

Dynamic modelling of sustainable livestock production systems

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Siziwang Banner, Inner Mongolia May 2006

The problem:

- ☹ Low vegetation cover & biomass
- ☹ Poor livestock productivity
- ☹ High wind erosion risk
- ☹ What strategies will help

rehabilitate grasslands and
improve incomes?

Methodology

- Bioeconomic modelling system
 - Evaluates livestock management
 - Measures grassland condition
 - Estimates soil erosion and impact upon production
- Simulation framework
 - Includes trade-offs for sustainability solutions
 - Considers the long-term
 - Considers economics & biology
 - Evaluates management & policy options for change

Methodology

$$\max J = \sum \pi(x_t, u_t) \delta^t$$

subject to:

$$x_{t+1} - x_t = g(x_t, u_t)$$

J = discounted performance measure

π = measure farm performance

x = stock of natural resources

u = set control decisions

δ = discount rate

g = change in stock of natural resource

States:

- Grassland condition (GC)
 - Soil depth (SD)
- Biomass carryover (HC)

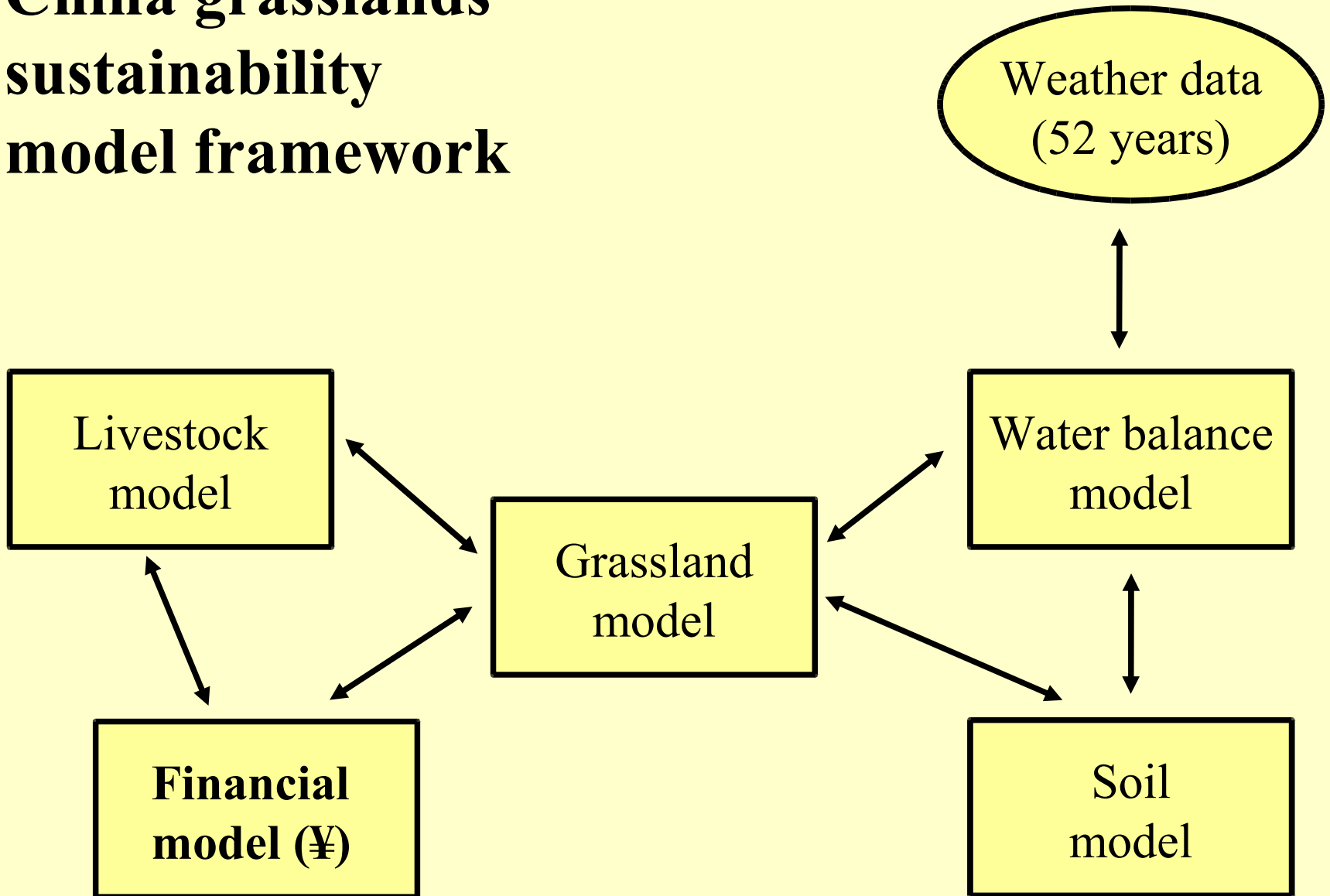
Decisions:

