High Productivity
Agro-Forestry

James Geoffrey Steen
Organic Grower’s School Fall Conference
September 2019
All uncredited photos by JGS

RAVEN RIDGE
farmscapes
Outline

Agro-Forestry Presentation
Lunch Break

Walkabout & Practicum
Compost Tea - Farm Tour - Mock Field Layout
About Me, and the Noble Tree
1.) what’s your name?
2.) where do you live & what are you managing?
3. any specific interest / something you want to add to your farm?
“Agriculture for the plains, Silviculture for the hills” J. Russell Smith, 1929

“Conservation IS the cropping system” Mark Shepherd, 2013
Fig. 1. The U. S. Soil Conservation Service reports that the soil washed out and blown out of the fields of the United States each year would load a modern freight train long enough to reach around the world eighteen times. If it ran twenty miles an hour continuously, it would take it nearly three years to pass your station. We began with the richest of continents, but . . .
“Problem Statement”

- Agriculture as the pivot point for many socio-economic issues
- 2013 Food riots & field capacity
- Externalities & waste; edible calorie measurement, 60% Ag. carbon footprint - USA
- Exploitation: Have’s/Have not’s
- Integrated agriculture and de-centralized economy
“Greatest forced migration in history”

- W. Berry, 1975
- Land Grant / Coop Extension
- Green Revolution
- Urbanization
- Vertical Integration

Photo credit: Wikipedia
American Agriculture is...

• ...headed for a Brick Wall *

• ‘Combine the CAFO with corn farm’, Age-old crop Rotation (Gene Logsdon, All Flesh is Grass)

• Deserves investment, more than 1% the workforce

• Take away: Science has been inappropriately applied to agriculture up til now, *but it’s not too late & it’s changing
AGRO-ECOSYSTEMS:
Tree Crops will save the Planet

- **Limits to Growth**, $2050 + 2 \text{ or } 3$ billion people. 60-80% more food needed

- **Integrated Farming**: Agro-forestry / Silvo-Pasture / carbon farming

- **Integrated living**: Neighborhood food security: roadside fruits and nuts

- **Improved tree genetics**
  
  _J. Russell Smith_ 1929

- **Trees in every field**, land utilization ratios: 50-60% Tropics, diminishing towards the poles
Dialectics

1.) The art of investigating the truth of opinions,
2.) inquiry into metaphysical contradictions and their solutions
3.) To see things broadly, unencumbered by narrow assumptions

~ Diet, politics, nature

~ “Some incredible Fruit”
   “Something works great somewhere for someone...!”

~ Farming is 40 centuries
   old- in our blood, start with
   good information to head in the
   right direction.
Getting past our hang-ups

Species Extinction

Endemic toxic waste

Insect Apocalypse, *October 2018 SCIENCE*

Changes in agriculture, gene editing, data farming, ‘dropcopter’ drone pollinizing, breeding new plants 6 times faster

- Will Technology *save us*?
- Diet: acid/alkaline, plant and animal macro:micronutrients (NPK: Fat, Carbs & Protein)
- SOIL PH/compost paradox
- bacterial/fungal dominance
- wild/invasive, liberal/conservative, carnivorous/herbivorous (*M. Pollan “Omnivore’s Dilemma”*)
- Ex: rainfall patterns and English plowing;
  Ex: climate change & weather history
  Ex: *Prunus serotina* in Deutschland
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Credit: Shutterstock
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Change is Constant

- **North America, last 15,000 years:**
  - Glacial retreat; plant species dispersal
  - Human arrival, MegaFauna extinction
  - European Arrival, Native die-out
  - New dispersal of plants, species addition & decline
The industrial synthesis of ammonia from nitrogen and hydrogen has been of greater fundamental importance to the modern world than the invention of the airplane, nuclear energy, space flight, or television. The expansion of the world's population from 1.6 billion people in 1900 to today's six billion would not have been possible without the synthesis of ammonia.

