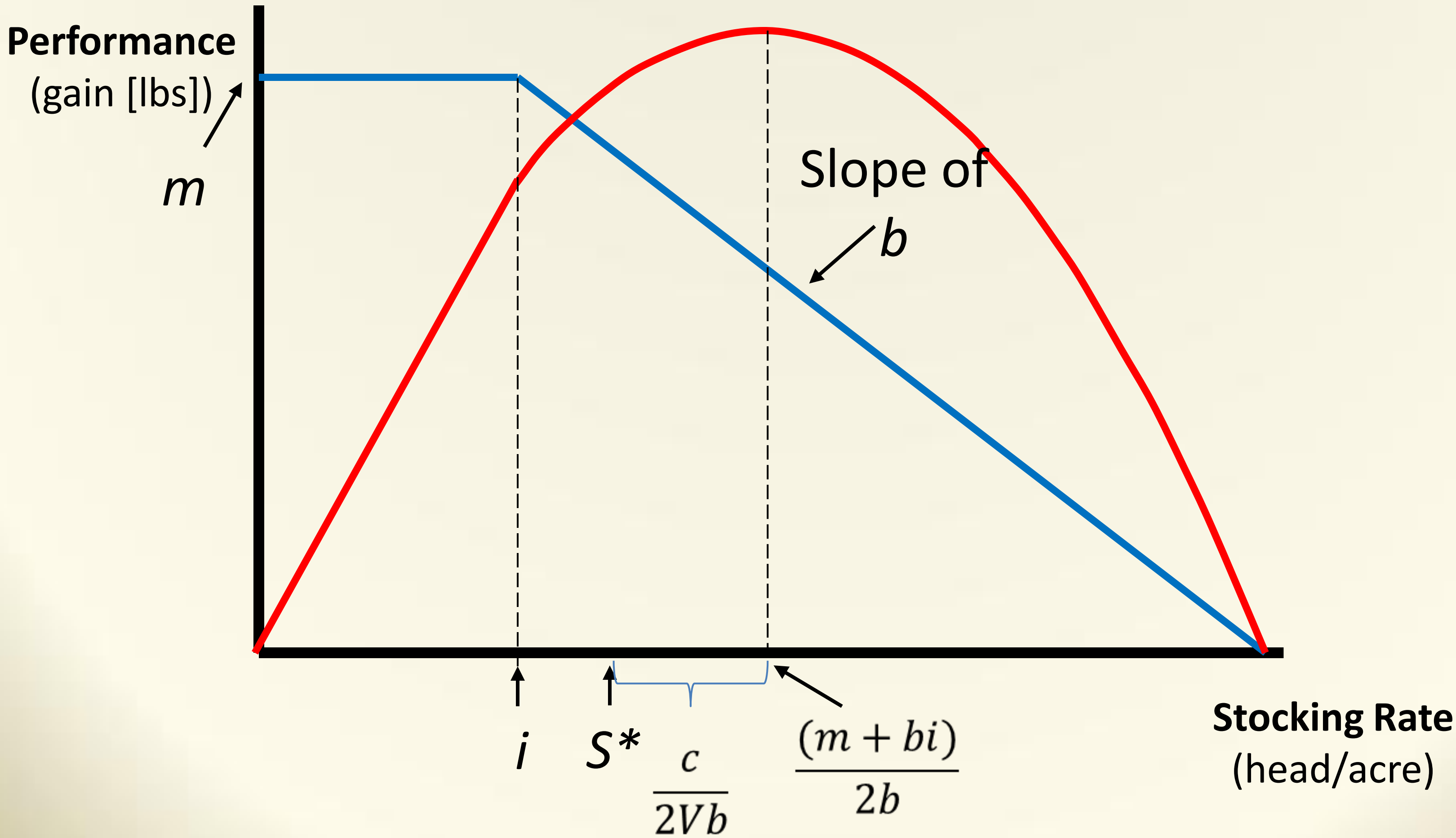
Identifying the Optimal Stocking Rate



A Numerical Example

- Courtesy of work that Dr. Tim Steffens conducted earlier this year
- Representative of a Colorado setting