- Stocking rate (SR)
- Supplementary feeding (SF)

Scenarios:

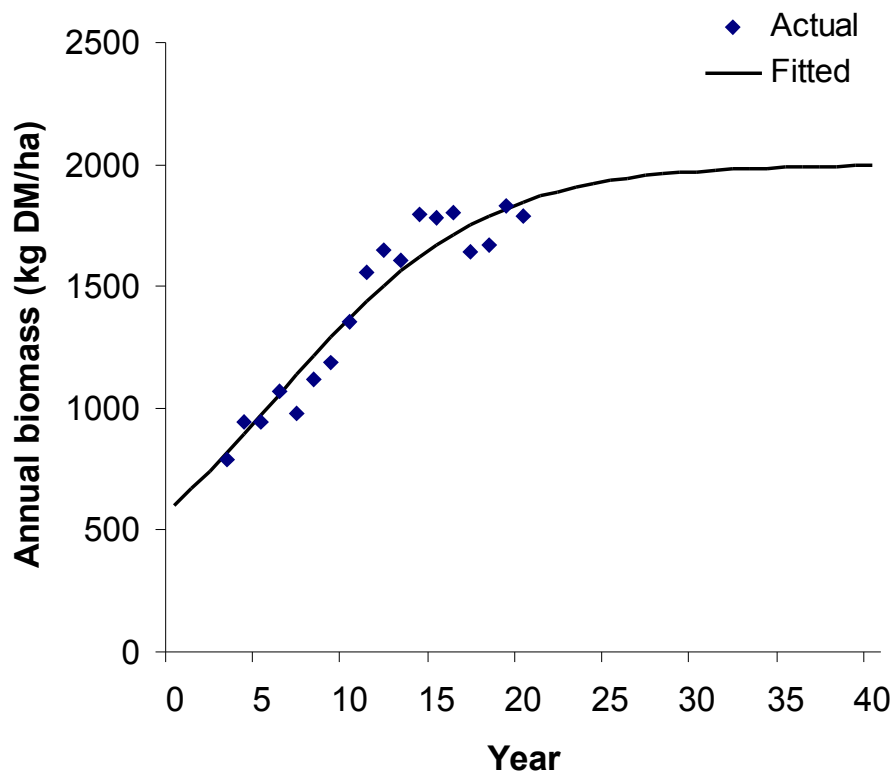
- Continuous stocking
 - Tactical grazing