“The ultimate goal of farming is not the cultivation of crops, but the perfection of human beings”

“If we throw mother nature out the window, she comes back in the door with a pitchfork”

“The healing of the land and the purification of the human spirit is the same process”

Masanobu Fukuoka

Photo credit: Wikipedia
New Ideas for temperate region cropping systems that maximize production of staple-food crops for humans
An approach to land management that incorporates useful trees into farmland to increase productivity, profitability and environmental renewal.

A unique form of stewardship which strives to replicate nature by optimizing nutrient cycling and increasing ecological services on farms.

Totally compatible with conventional or organic systems and modern technology like robotics and precision or ‘data’ farming. Furthermore, it offers an open door to innovation for woody crops.
A new way of thinking

- from a CARBON to a CARBOHYDRATE economy
- stacking functions, diversifying management, basically integrated cropping; Correct application of Science to farming + Smart management for increased nutrient-cycling & production with nature-as-model approach
- Every field and farm is a solar collector: agro-ecosystems
\[ \text{CO}_2 + \text{H}_2\text{O} = \text{C}_6\text{H}_{12}\text{O}_6 + \text{O}_2 \]

Photosynthesis & Respiration, organic to inorganic (NPK/PFC), plant to animal to plant

- Intensively-managed, integrated farming systems sequester carbon massively (‘Toensmeier’)
- What fattens animals, makes eggs and milk...?
Eco-system mimicry

- Design of self-maintaining food-producing landscapes
- Integration is key
- N. American Savanna & Megafauna munching leaves
- European Pine/Hazelnut
- Conservation IS the cropping system - M. Shepard
What we’re doing in Marshall

- 2.4 acre Forest Garden
- Share-cropping with Neighbors, 3-4 acres Chestnut
- 6 cow dairy on 20+ acre Silvo-Pasture
- Abha Farm, mixed veg & Hemp + Orchards
The Site

- zone 6b
- 35-38 inches rain/year (90 cm)
- ~2,000 ft/800 meters elevation
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**Goal:** mimic the North American Oak savanna in mid & late succession for production of food, fuel and fodder. Chestnut is substituted for Oak as the dominant carbohydrate crop with dairy cattle managing the understory.

**Methodology:** Densely planted multi-specie trees ‘in-row’ and widely ‘between-row’. Animals are essential for maximum productivity and ecosystem services. Dairy cattle rotationally grazed & seasonally milked March - December.
i.) Layout: establish contours, dig swales

Steep land: hand-dig or mini-ex

flat/rolling: moldboard plow
2.) **Plant trees**

- **Fodder crop**: Black Locust, Russian Mulberry, Autumn Olive. These provide early succession overstory, **N**-fixation for upcoming food trees, shade, forage (for the dairy cattle), leaf hay, eventually firewood and fenceposts ($ in the bank)

- Green Manuring with trees: **Chop & drop method**
3.) Plant more trees

**South Slopes:**

- Chestnuts planted 12’ apart
  - in-row Red Currant and Aronia understory
- Then, 30’ between-row Mulberry + Persimmon 8m apart
  - hybrid am X euro Hazelnut understory, planted 3’ apart.
4.) Trees!

**North Slopes:**

- Chestnut *(currant and chokeberry understory)* alternating with rows of Apple and Pear 24 ft apart, with 3-5 Hazelnuts between
Prep, plant and maintenance

- Tree shelters for production trees
- ‘STUN’ method
- NPK + micronutrients (azomite, bone meal)
- Special inoculants, IMO’s.
  
  Recipes: Dr. Elaine Ingham
  soilfoodweb

- Grafting, improve inexpensive seedling trees inexpensively
4 y.o. Chestnuts flowering
Grafted Mulberry seedling ‘Silk Hope’
Coppice Agro-forestry

Chop & Drop Green Manuring
Nurse Trees

- Natural regeneration of a seedling usually occurs under the shade of its parent where conditions are characterized by lower light intensities, higher humidity and reduced air movement, all of which combine to reduce planting stress.
N+ Fixers

- Locusts =>
- Alders
- Eleagnus
Costs of trees

- **Hazelnuts**, $5 hybrids from ForestAG, cheaper from state nurseries but not recommended due to smaller nut size
- **Chestnuts**, $0.60 to $3.00 apiece seedlings
- **Apples and Pears**: from $0.80-$1.10, seedling rootstock
- **Mulberries, Persimmons, Locusts**, $0.10-$1.00
- **Experimentals**: *Caragana arborescens, Hippophae rhamnoides* - Lawyer Nursery/Burnt Ridge Nursery
- **Costs of a fence**: $1300/acre 4-strand electric incl. labor
Q & A
Highlight: Bliss Springs Farm
Andersonville, TN

2.3 acres planted March 2016
Layout with roll-measure, A-frame level, flags and paint
Highlight:
Ananda Viplava
Cairo, NY

1.4 acre Alley Crop Field
100 Hazelnuts, 22 Chestnuts
14 Fruit Trees
150 N-Fixers
Prep your site
Clear the site!!
remove brush / mow grass in order to do:
Orchard Layout,
spacing & stakes
Special needs, fertilization, pH, fencing
Planting & Disturbance:
tillage, hand-dig, mulch

Thursday, September 5, 19
Prep your site
Clear the site!!
remove brush / mow
ground in order to do:

Orchard Layout,
spacing & stakes
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Thursday, September 5, 19
Rainbow Bridge
Why Chestnut

- Castanea spp, Family Fagaceae
- Carbohydrates, similar to Rice
- Not a true nut, but an Acorn (wet & perishable)
- sweet, nutty taste
- storage, drying and milling (chestnut pancakes!)
- improved genetics: hybrids from C. mollisima, C. dentata, also Korean, Japanese & European
Typical growth form of *C. Mollisima*, equal height and spread with multiple stems originating from the base. Shade intolerant tree casts a deep shade.
The American Chesnut

Thursday, September 5, 19
The American Chesnut
Numbers on Chestnut

- The United States is one of the few nations in the world that can grow chestnuts, yet doesn't have a significant chestnut industry. U.S. chestnut production is less than 1 percent of total world production. The United States has 919 farms producing chestnuts on more than 3,700 acres. The United States imported 3,200 metric tons of chestnuts in 2017. **Source**: https://www.agmrc.org/commodities-products/nuts/chestnuts

- **25-50 trees per acre depending on a spacing of 20’ or 30’**

- **1,000-2,000 lbs/acre**

- **$0.75-$2.50 wholesale, $2.50-$10 retail**

- **50+ year old tree (Mollissima)**

- **A $10,000 TREE! (E. Soloviev)**
Orchard Specifications

• Light soil is best, suitable for hilly land

• $pH$ 5.0-6.0

• *Phytophthora* root rot

• *Anasoria senatoria*

• *Weevils* | *IKB*

• *Pollenizing*
Further Reading

• Route 9 cooperative / Empire Chestnut Co.
• MO Center for AgroForestry, Symposium last month
• Cornell University
• Facebook - ‘All about Chestnuts’
Nut Bins
Why Hazelnuts?

Oil & protein, *non-perishable*

Dries down naturally for stable storage, a *true nut*

Wildlife habitat, *windbreaks, riparian buffer, property lines*

An important crop, *Diverse Genetics (6,000 y.o. pollen maps)*
Hazelnuts for everything

- Hulls for industrial heating
- High quality edible Oil = meal for feed
- Charcoal (coppice-culture)
- Construction, fencing, artwork
About Plants

- Vigor, Precocity, growth form
- Diecious/Monoecious, pollination
- Potted/Bare-root (retail/wholesale)
- certified disease-free
- grafted/seedling
- ‘Nurse tree’, green manure

*Suggestion:* Learn to identify fruit trees based on growth form, leaf, bud & bark and observe them in all seasons in order to understand how they’ll look in your yard or farm
Silvo Pasture
trees & livestock
Management of Trees

- STUN, inexpensive seedlings mechanically installed fend for themselves

- Prune lower branches to grow above the ‘browse-line’, polywire electric fencing on a hand-crank reel until then (alternatively ind. shelters cages of wire)

- Cut on a cycle for animals/green manure, Coppice Agro-Forestry unpublished book *. Coppice: trees vegetate longer, increases life span

- Cut as feed during summer drought, trees maintain sugar & protein levels better than grass
Science of Silvo-Pasture

- Most plants top out at 50% light saturation
- