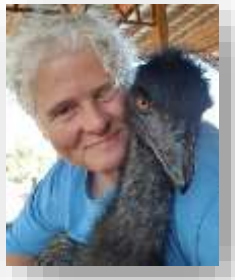
FACT
Food Animal Concerns Trust

Enticing Animals to Eat Unpalatable Plants

Introductions

Food Animal Concerns Trust (FACT) is a national nonprofit organization that works to ensure that all food-producing animals are raised in a humane and healthy manner.



Larissa McKenna & Samantha Gasson
FACT's Humane Farming Program Team
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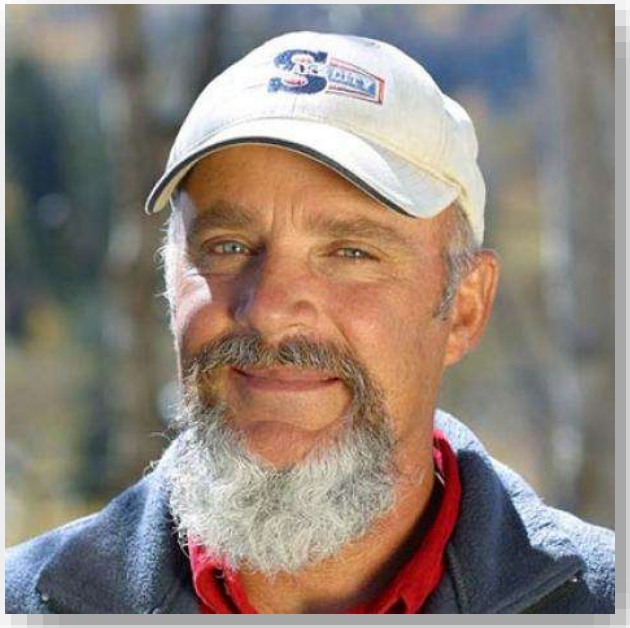
Website: foodanimalconcernstrust.org/

FACT's services to support livestock and poultry farmers include:

- **Humane Farming Mentorship Program** (applications available – ***apply by Nov 30***)
- **Conference scholarships** (ongoing)
- **Customized handouts** (ongoing)
- **Free webinars + short courses** (ongoing)
- **Fund-a-Farmer Grants** (applications available in mid-November)

Our Presenter



Dr. Fred Provenza

Enticing Animals to Eat “Unpalatable” Plants

Herbivores are challenged to select diets from hundreds of species of grasses, forbs, shrubs, and trees, each unique biochemically.

Some species and plant parts are nutritious, others are toxic.

Individual plants can be nutritious or toxic depending on the time of the day, week, and season…

…and on the resources available in the environment where the plant is growing.

Why do animals eat some plants and not others?

Physical Characteristics

Chemical Characteristics

Lack of Experience

How do animals know how to meet needs for nutrients and medicines?

Nutritionists

Pharmacists

Veterinarians

Flavor
Feedback

Wisdom
of the Body

Satiety
Variety

Social
Cultural


Food for Thought

Diets of rabbits are a result of social transmission of food preferences: amniotic fluid, mother's milk, and fecal pellets.

Rabbits are born in winter and early spring, but milkweed doesn't grow until May.

How might young rabbits learn to eat milkweed?

Natal experiences affect food and habitat preferences in a broad range of animal taxa including insects, fish, birds, and mammals (Davis and Stamps, 2004).

A Mother's Lifelong Influence on Diet and Habitat Selection

In utero
Mother's Milk

Mother
as a Model

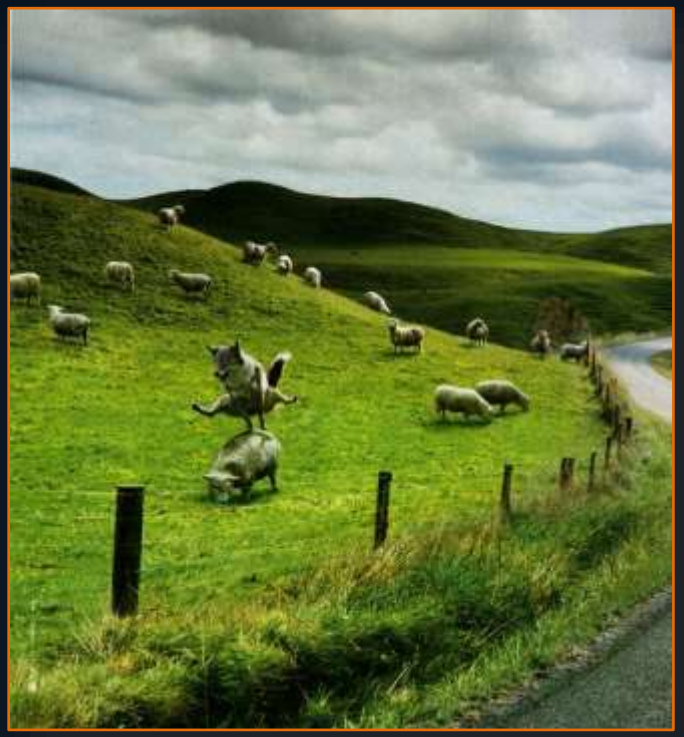
Family Dynamics

Mother adds stability

Offspring add creativity

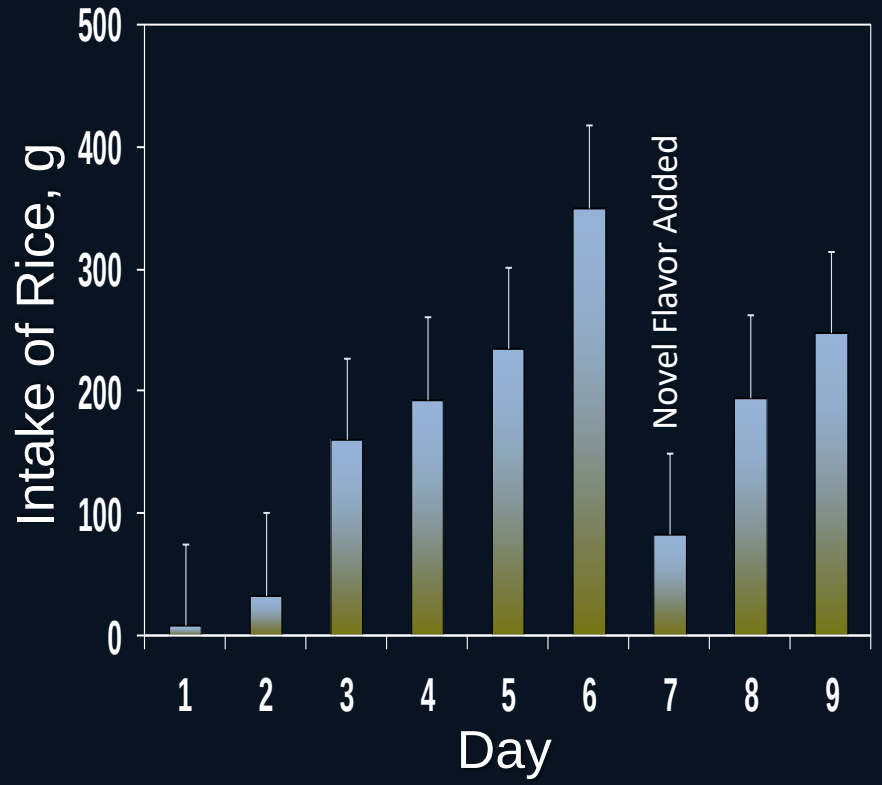
Ewes, Lambs and Douglas-fir

Old dogs can learn new tricks, but young dogs learn them quicker.



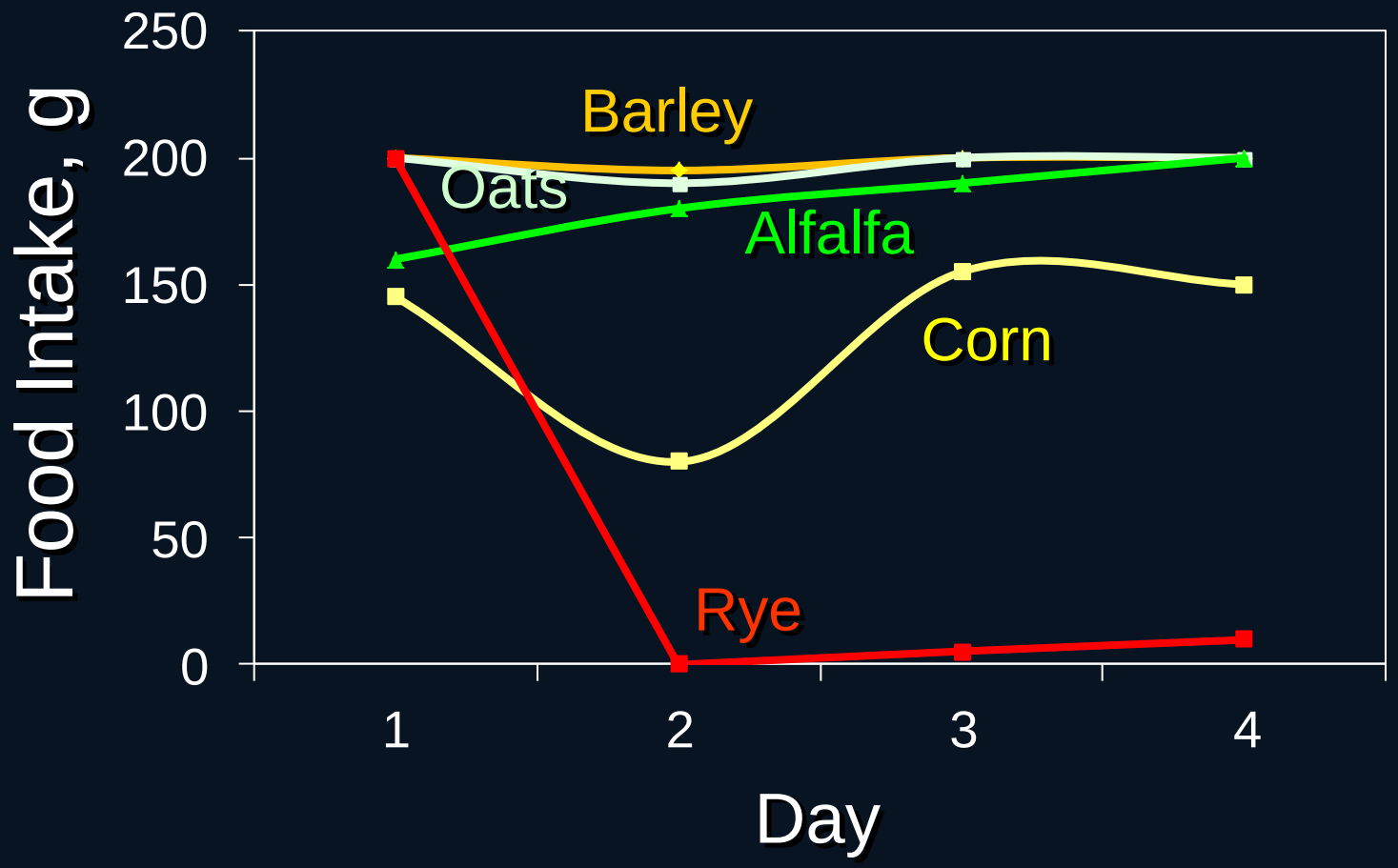
Age and challenge influence how quickly animals can learn.

If nutritional state is adequate, familiarity breeds content, novelty breeds contempt…



…and animals are neophobic.