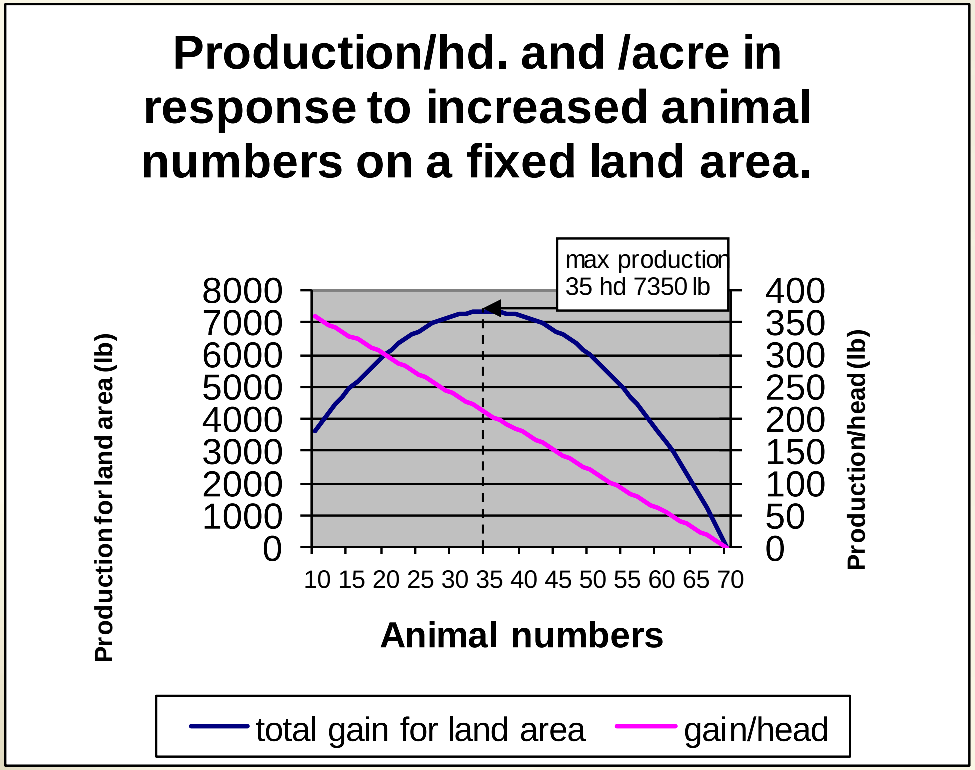
CO Auction Summary 1/13/12

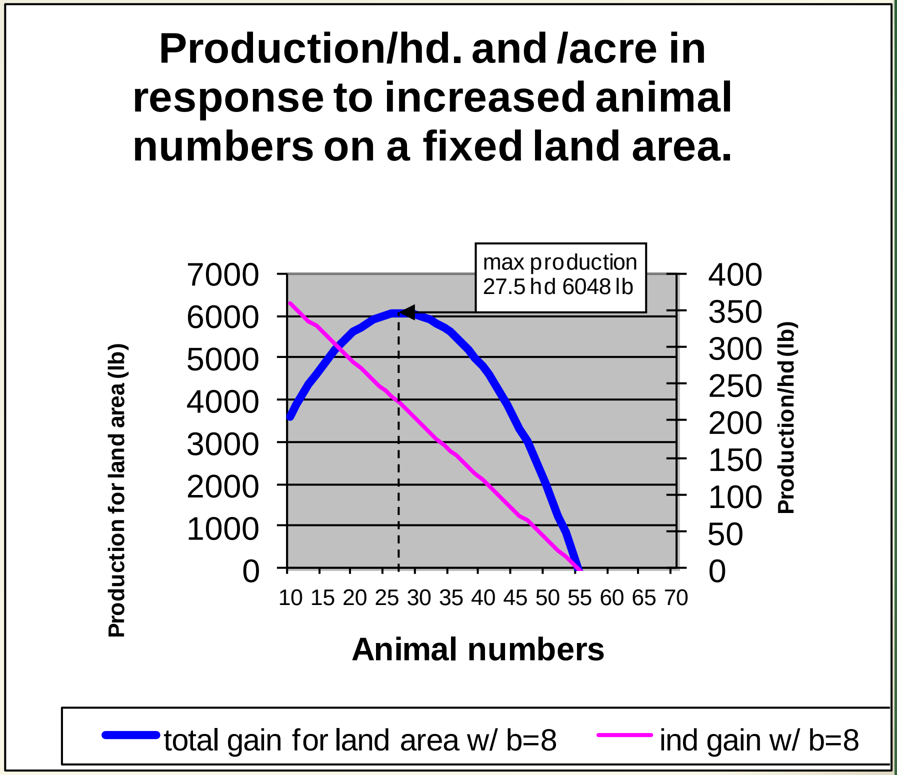
Wt (lb)	Price/lb	Value/hd	Value/lb gain
400	$2.08	$832	
500	$1.81	$905	$.73
600	$1.615	$969	$.685
700	$1.51	$1057	$.75

Price and Performance Parameters

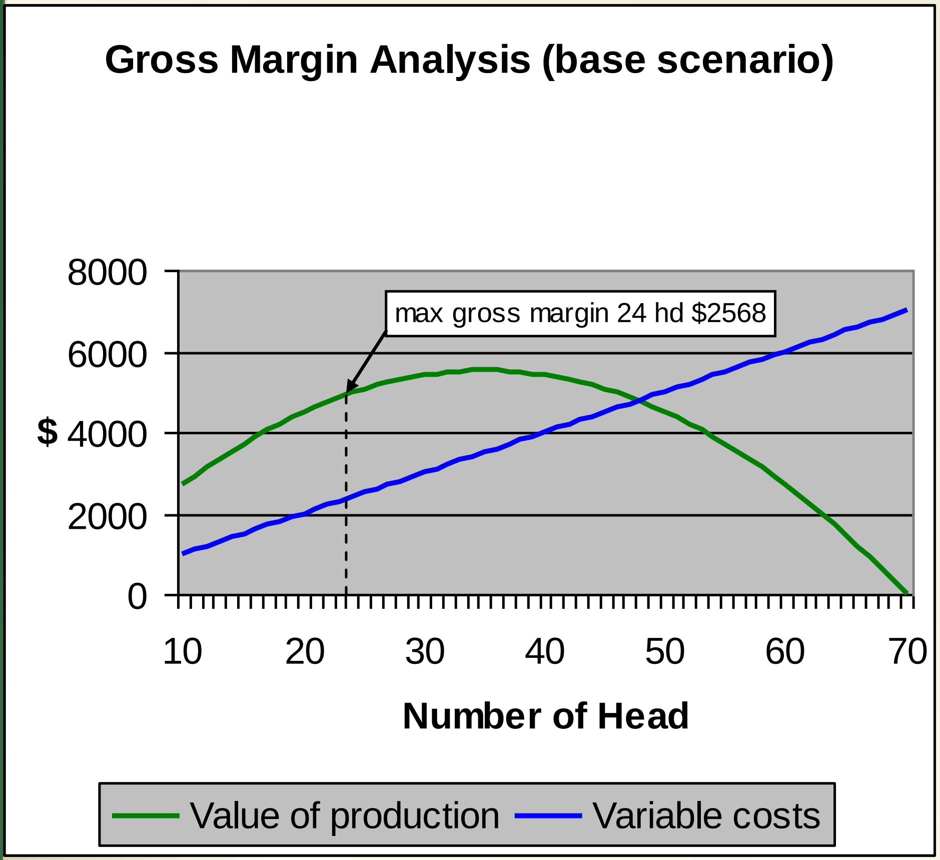
- Base Scenario:
  - Max. individual gain for a 150 day grazing season is 360 pounds
  - Average gain per animal begins to decline when parcel is stocked with 10 head
  - Each additional animal reduces individual average performance by 6 pounds for the season
  - Value of gain is $.75/lb
  - Variable costs are $100/hd
  - Fixed costs are $1750

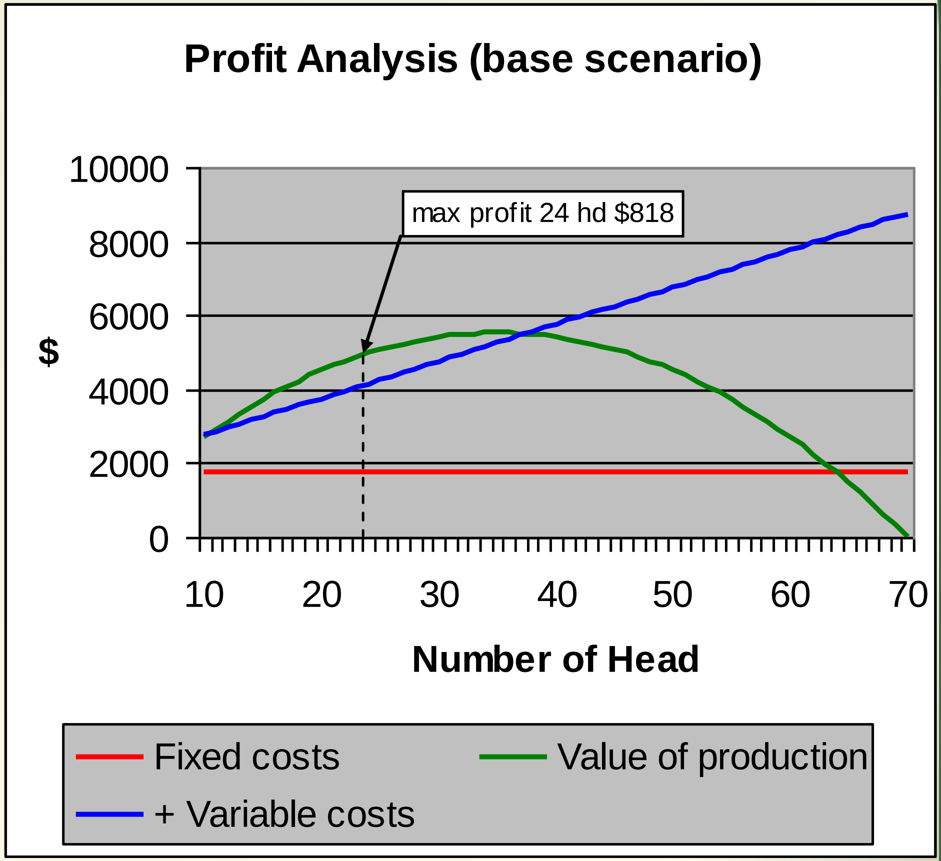
Comparison of Production under Different Response Parameter (b)