China grasslands sustainability model framework

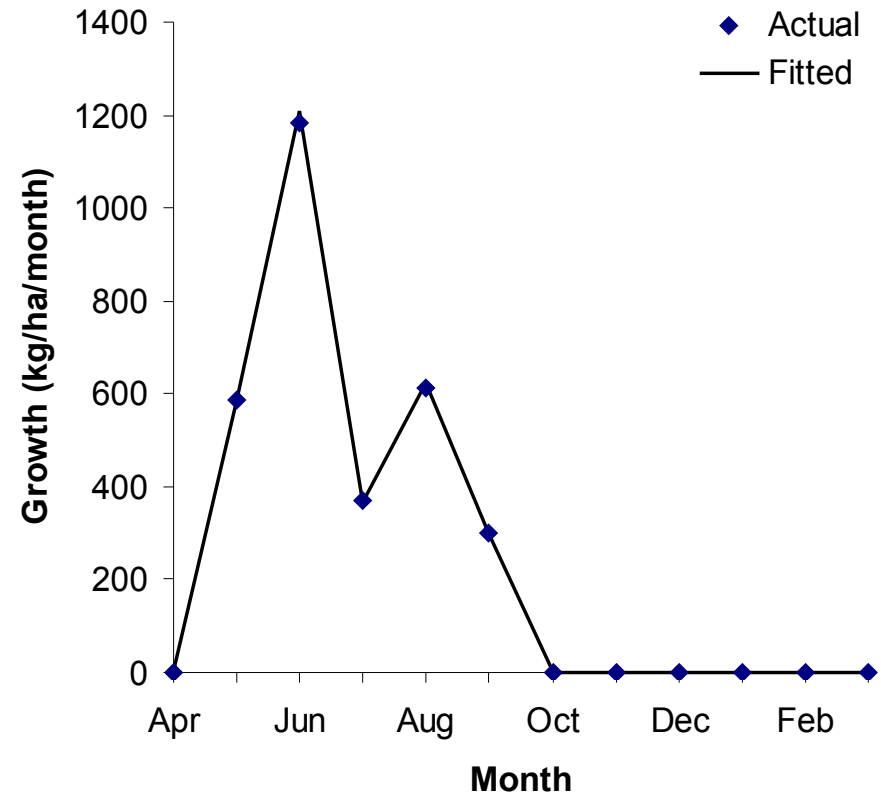


Data – Siziwang Banner

(a) Grassland condition state

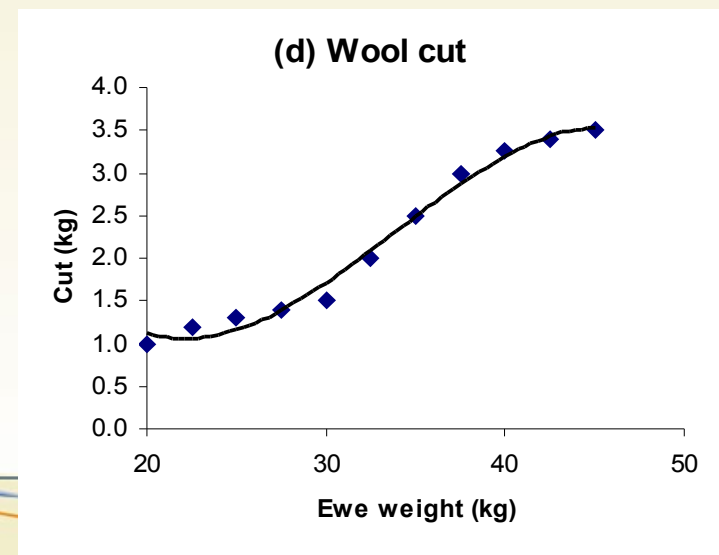
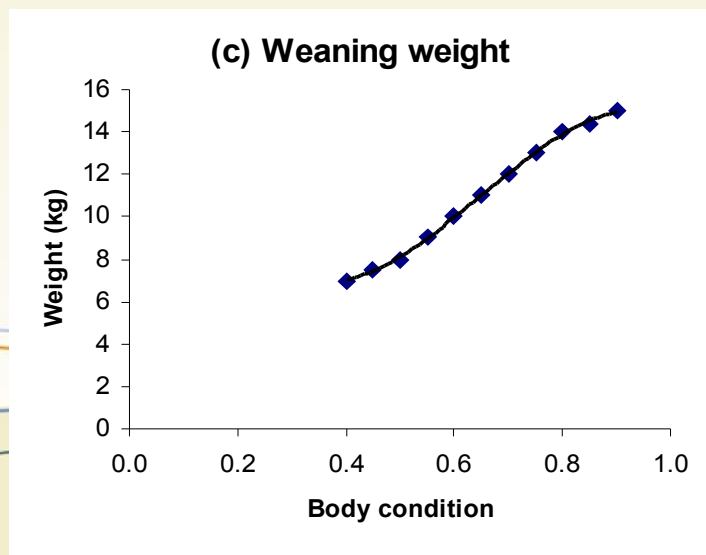
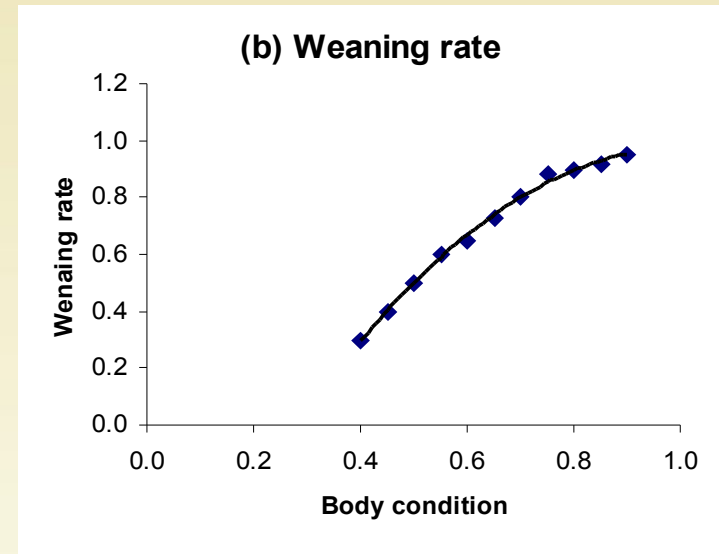
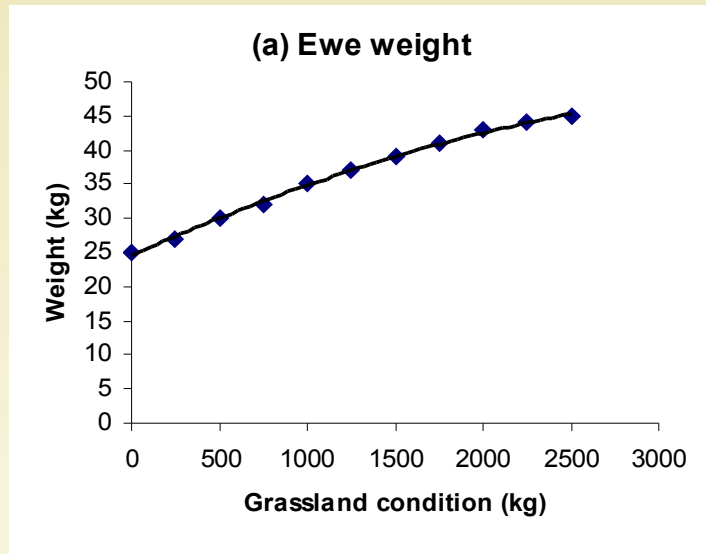


(b) Sigmoid pasture growth curve



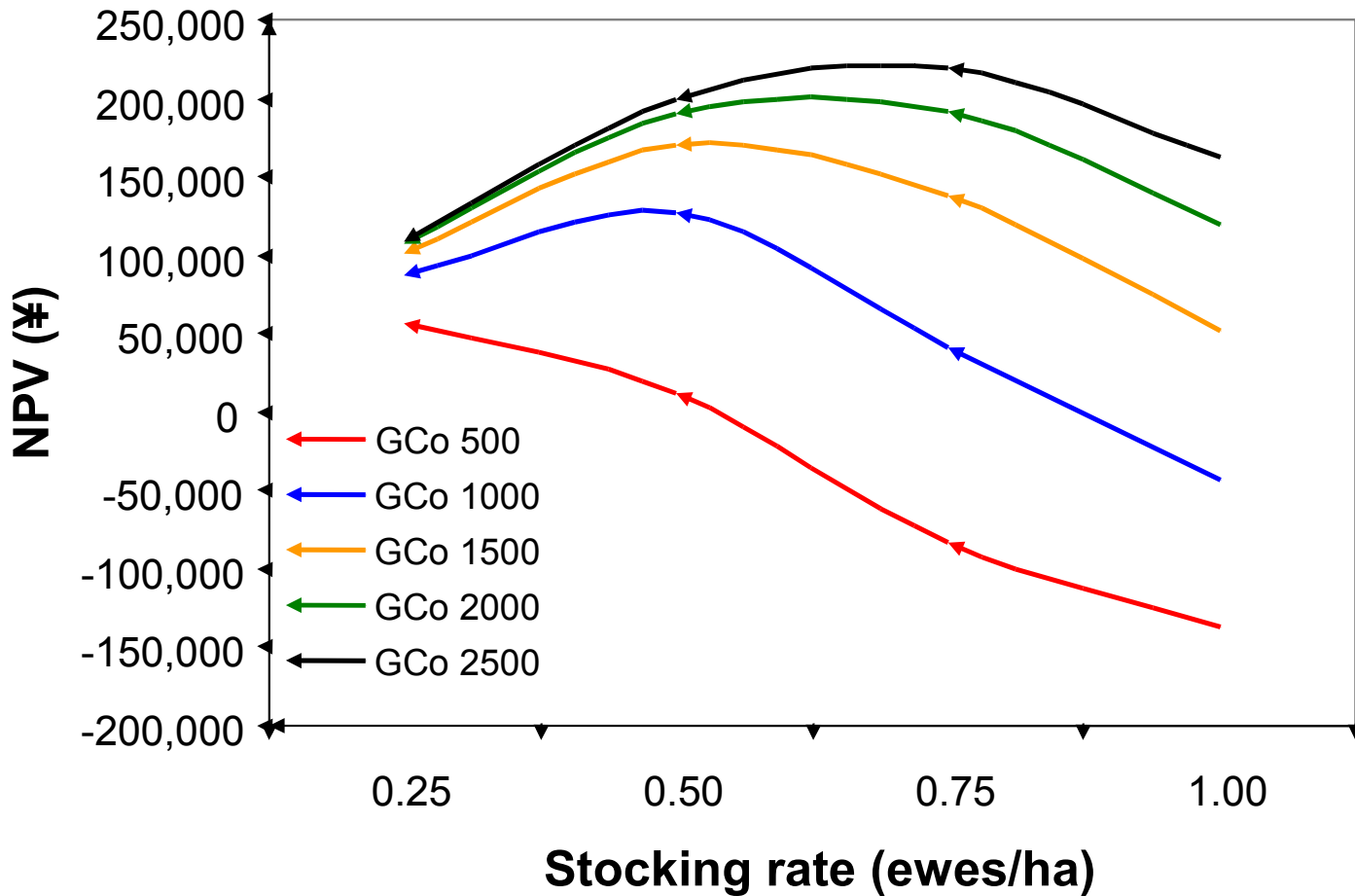
Response functions

Grassland condition important for body weights, weaning rates and wool production