Familiar-Novel Dichotomy

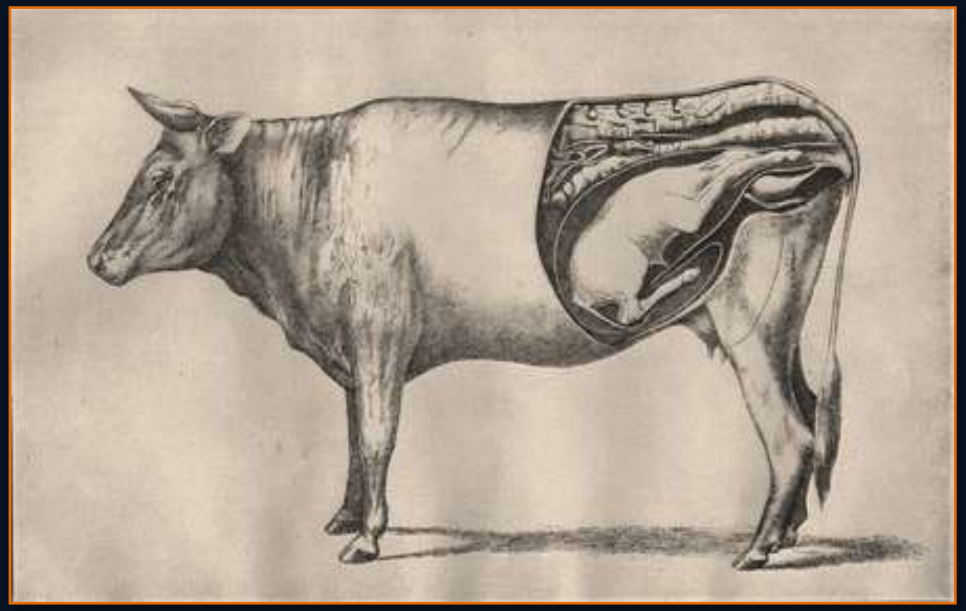


Attractants like molasses can entice livestock to sample unfamiliar plants

Lambs exposed to saltbush *in utero* grow faster and handle a salt load better than lambs from mothers on pasture…

…they excrete salt more rapidly, drink less water and maintain higher intake when eating saltbush.

Calves exposed to straw in utero eat more straw, digest straw better, and grow faster than calves not exposed to straw.



Mature cows, who were fed straw as calves 5 years before the study…

- ✓ digest straw better
- ✓ higher body weight/condition
- ✓ produced more milk
- ✓ shorter post-partum intervals

…when fed straw as the bulk of the diet during pregnancies from 5 to 8 years of age.

Young goats reared by their mothers on blackbrush, a shrub high in fiber and tannins...

…ate 2.5 times more blackbrush than did goats naive to blackbrush.

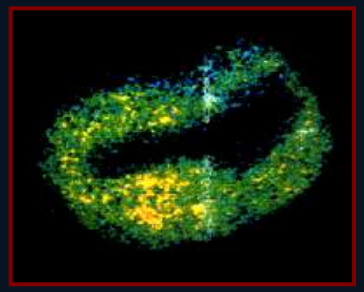
When allowed to choose, experienced goats ate 30% more blackbrush than did inexperienced goats at any level of alfalfa pellet availability, which ranged from 20% to 100% of ad libitum.

Preference for plants high in secondary compounds is not due solely to breeds, as illustrated in cross-fostering studies with two breeds of goats.

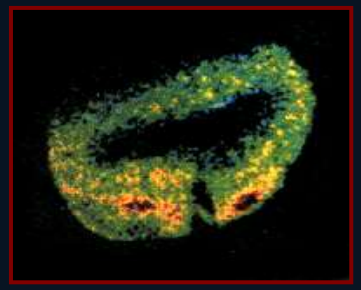
Offspring from one breed (Damascus) were reared from birth by females from the other breed (Mamber) and vice-versa.

The preferences of the kids for high-tannin browse strongly reflected the preferences of their foster mothers.

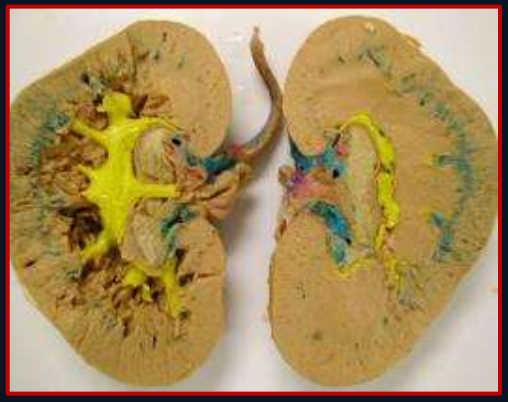
Experiences influence gene expression, which influences form, function, and behavior and ever-changing environments ensure no two individuals are alike.

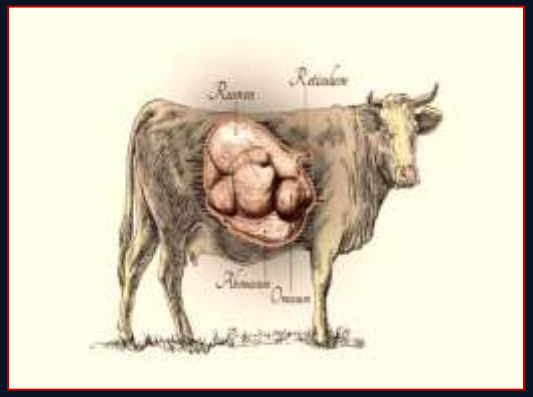


Enhanced neural response to familiar olfactory cues



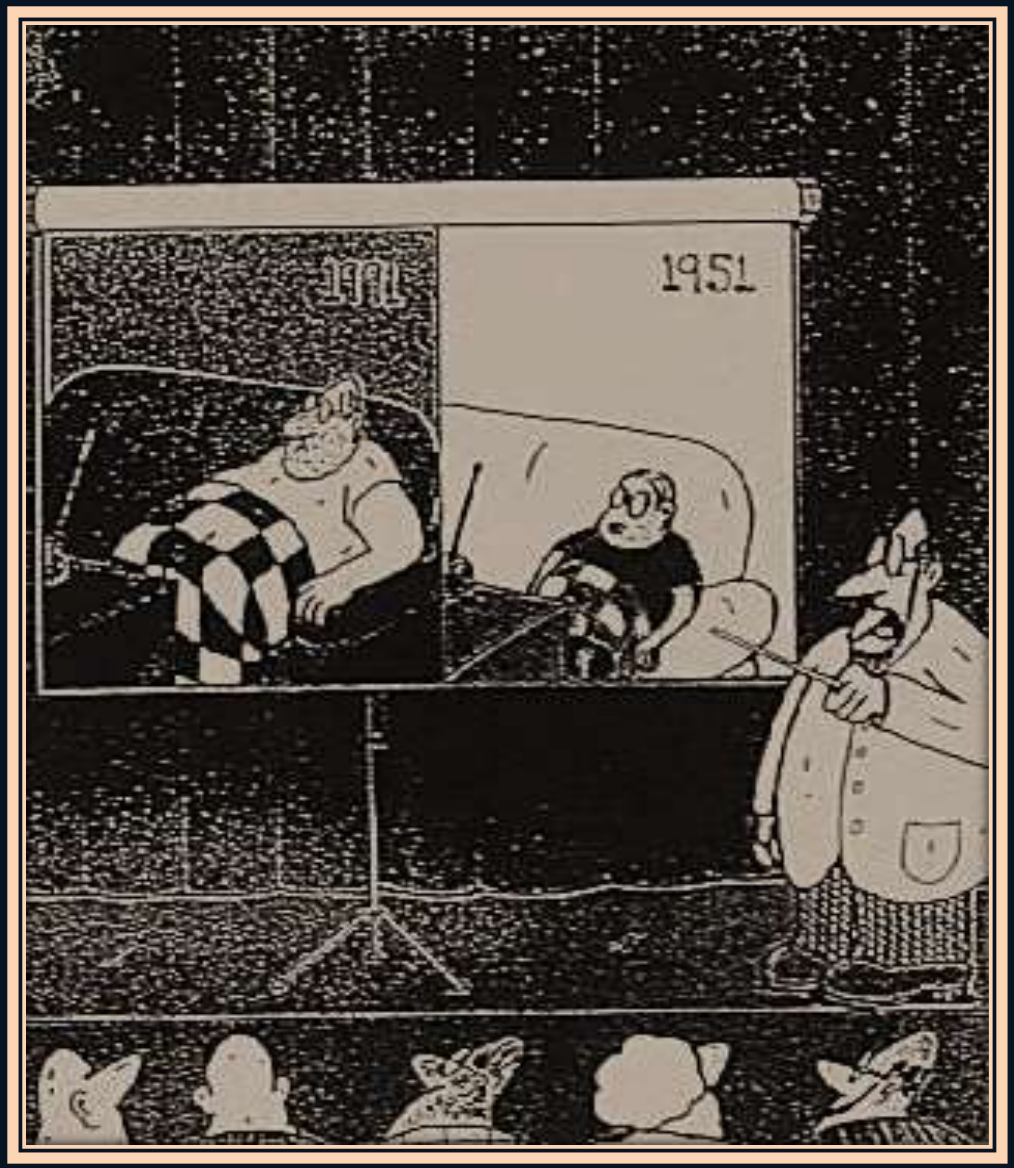
Enhanced kidney function





Altered rumen development

Therefore, after a forty-year case study, it is my contention that couch potatoes actually begin to develop early in life as tater tots…



On the riverbank…

In the ocean…

In the Arctic…

In India…

In Africa…

In Africa…

In Africa…

In Africa…

In Your House

Somewhere near Walmart

Diets of rabbits are a result of social transmission of food preferences: amniotic fluid, mother's milk, and fecal pellets.

Rabbits are born in winter and spring, but milkweed doesn't grow until May.

Compounds in mother's diet, stored in her fat and released during pregnancy, provide flavor cues from milkweed eaten the previous season.

amygdalin

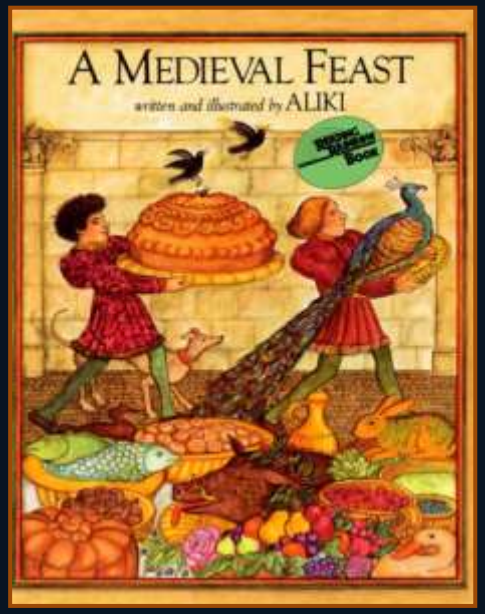
Flavor
Feedback

Wisdom
of the Body

Satiety
Variety

Social
Cultural

What is Palatability?




OPEN
Picante Sauce
Gerber
2ND FOODS

Liking for Food

Palatability is more…

…than a matter of taste

Feedback Cells/Organ Systems

Primary Compounds

Secondary Compounds

Metabolically Mediated Flavor-Feedback Associations Alter Liking for Food as a Function of Need

Primary Compounds

- Energy (cellulose, starch, glucose, VFAs)
- Protein (NPN, rumen degradable, bypass)
- Minerals (Na, P, Ca, Se, S)
- Vitamins (E)

Secondary Compounds

- Phenolics
- Alkaloids
- Terpenes
- Nutrients
- Medicines

Interactions among Primary and Secondary Compounds

Herbivores are challenged to select diets from hundreds of species of grasses, forbs, shrubs, and trees, each unique biochemically.

Some species and plant parts are nutritious, others are toxic.

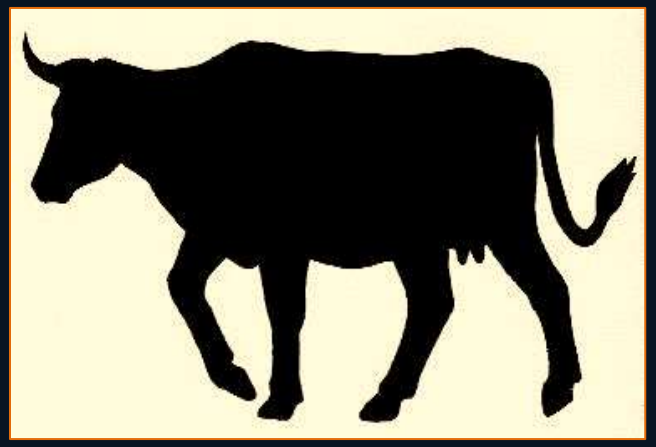
Individual plants can be nutritious or toxic depending on the time of the day, week, and season…

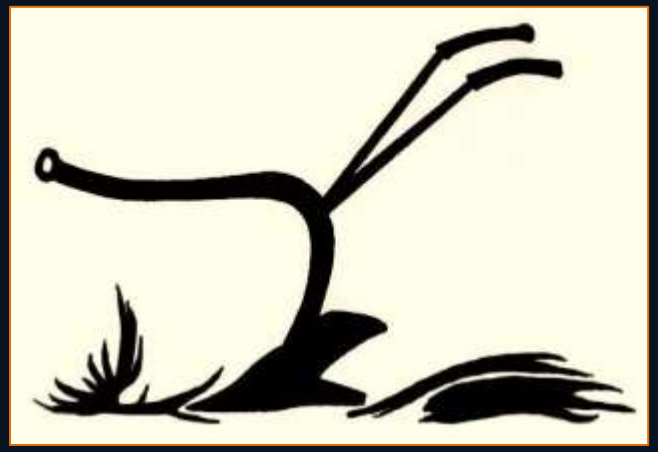
…and on the resources available in the environment where the plant is growing.