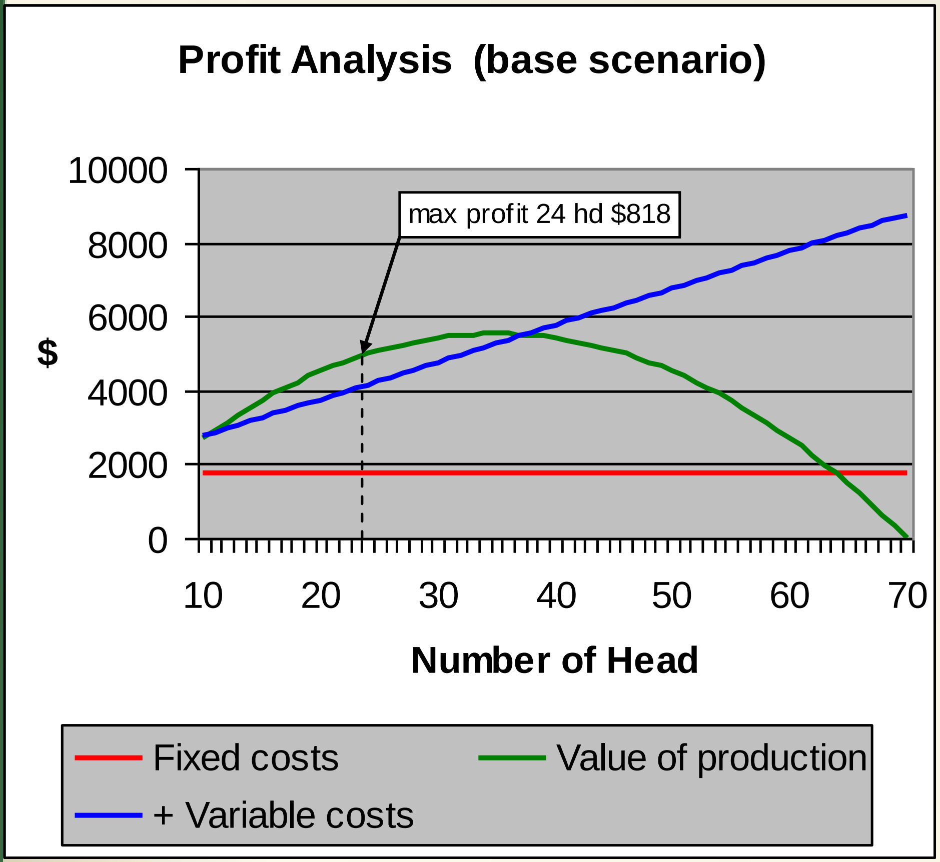


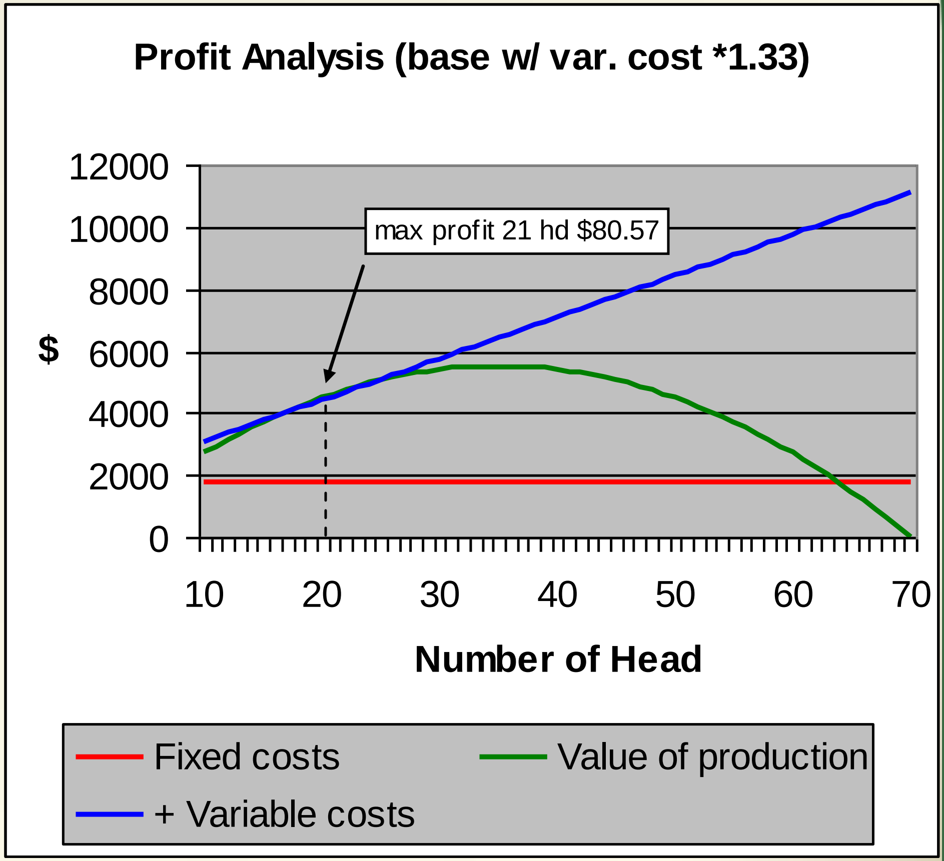
Comparison of Gross Margin Analysis vs. Profit Analysis



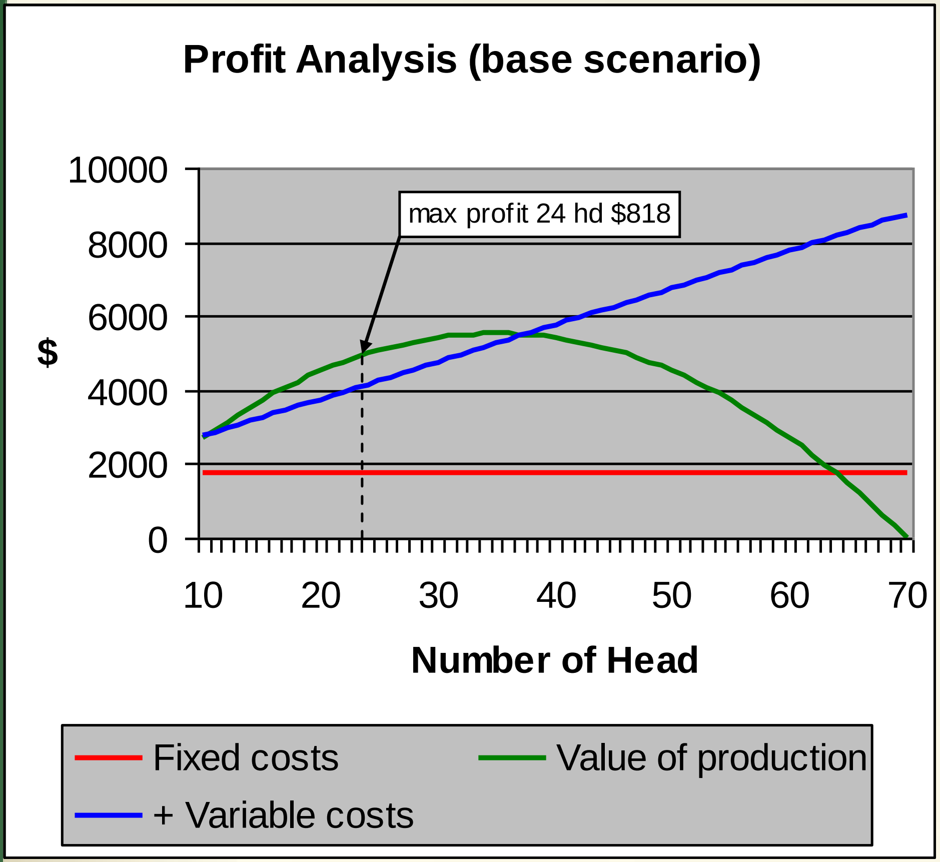


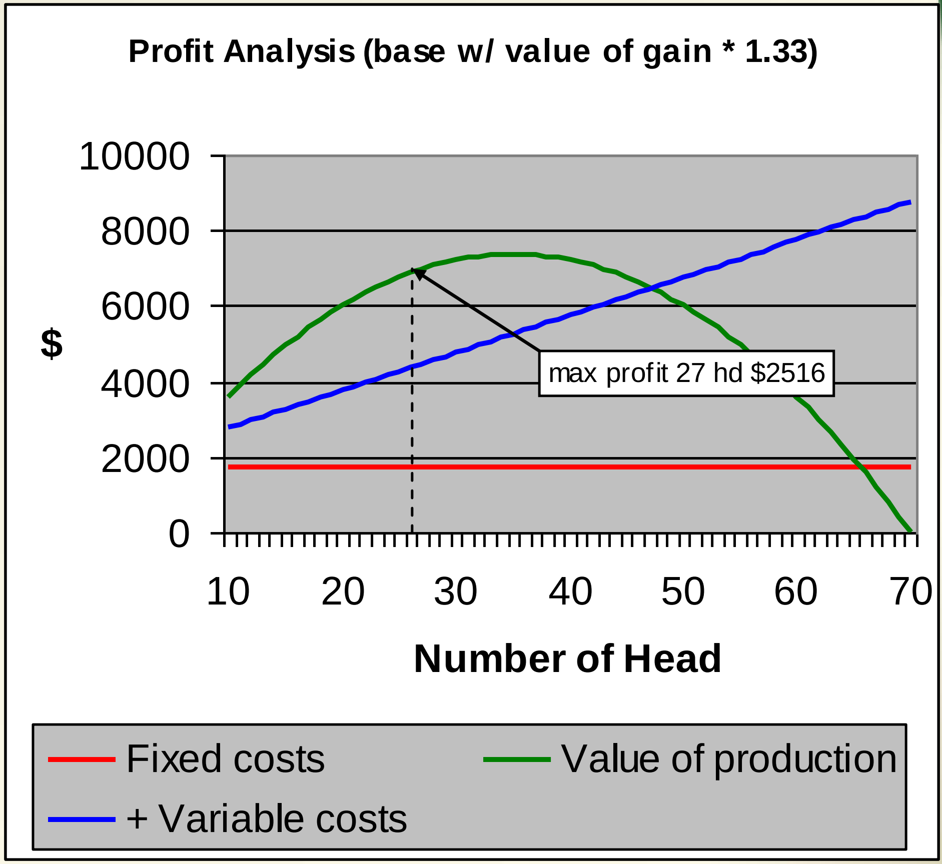
Comparison of Base Scenario with a 33 Percent Increase in Carrying Costs