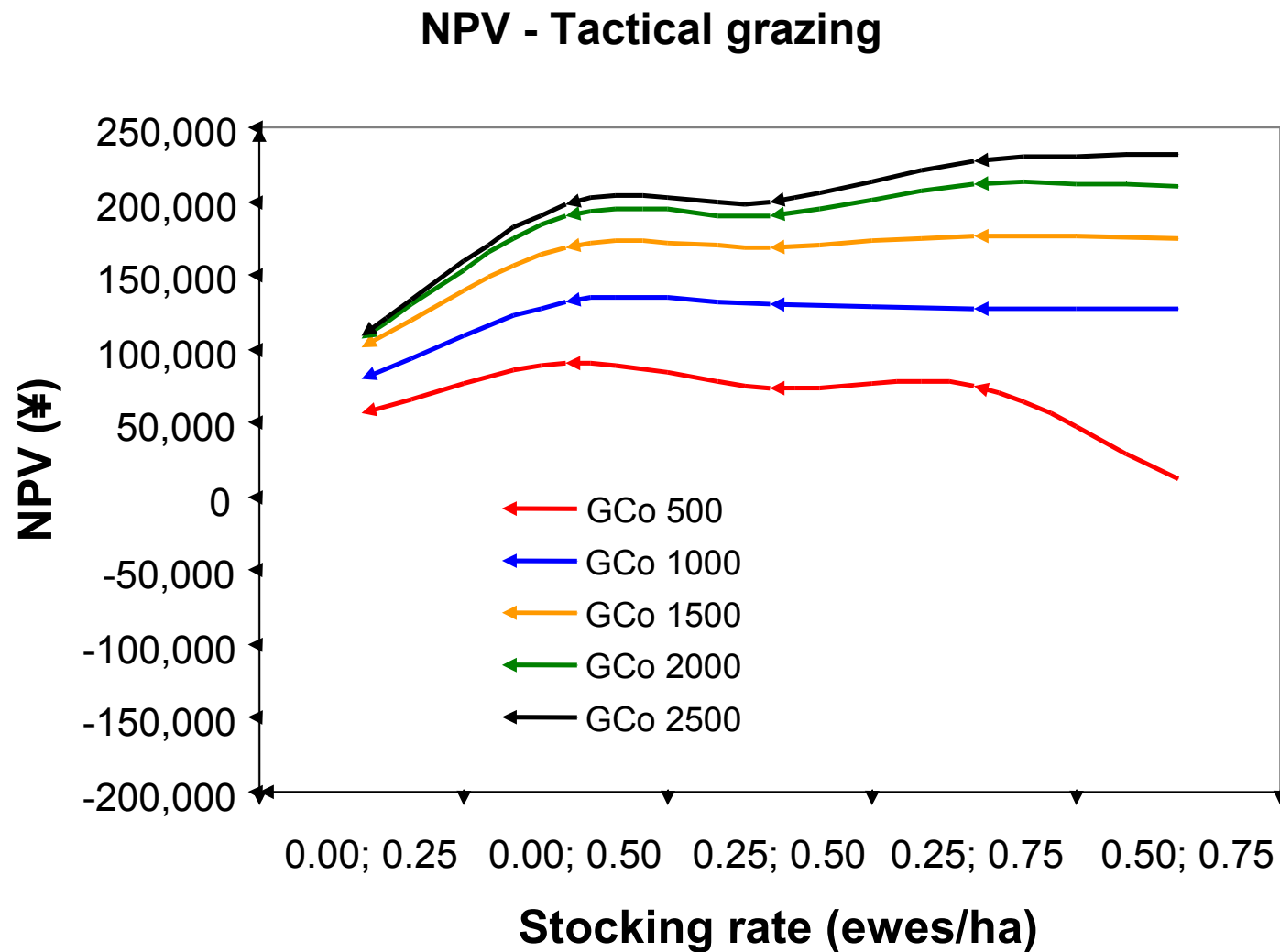


Continuous grazing over 50-years

NPV - Continuous grazing to target herbage mass?

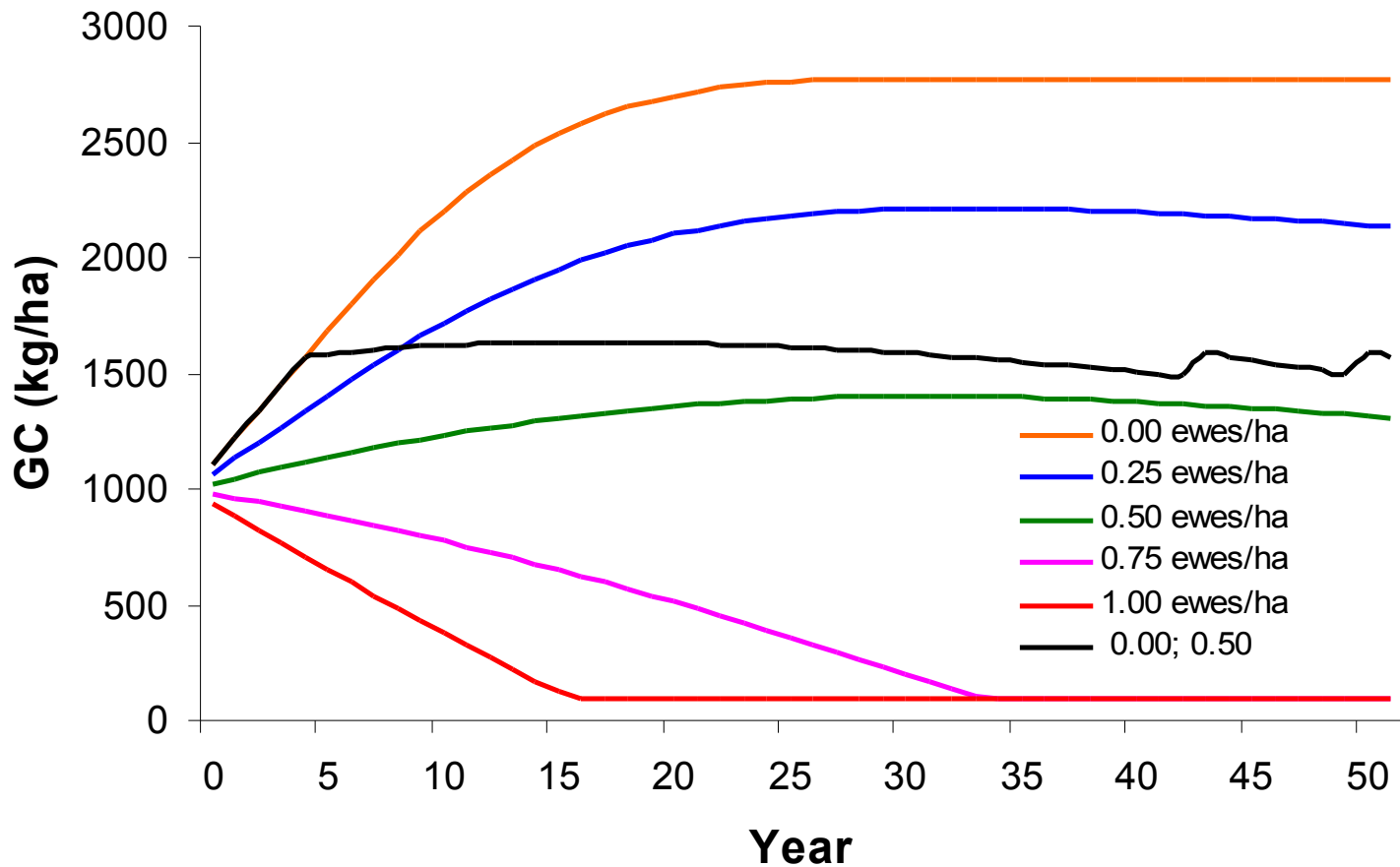


Tactical grazing over 50-years

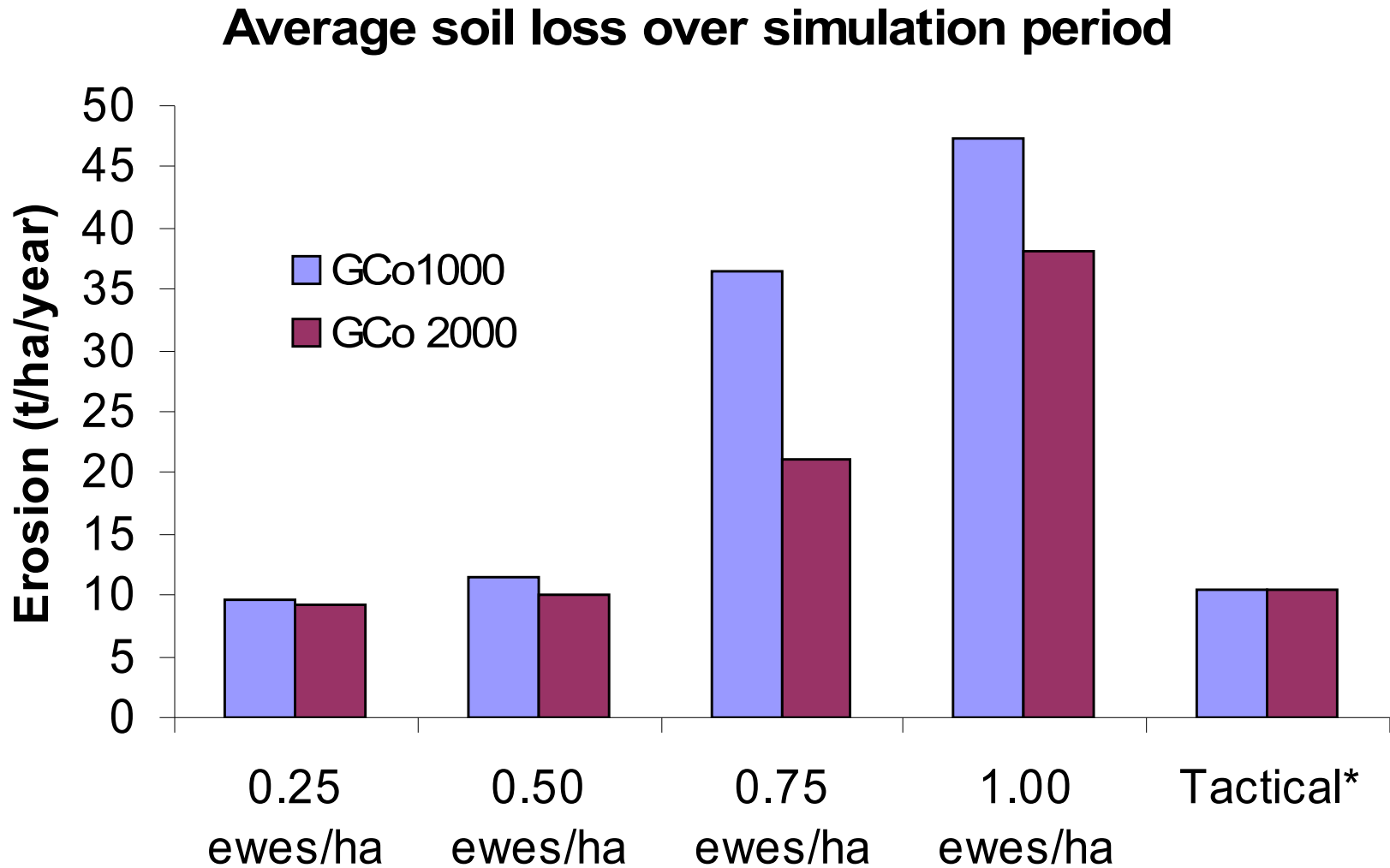


Grassland condition over 50-years

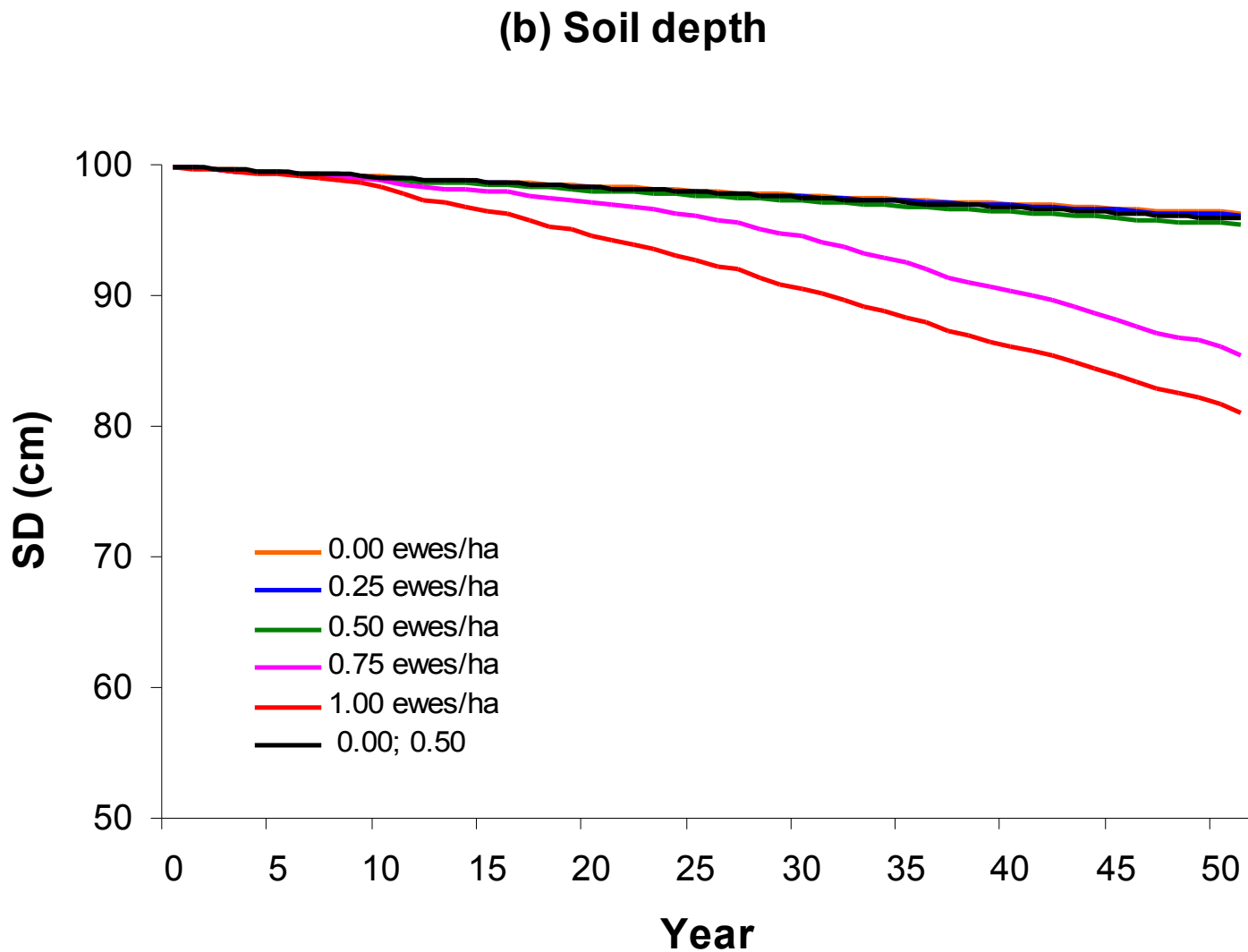
(a) Grassland condition