Food for Thought

Is it better to make animals hungry so they will eat plants?

Or, should you supplement then with energy and protein?





The Ax, the Cow, the Plow, and the People
Managing Livestock Grazing for Biodiversity

Rejuvenating Sagebrush-Steppe

Turning cattle and sheep into low-cost rejuvenators of sagebrush-steppe Oregon, Montana, Nevada, Wyoming and Utah.

Spring grazing → favors sagebrush over grasses/forbs → young sagebrush avoided → leads to re-establishment of sagebrush with time

Increase sage, Decrease herbs

Less plant and animal diversity

Decrease in nitrogen

Increase lignin and terpenoids

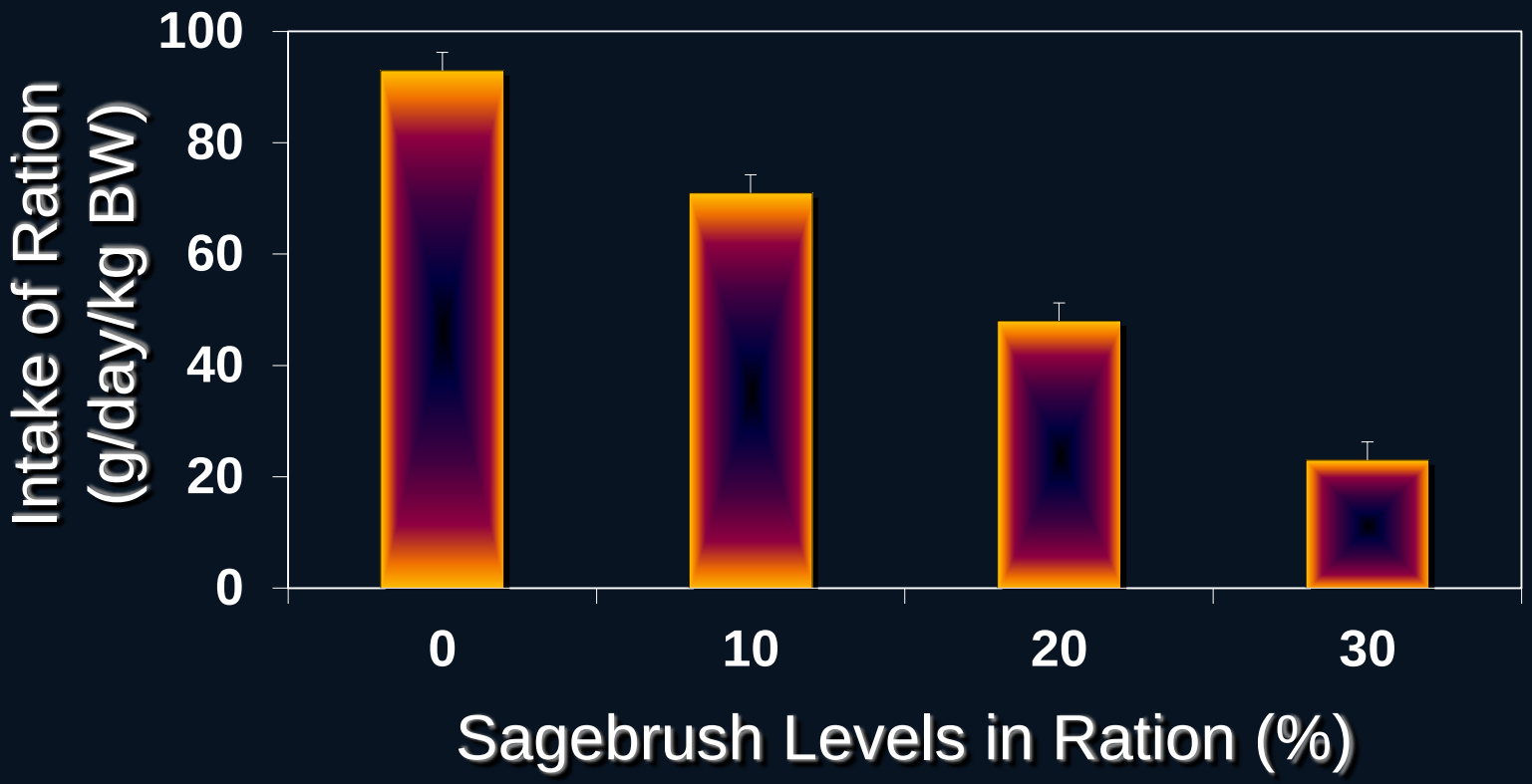
Decrease rates of plant decomposition and nutrient cycling

Timing of Grazing

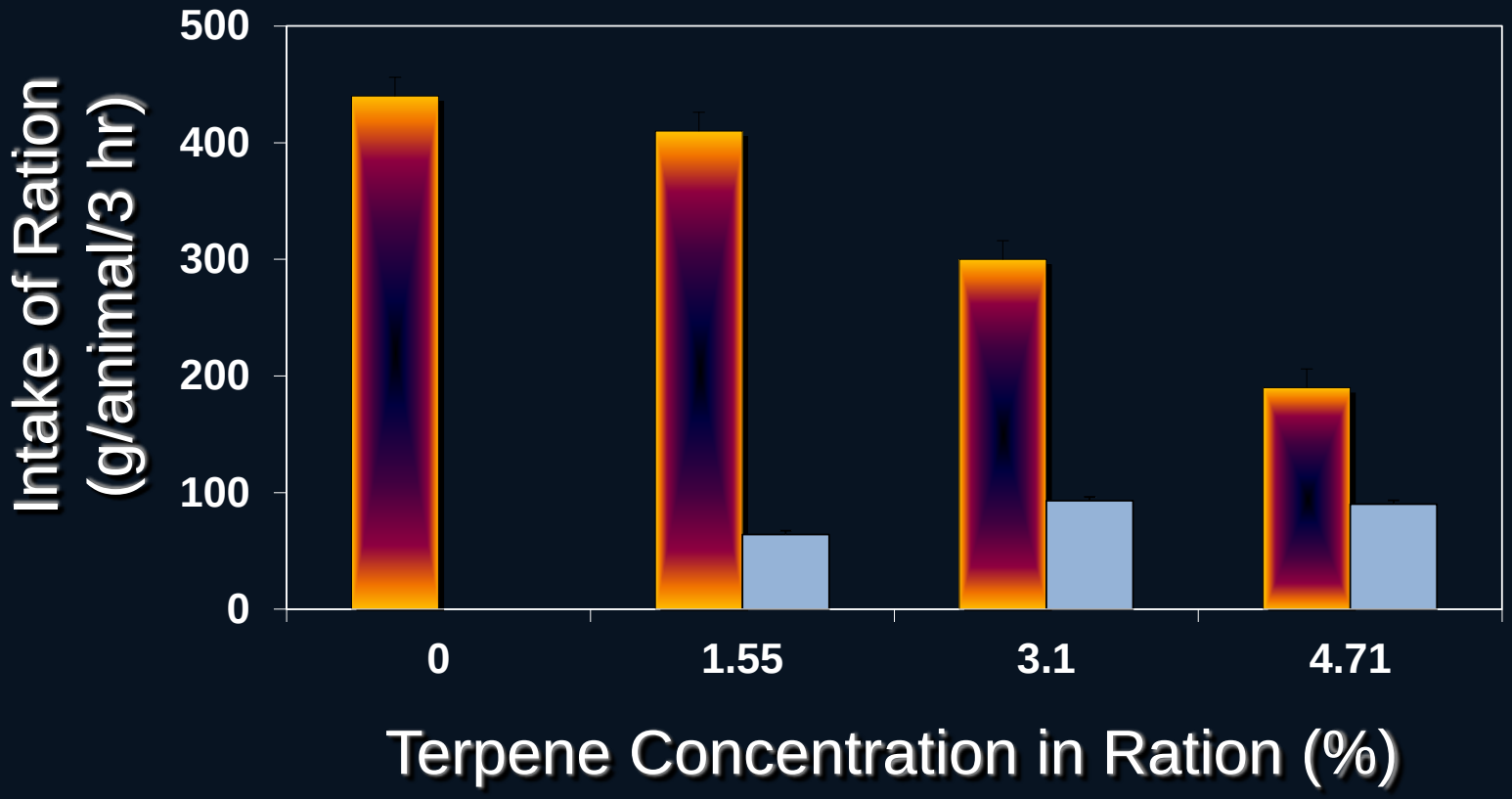
Fall and winter best for herbs, sagebrush, herbivores and ranchers.

Terpene concentrations in sagebrush lowest in late fall and winter.

Sagebrush limits intake of a palatable ration…



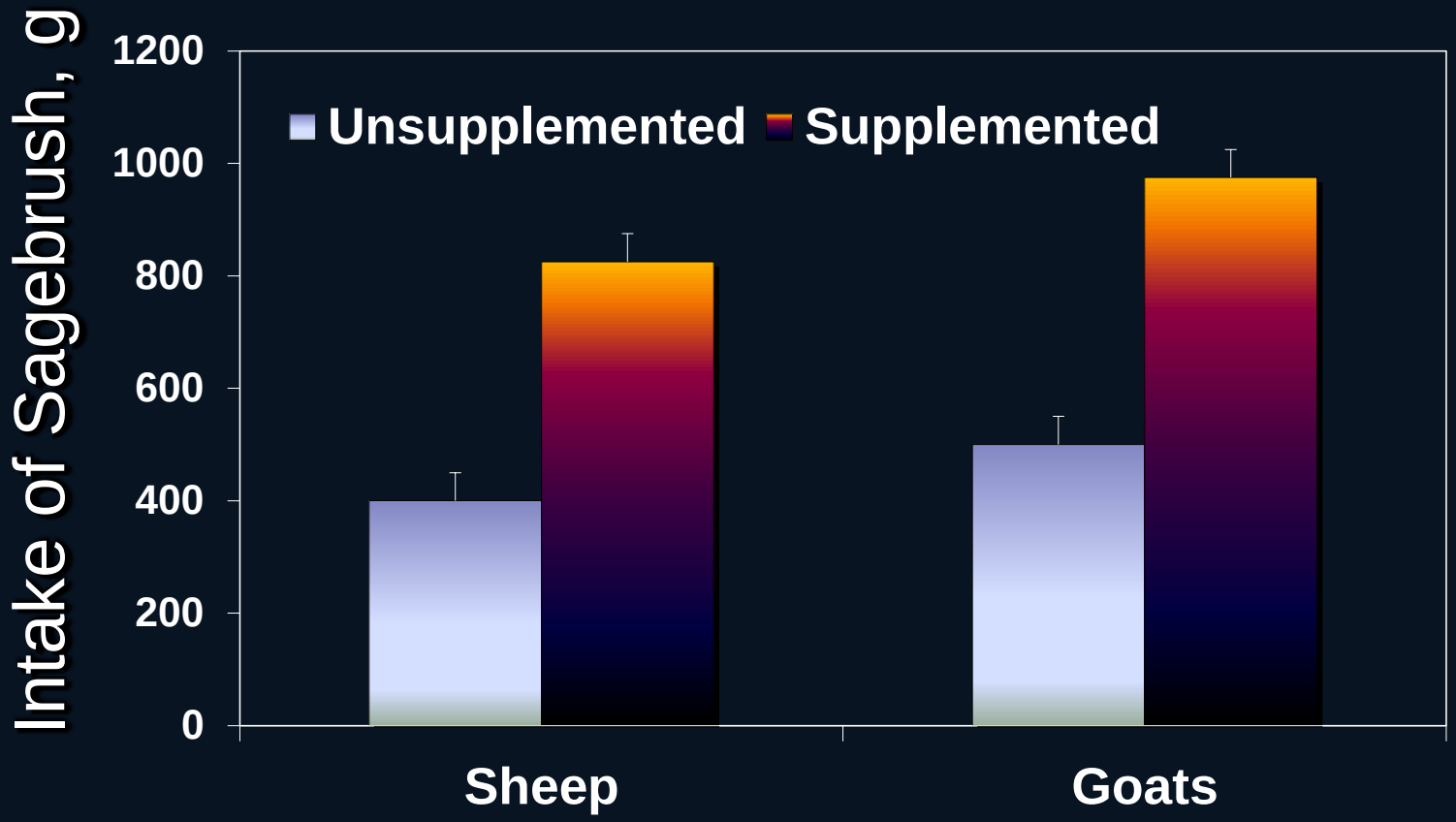
…and terpenes limit intake of sagebrush



Supplemental energy and protein enhance intake of foods containing sagebrush.

Nutritional supplements enhance detoxification and elimination of secondary compounds.

Supplemental protein and energy increase intake of sagebrush



In 2001

Low Stock Densities

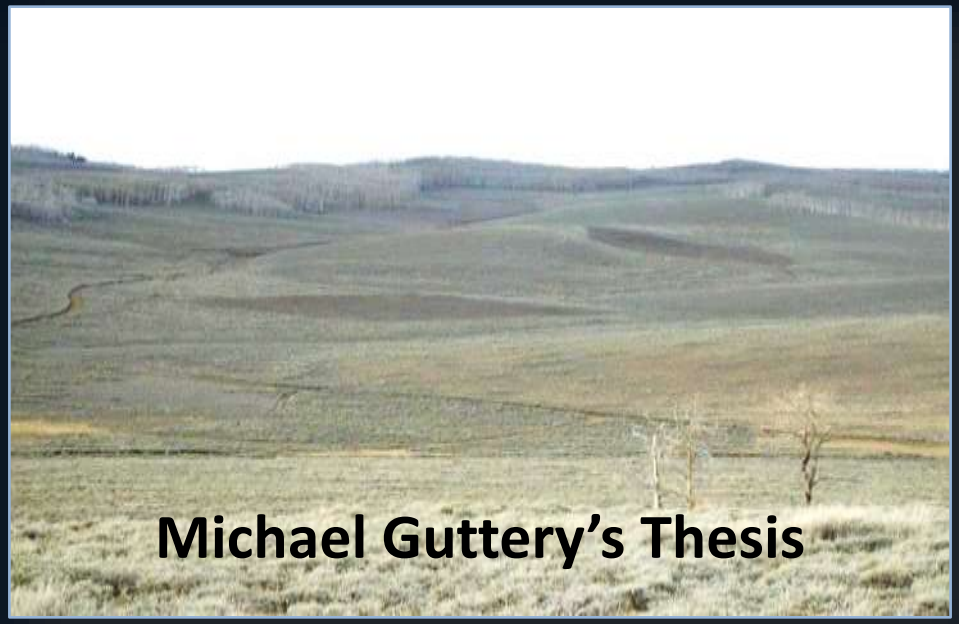
No Supplement for Control Animals

In 2003

High Stock Densities

Adequate Supplement

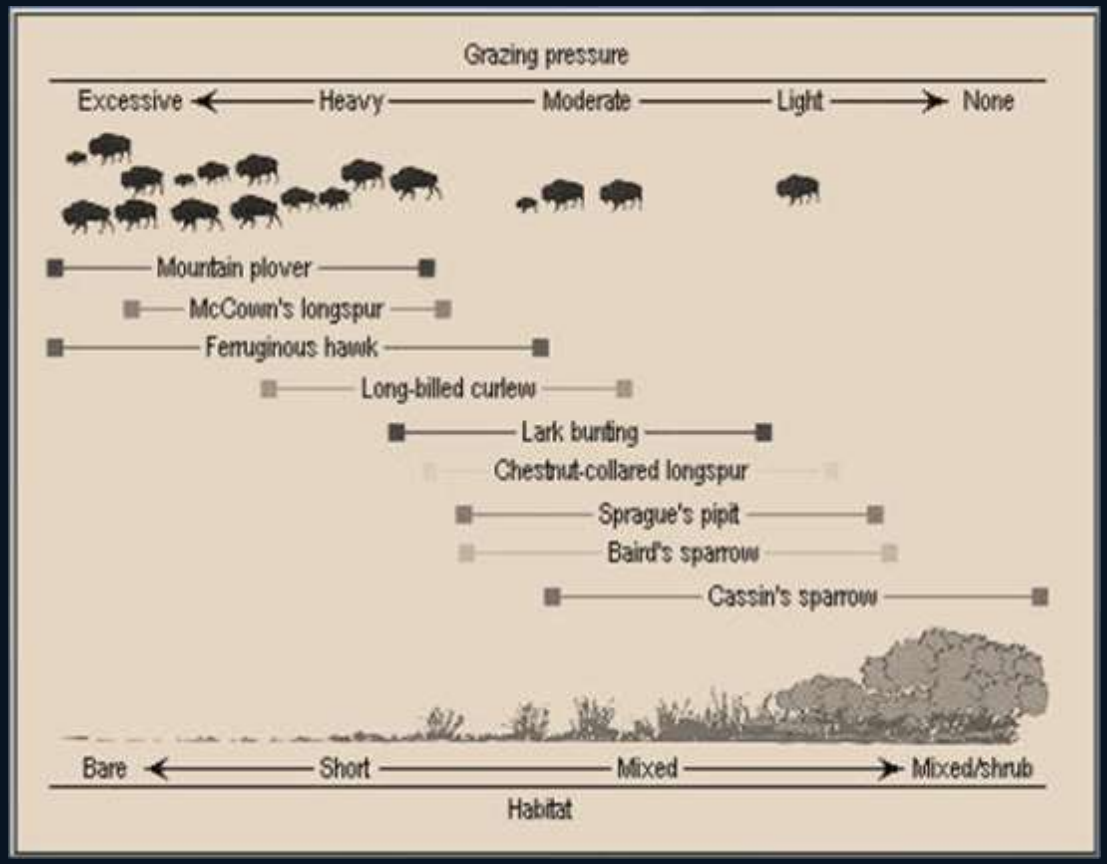
Sheep rejuvenate sage grouse habitat



Our Goals

✓Integrate livestock into the system

✓Not a treatment



Create mosaics of habitat to meet different needs within and among species

Create cattle able to use local foods and habitats

Agee Smith Cottonwood Ranch

Chuck Petersen's Thesis

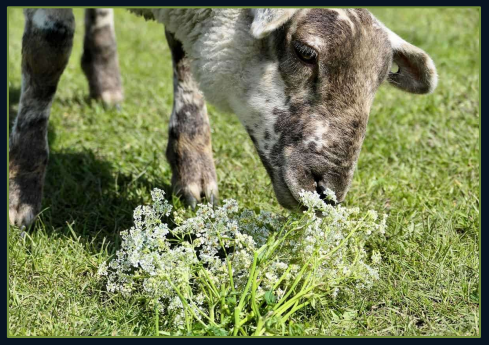
Mat Carter
Crown Cattle
Company

From sagebrush as a costly nuisance to sagebrush as a forage resource in winter

Self-Medicating


Food for Thought

How can diets rich in phytochemicals…



…enable herbivores to eat unpalatable plants?

Two Ways to Self-Medicate Therapeutically

When they have access to diverse mixtures of plants, animals from insects to primates use phytochemicals to self-medicate therapeutically prophylactically.

Livestock Learn to Self-Medicate:

- ✓ Acidosis
- ✓ Bloat
- ✓ Toxins
- ✓ Parasites

Goats and sheep are more inclined to self-medicate when they aren't provided with anti-parasitic drugs

Parasitized sheep eat less high-tannin food when their parasite infection is terminated with ivermectin, a drug that kills internal parasites.

Two Ways to Self-Medicate

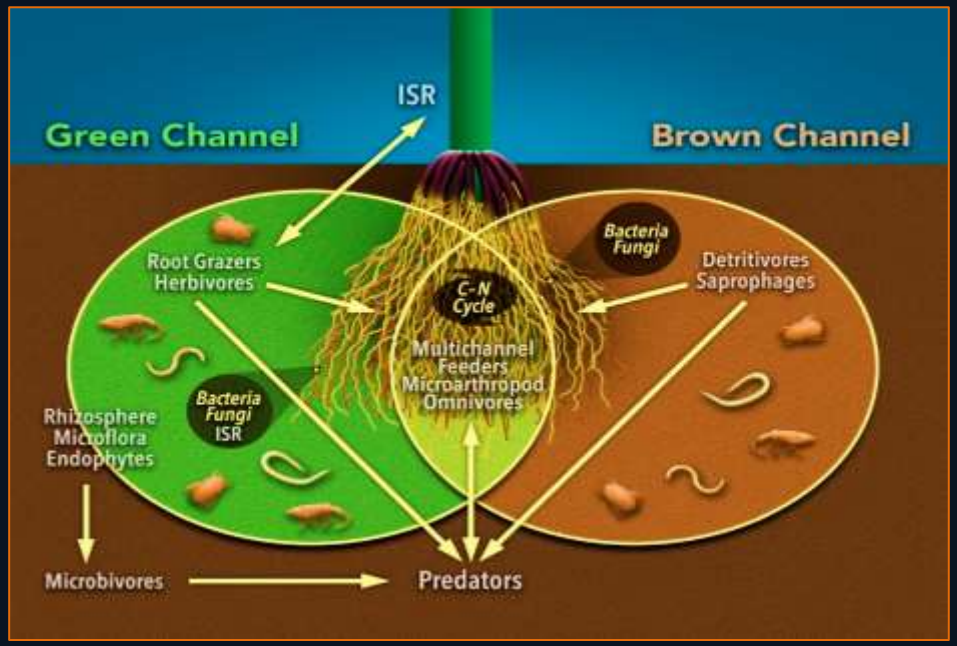
Therapeutically

Prophylactically

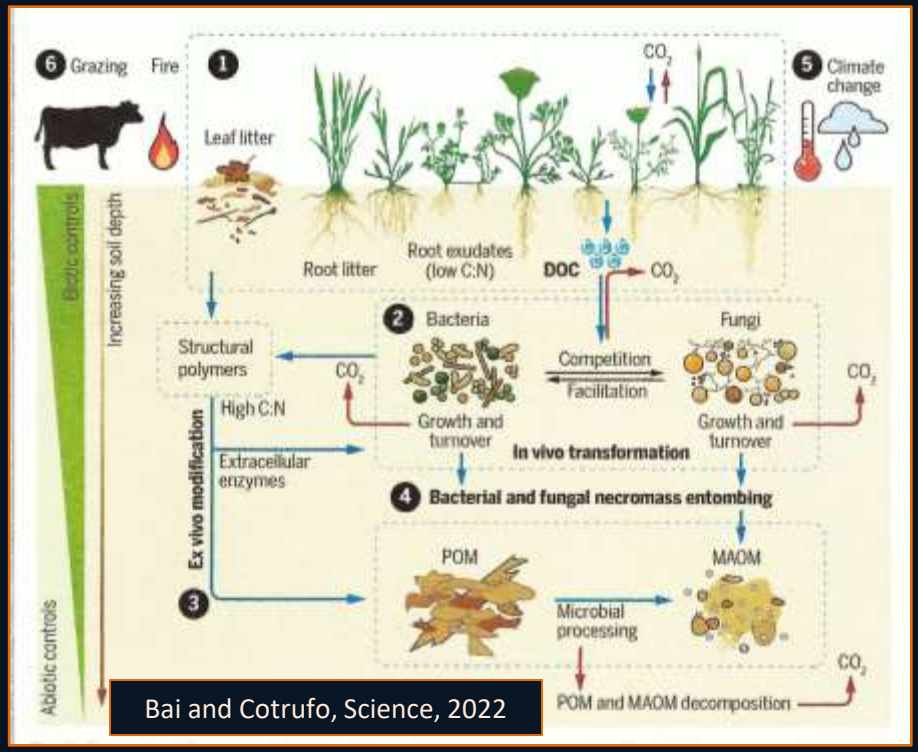
While 3 to 5 plants make up the bulk of the diet, herbivores often eat 50 to 75 plants in a meal.

Health is enhanced when livestock graze phytochemically rich mixes of grasses, forbs, shrubs, and trees.

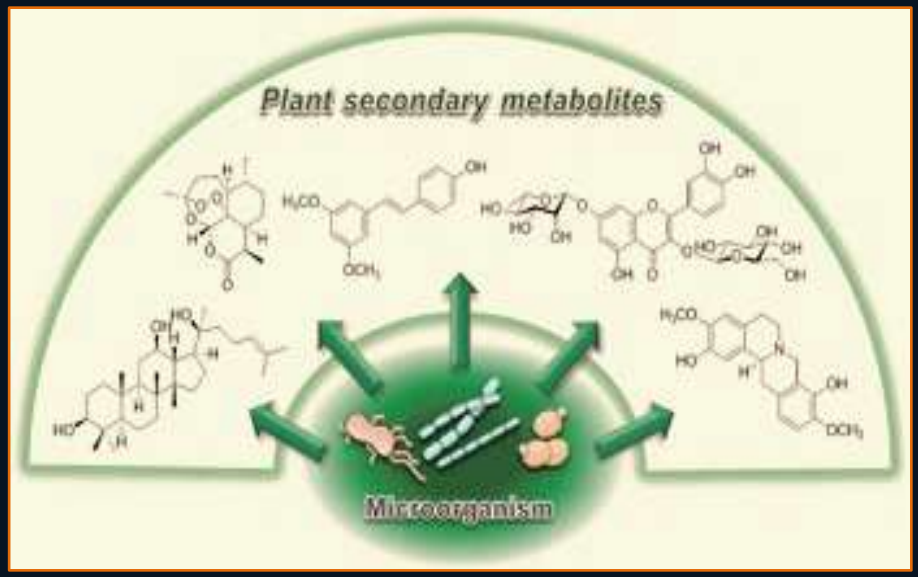
Plants turn dirt into soil and diverse mixtures of plants turn soil into homes, grocery stores, and pharmacies for herbivores, carnivores, and omnivores below and above ground.



Each plant species harbors a unique rhizosphere community. Diverse mixes of species interact in ways that enhance the soil microbiome, nutrient availability, and plant chemistry.



Bai and Cotrufo, Science, 2022



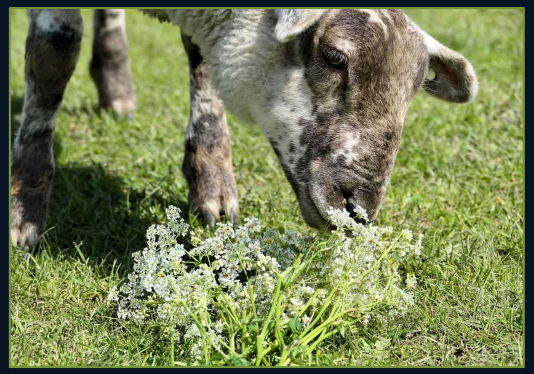
After 23 years, plots with 16 perennial plant species have ~150 to 370% more N, K, Ca, and Mg in plant tissues relative to monocultures of the same species.
(Furey and Tilman PNAS 2021)

They also have ~30 to 90% more water- and nutrient-holding carbon in soil.

Nothing is more important for health through nutrition than landscapes with a variety of plants for herbivores, omnivores, and carnivores below and above ground.

Health improves when livestock graze diverse mixes of plants compared with monocultures. They gain weight more efficiently (with less emissions of CH_4 and NO_3) and they can reach slaughter weight as quickly as animals in feedlots.

Photochemically rich diets increase diversity of species in the microbiome of the rumen…



…and they enable herbivores to eat toxic plants.

amygdalin

Flavor
Feedback

Wisdom
of the Body

Satiety
Variety

Social
Cultural


Food for Thought

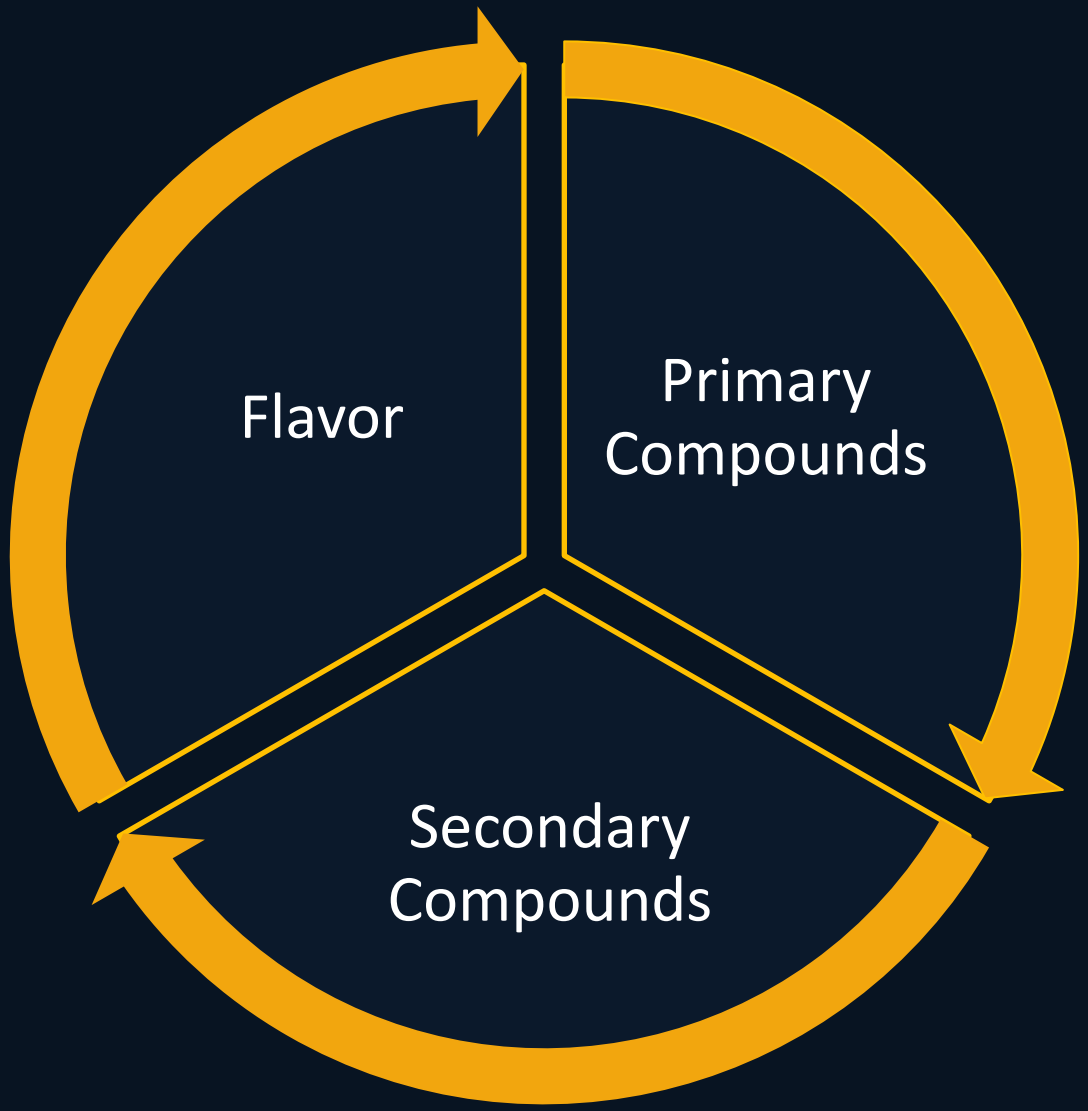
Why do cattle perform so well on the mix of plants from hell?

Explanations for why animals eat a variety of foods.

- Primary Compounds
- Satiety Hypothesis
- Flavor-Feedback
- Secondary Compounds

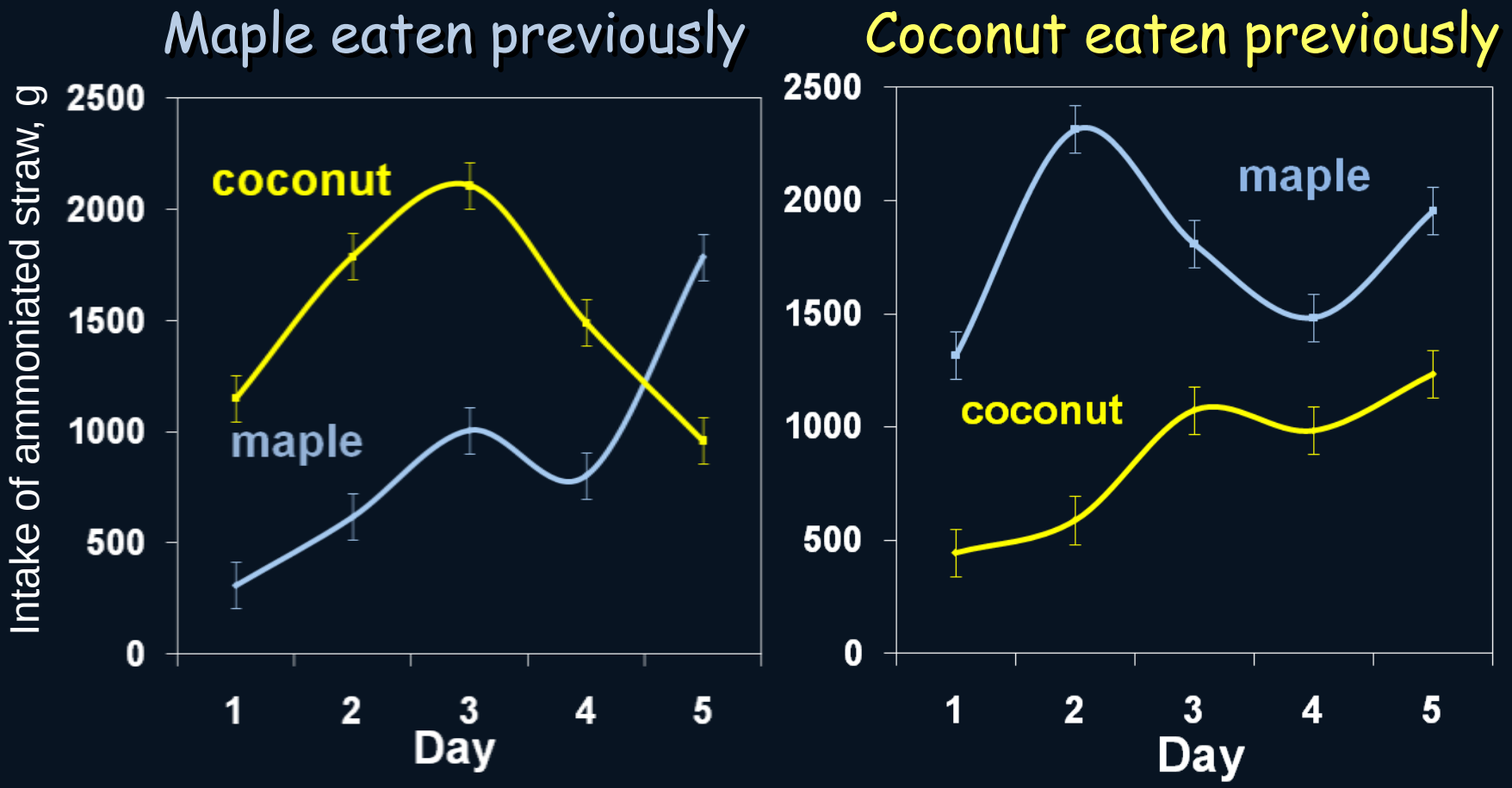
Eating any food to satiety causes a transient food aversion based on interactions among flavor, primary, and secondary compounds.


The GRASS IS ALWAYS GREENER...


Flavor
Primary Compounds
Secondary Compounds

Flavor-Specific Satiety

Flavor-Specific Satiety



Nutrient-Specific Satiety

Nutrient-Specific Satiety

	Preference	
Meal	Energy	Protein
Energy	↓	↑
Protein	↑	↓

What's fed in the barn influences what dairy cows eat on pasture.

Mixed rations high protein fed in the barn cause cattle to eat less clover and high-protein plants and plant parts on pasture.