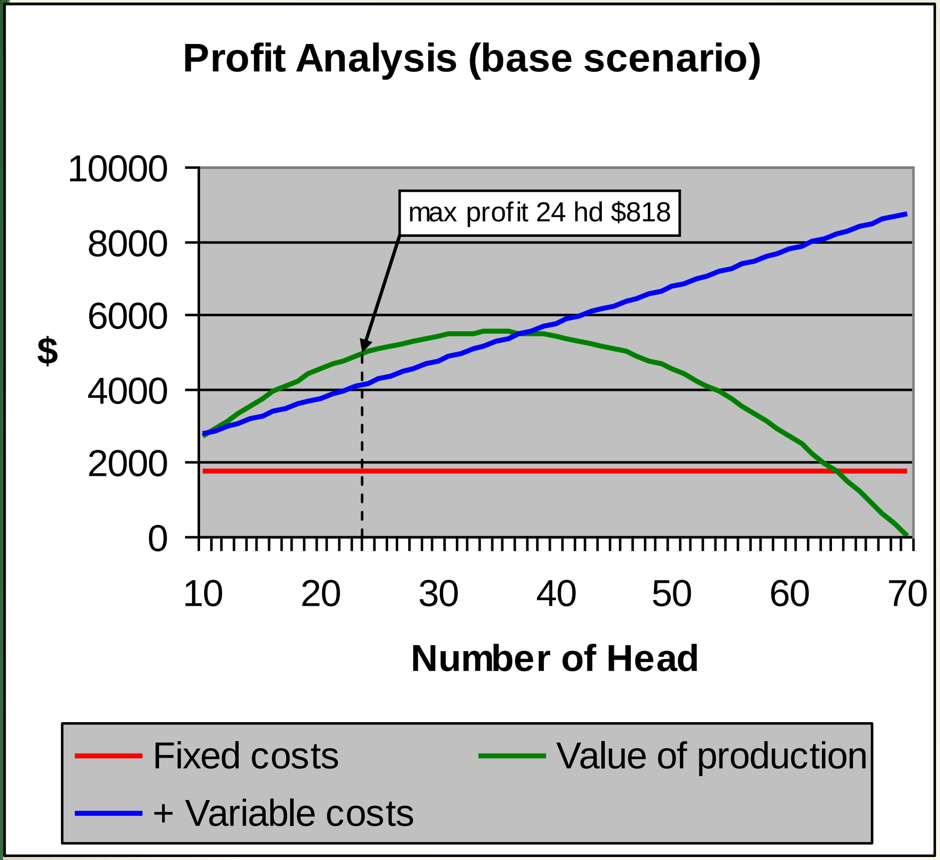


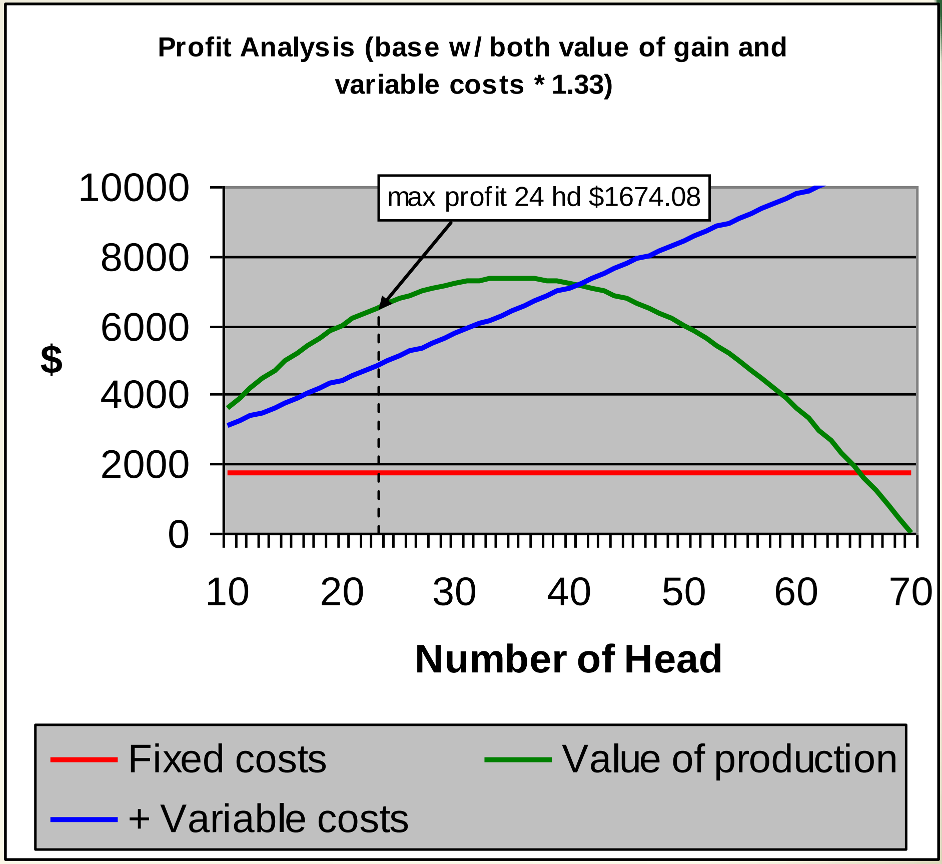
Comparison of Base Scenario with a 33 Percent Increase in Value of Gain





Base Scenario versus a 33 Percent Increase in both Value of Gain and Carrying Costs





Sensitivity of the Optimal Stocking Rate

Production max.

- Profit maximized where:

$$S^* = \boxed{\frac{(m+bi)}{2b}} - \boxed{\frac{c}{2Vb}}$$

where:

S = Stocking Rate (Number of animals/acre)

Biology

m = maximum individual performance (lb)

b = slope of the individual performance curve

i = max. no. of head with max. individual perf.

Prices

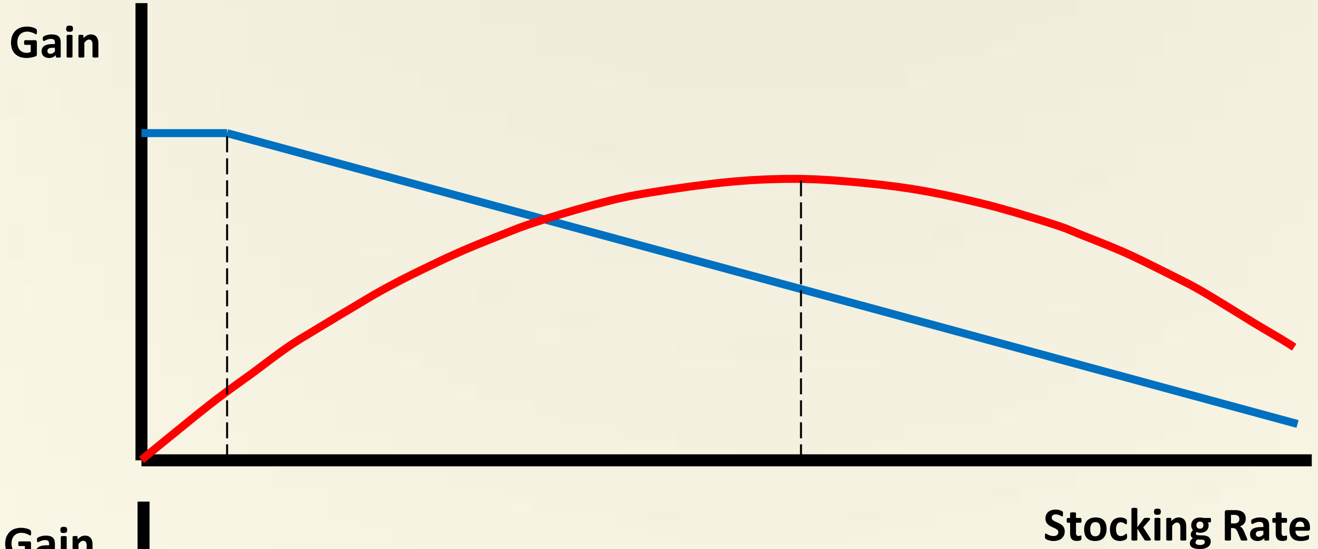
V = Value of gain ($/lb)

c = variable costs/ head

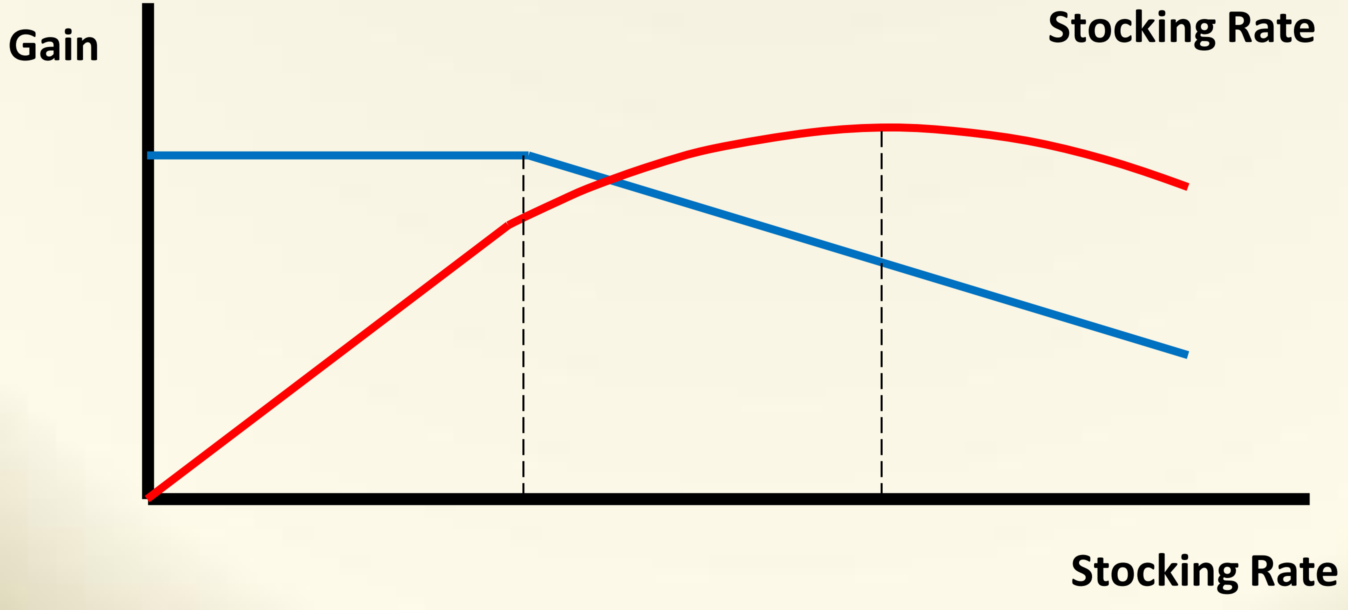
F = Fixed costs or overhead costs ($)

Generalizing Scenarios

(A)



(B)



Caveats of Findings from "Simple" Model

- Not representative of all important elements in the stocking rate decision.
- Does not explicitly account for implications of decisions across time.
- The more "inclusive" we are in suite of alternatives that we wish to compare and the range of benefits and costs, the more difficult it is to obtain parameter estimates that are grounded in reality.

Complexities of Reality

- More “controls” than just Stocking Rate
  - Start and End of the grazing season
  - Animal type
  - Land inputs
- Production, price, and cost relationships can be more complex
- Stocking Rate is inherently a dynamic decision where we can (and do) change it within and across seasons in response to changing states of nature and the economy

Take-Home Lessons

- If there is ANY variable carrying cost for grazing animals, the profit maximizing stocking rate will be less than the stocking rate that maximizes pounds of gain per acre.
- Fixed costs have no bearing on the most profitable stocking rate but WILL affect the amount of that profit.
- Thinking in terms of the tradeoffs faced ***at the margin*** can help managers arrive at outcomes consistent with what the mathematical model would suggest.
- Think in an appropriately broad “accounting stance” of benefits and costs when determining your optimal SR.

Shameless Self-Promotion

- Agricultural and Resource Economics
  - Bachelor of Science in Agricultural Business
    - Traditional Face-to-Face program
    - Online Distance Degree Completion Program
    - Emphasis on Applying Business Principles to Real World Problems
    - Dual Major Programs
- College of Agricultural Sciences
- Warner College of Natural Resources
- Western Center for Integrated Resource Management

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IRM class Fall 2012

Integrated Resource Management (IRM) is the concept within agricultural production that addresses economic and environmental variables that are oriented toward a more sustainable production. Changes in rural America require agricultural managers to manage land, animal, human, and natural resources, ensuring both long term profitability and sustainability of farms, ranches, and rural communities.

At the same time, society demands preservation of open space and outdoor recreation as a requirement in both urban and rural areas. Preservation and sustainability of agricultural land is vital for food security, wildlife habitat, outdoor recreation, and continuing the rural heritage of families and communities. The Master of Agriculture degree gives students the knowledge and skills necessary to operate an agricultural

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addition to formal course work, students are expected to participate in a minimum of one, preferably two, internships as well as complete a professional paper.

Our interdisciplinary research programs address specific problems facing Colorado range livestock producers. Past and current projects target nutrition, reproductive management, quality assurance, land resource management, economic efficiency, intensive sheep management and intergenerational estate transfer.

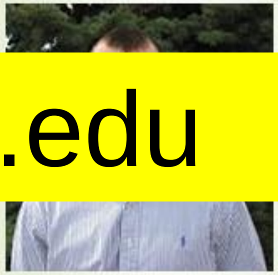
QUICK LINKS

- Nick Petry Workshop 2012 Sign Up
- Class Updates
- Upcoming Events
- Current Job Listings
- College of Veterinary Medicine and Biomedical Sciences
- Warner College of Natural Resources
- Graduate School
- GS6 Instructional Video

IRM Educational Program Video

SPOTLIGHT

KURT THIBAULT



I grew up on my family farm in Massachusetts, where we raise beef cattle for seed stock and the growing local meat market. After obtaining my

Questions?

Photo courtesy of Matt Barnes