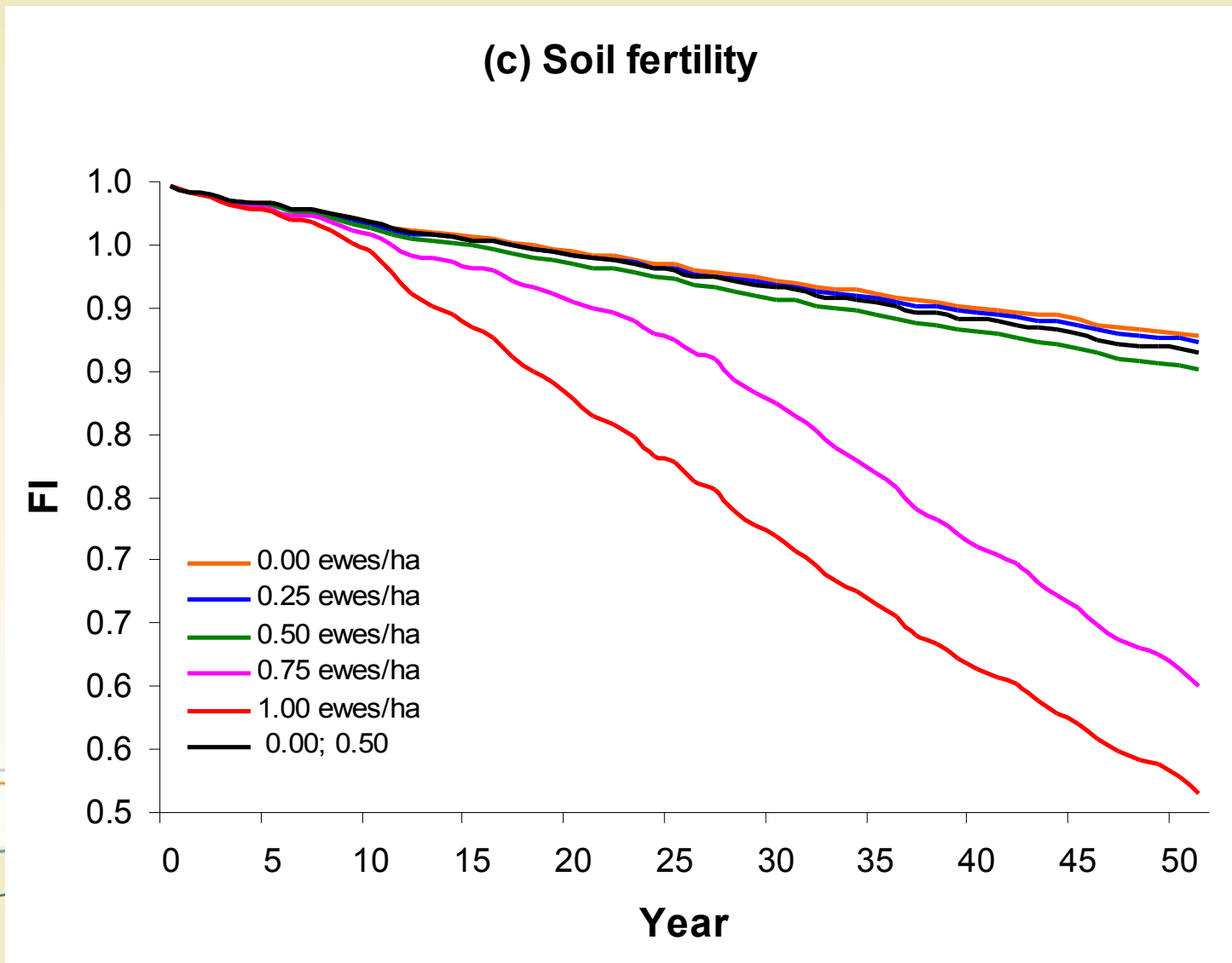
Average soil loss over 50-years



Surface soil loss over 50-years



Soil fertility decline over 50-years



Conclusions

- Current stocking rates of 1 ewe/ha need to be reduced to around 0.25 - 0.5/ha
- Tactical grazing achieves better long-term results, though requires an initial grazing ban
 - Policy issues to consider
- What principles can we extract?
 - Trade-offs to achieve sustainability
 - Costs to China & to farmers