Secondary Compound-Specific Satiety

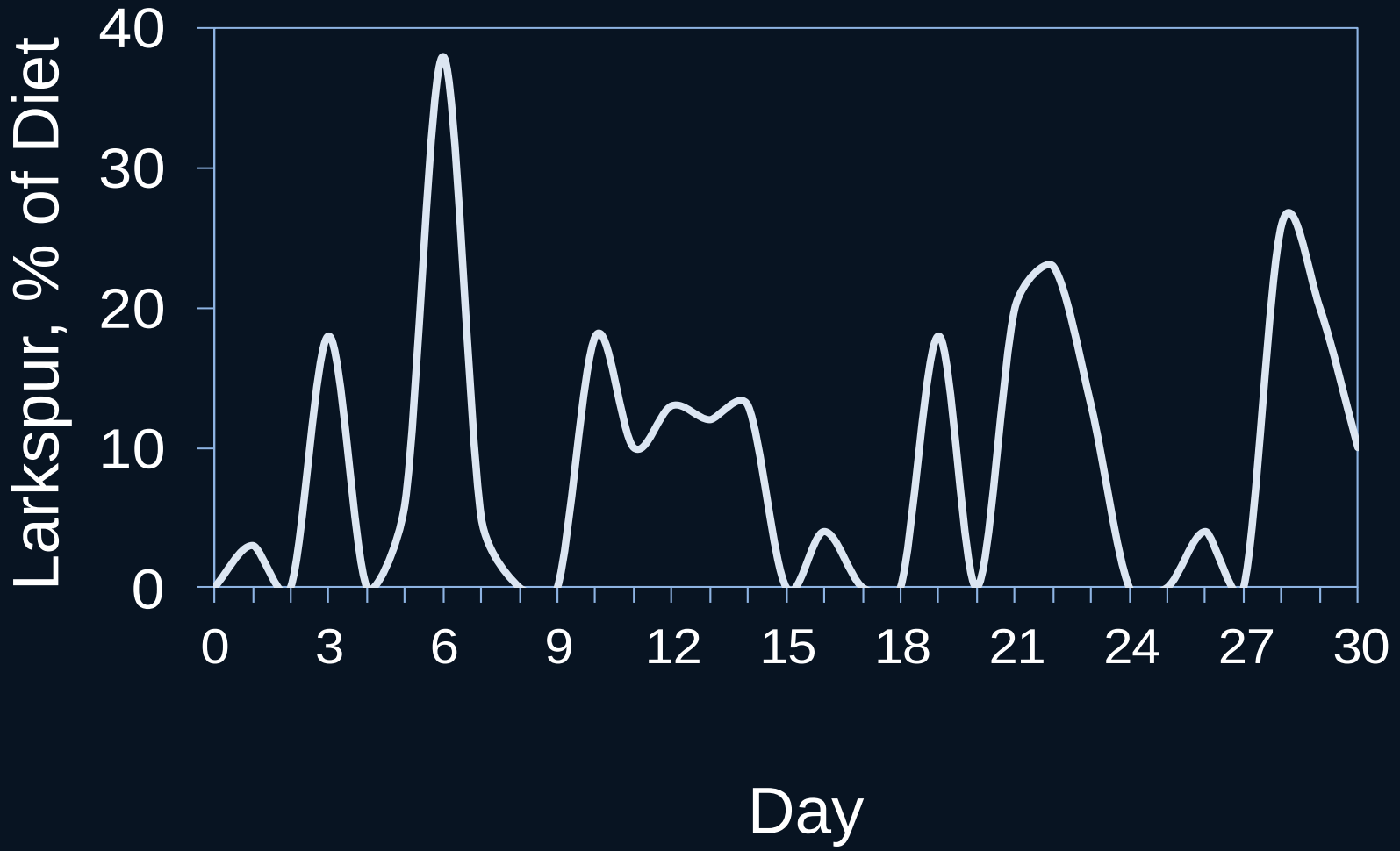
All Plants Contain Secondary Compounds

Secondary compounds limit intake by insects, fish, birds, and mammals.

Ecology → Defenses

Agriculture → Toxins

Alkaloids Limit Intake



Satiating on Secondary Compounds

Given a supplement of saponins:
sheep eat less alfalfa (saponins)
and more trefoil (tannins).

Given a supplement of alkaloids:
sheep eat less fescue (alkaloids) and
more trefoil (tannins) and alfalfa (saponins).

Why do cattle perform so well on the mix of plants from hell?

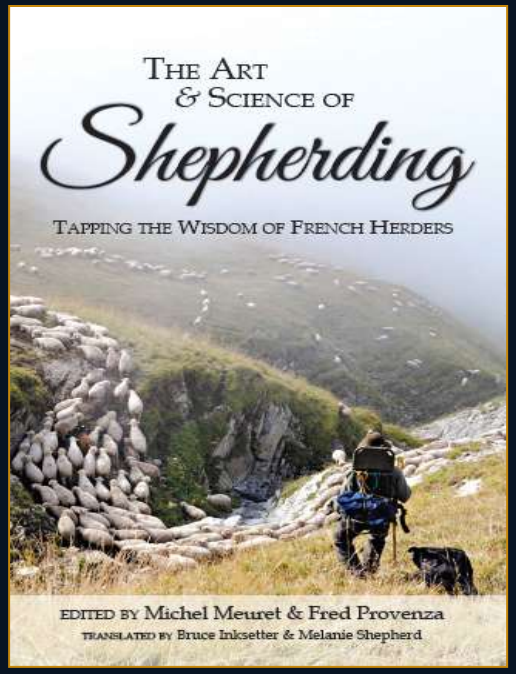
Complimentarities and Sequences


Food for Thought

Glenn Elzinga

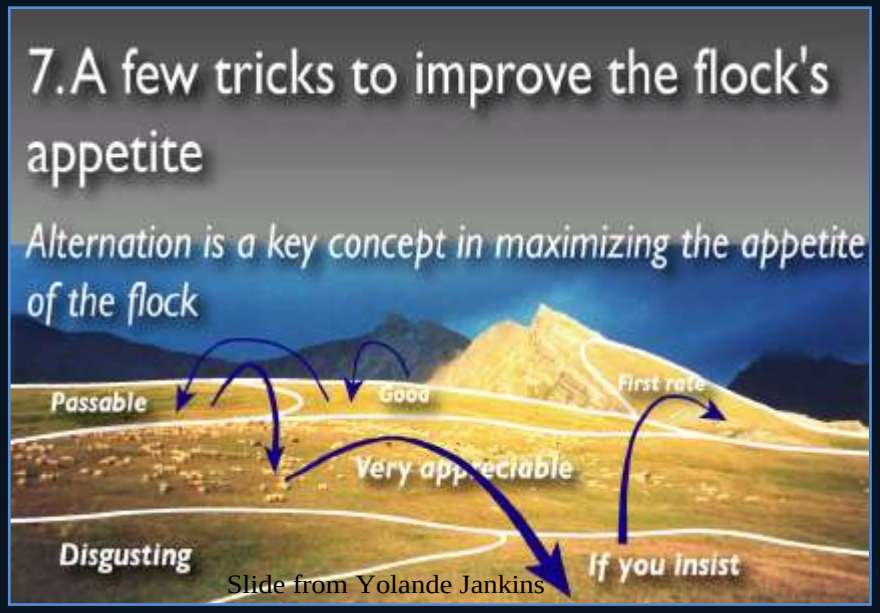
Alderspring Ranch

Nurturing health from soil and plants to herbivores and humans.



Grazing Circuits

- ✓ Enables individuals to regulate intake of primary and secondary compounds
- ✓ Stimulate appetite/intake
- ✓ Target grazing to enhance/ maintain biodiversity



Slide from Yolande Jankins

Biochemically diverse diets enable sequences that complement one another.

An appetizer of trefoil (sainfoin) helps the fescue go down.

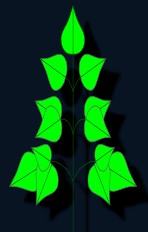
An appetizer of bitterbrush helps the sagebrush go down.

Inexperienced

Experienced

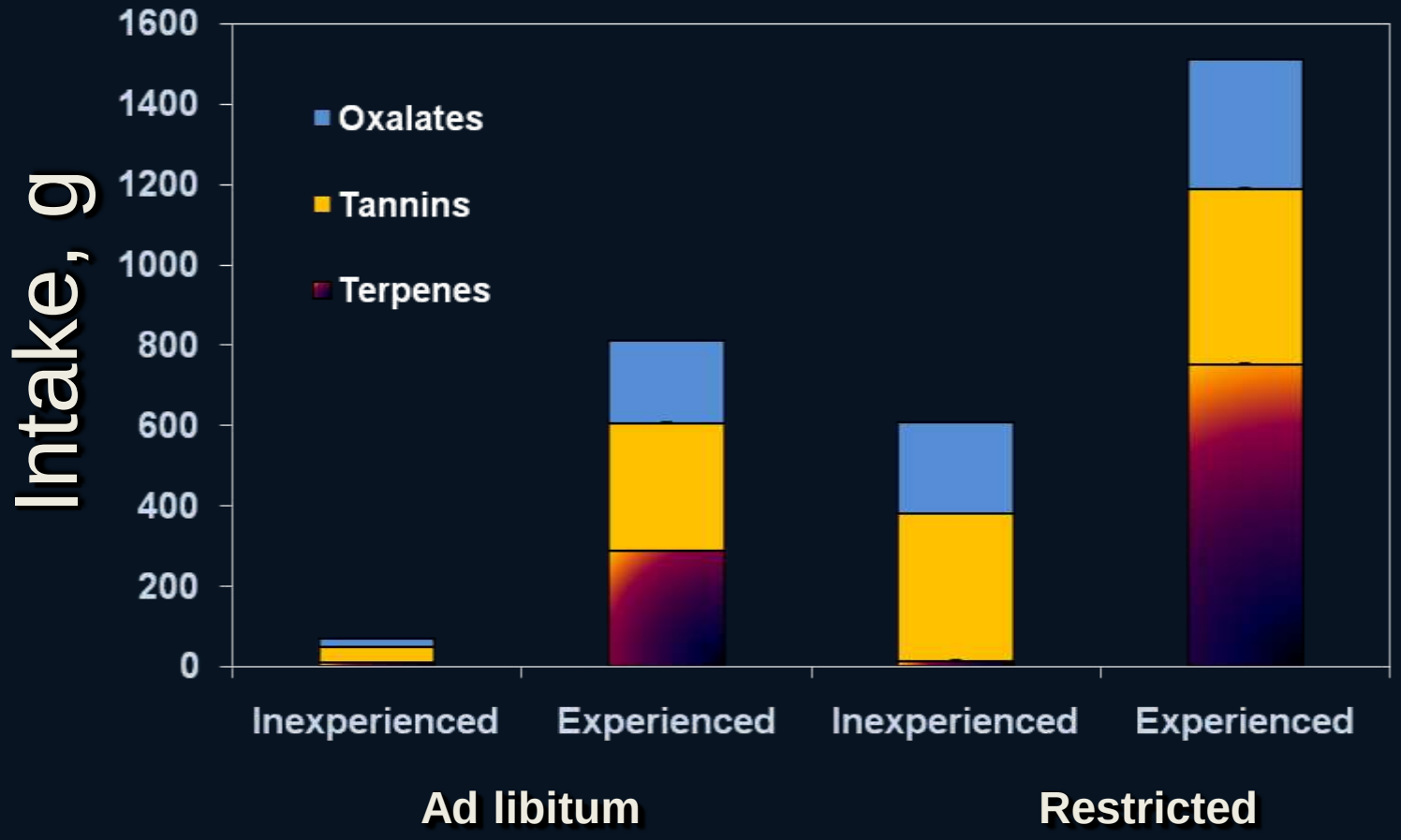
Tannins

Terpenes



Oxalates

Experience & Alternatives



In Mediterranean Woodlands, goats ate: kermes oak + black locust + white mulberry (650 g) > kermes oak + black locust (530 g) > kermes oak + white mulberry (441 g) > kermes oak (287 g).

Goats fed with browse combinations gained weight while those fed only kermes oak lost weight.

Four Actions Implemented by Herders

Teach naïve animals about forages and herding conditions (time: years)

Teach herd to respect boundaries of grazing sectors (time: months)

Modulate temporary palatability scoring of various forages (time: weeks)

Design grazing circuits to create food synergies by meal sequencing (time: day, minutes)

Herders try to avoid two situations…

Offering a highly desirable, but rare, forage can lead to frustration and reduce food intake.

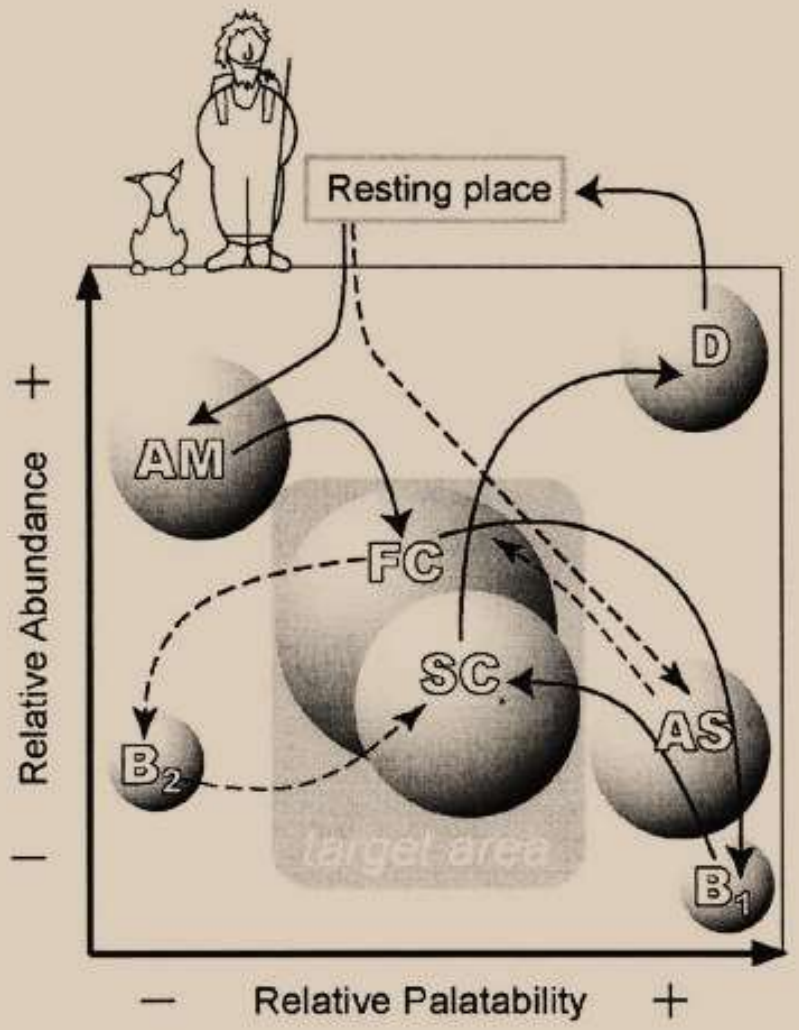
Offering a limited array of forages can lead to wariness and lower daily food intake.

To avoid
frustration and wariness…

Herders make use of different vegetation patches.
They do so predictably during a day or half-day.

Herders end each circuit
with highly appreciated forage(s).
That prevents animals from searching
for them during the day.

Herders ration access to the ‘best spots’, such as riverbanks or tree fruits, during each grazing circuit, to reinforce the herd’s reliance on and trust of the herder.



Meal Phases

AM - Appetite Moderator
AS - Appetite Stimulator
FC - First Course on target area
B - Booster
SC - Second Course on target area
D - Dessert

Stockmanship to move and place cattle to improve habitat for mule deer and elk at Hardware Ranch

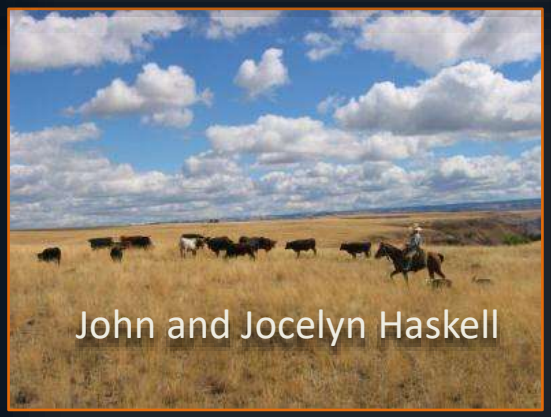
Graze Herbs

Late Vegetative

Early Reproductive

Winter use by mule deer

Spring use by cattle

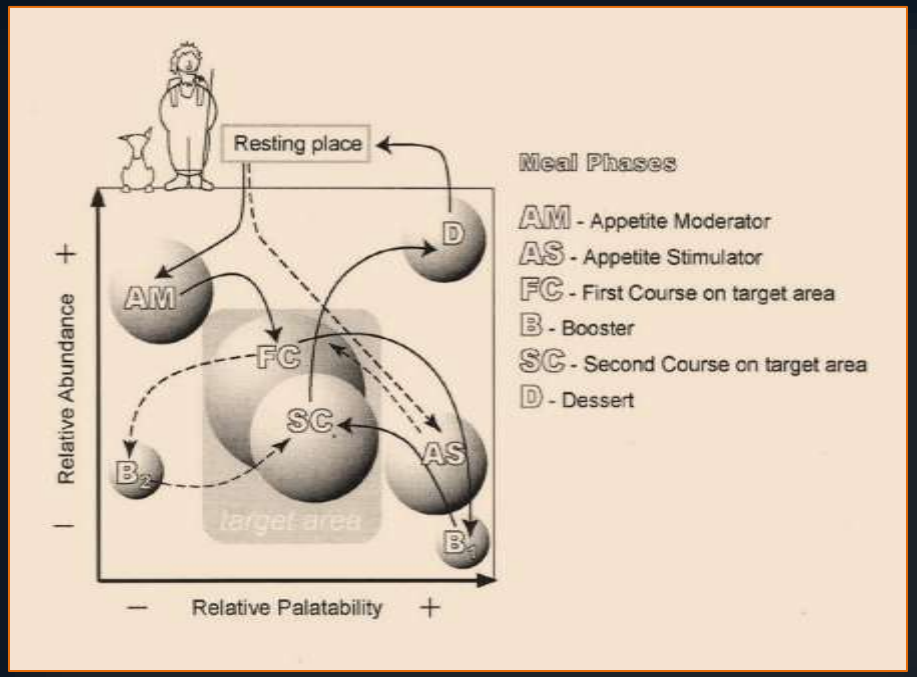


John and Jocelyn Haskell

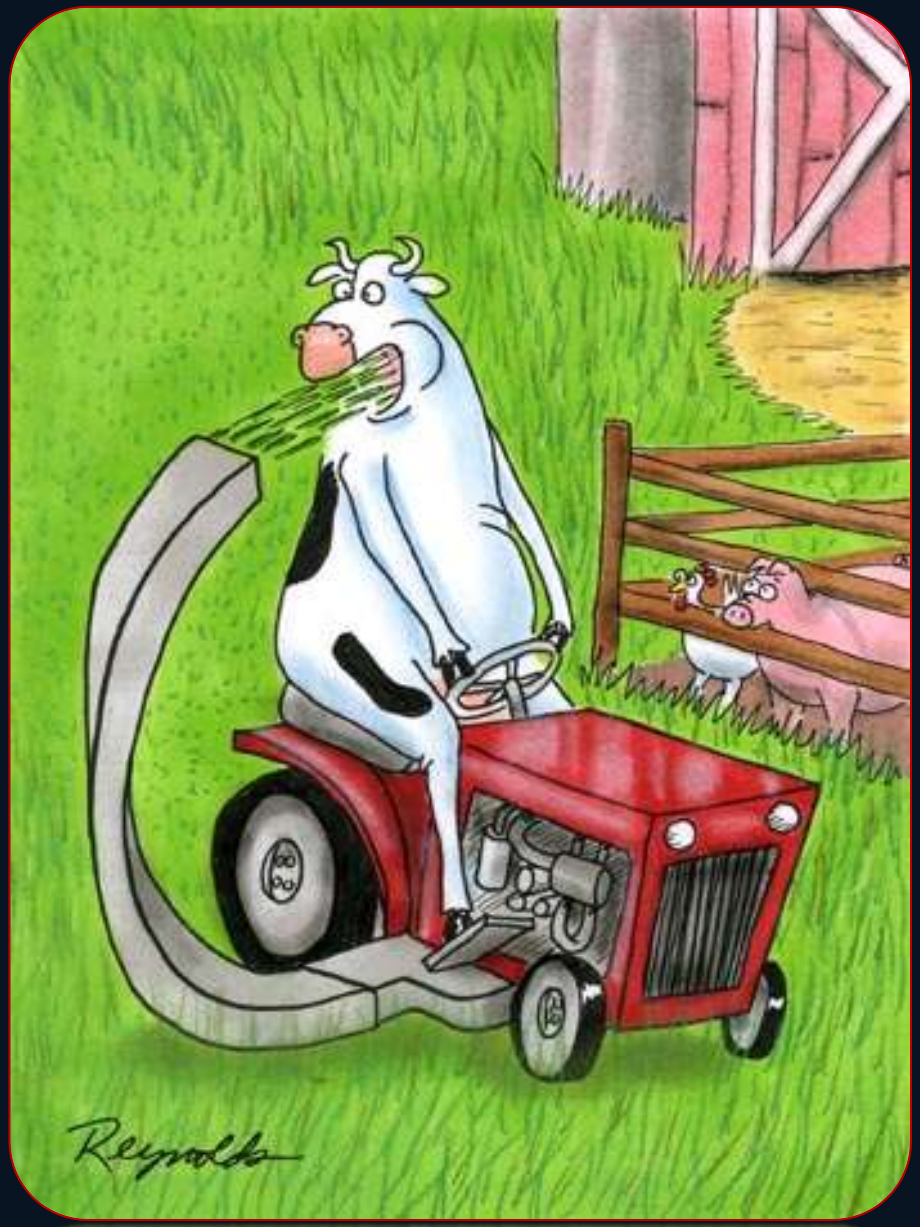
Stockmanship Management- Intensive Grazing

Weeds - Australia

Watersheds - Namibia



Plant physical characteristics and foraging skills of animals' influence preference.

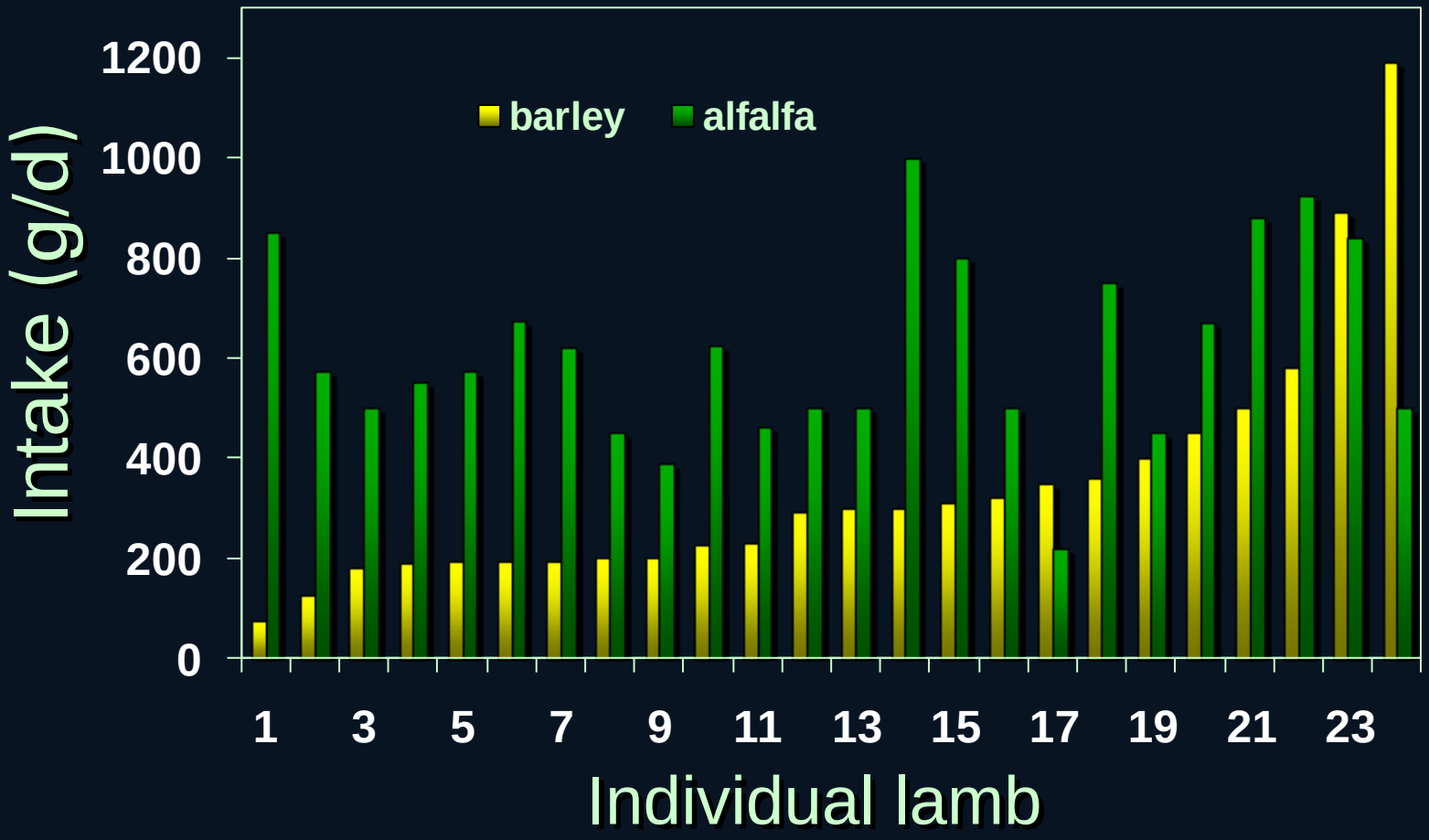


Grazing at high stock densities for short periods

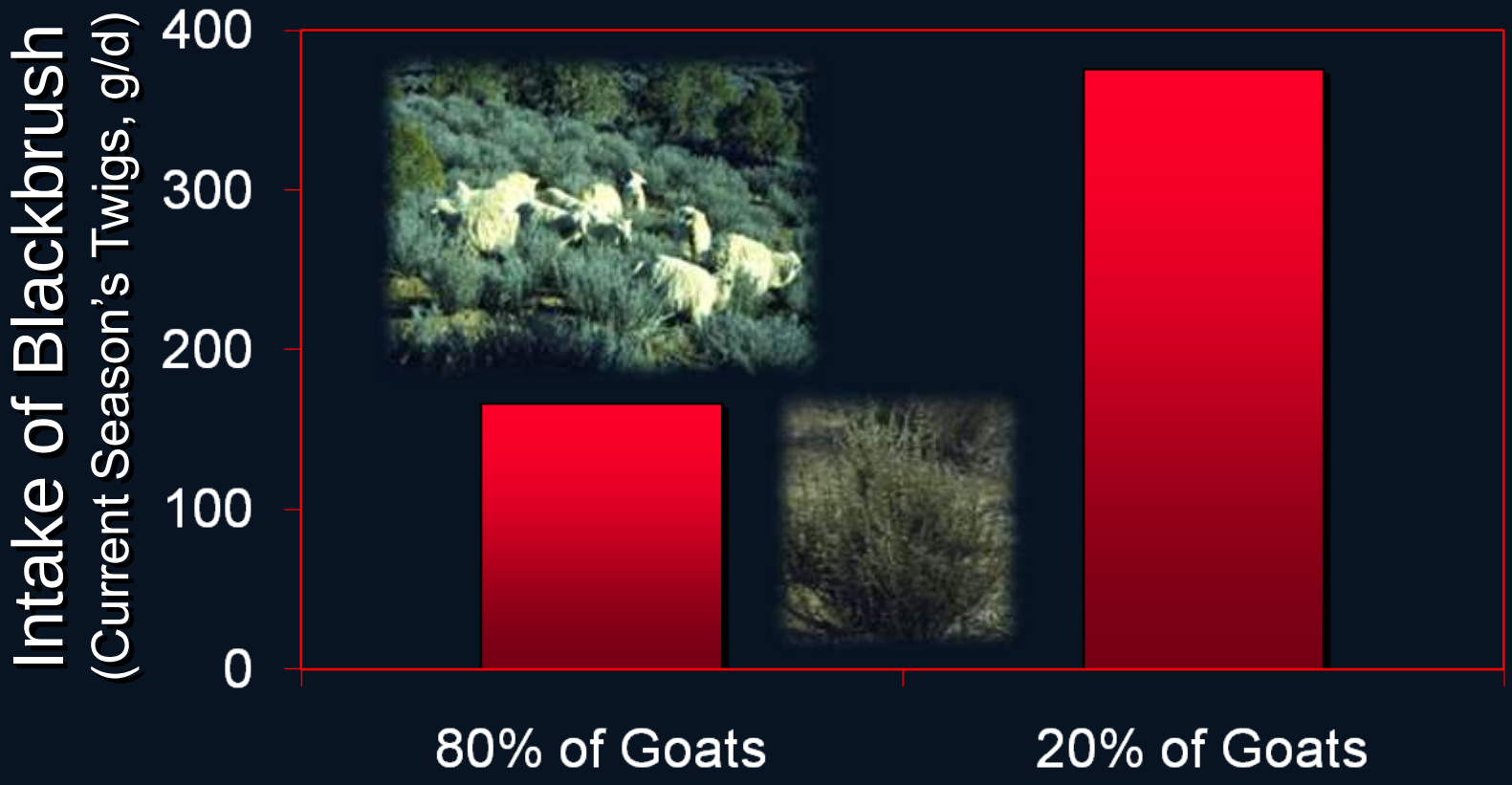
Ray's cows learned to "mix the best with the rest" rather than "eat the best and leave the rest"

Biodiversity Enables Individuality

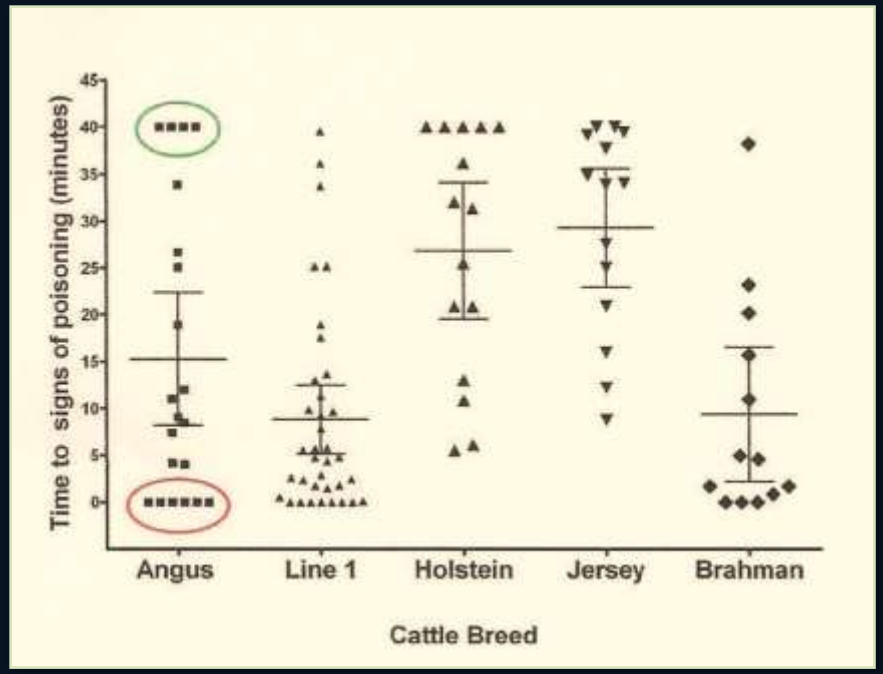
Variation among Lambs



Variation among Goats



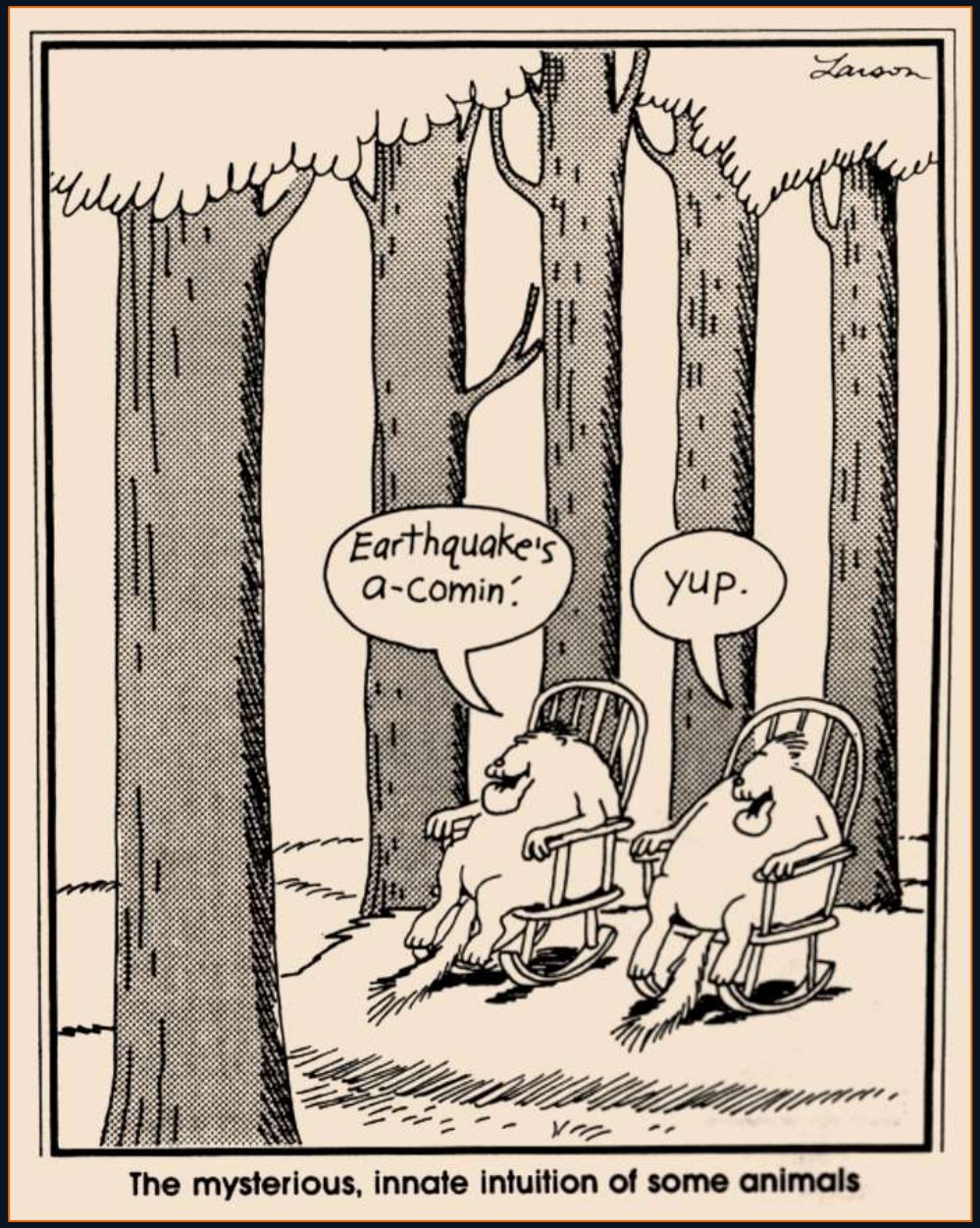
Variation among breeds and individuals with respect to larkspur toxicity.




Endophyte-infected Tall Fescue

In Summary...

We stress genetics as the mechanism of evolution...



...not appreciating that genes dialog continually with social & biophysical environments.

In the animal self-help section

Organisms create relationships with what they deem are the relevant facets of the social and biophysical worlds they inhabit.

Foraging behaviors develop as a function of history, necessity, and chance and then become part of a culture.

Goats eat woodrat houses to alleviate a protein deficiency.

Of 18 groups of goats during 3 winters, only 1 group learned to eat woodrat houses.

Animals aren't machines and genes aren't destiny. Animals are *involved* in the world which helps them to *evolve* with the world.


Questions?
ease type into the Q & A tab

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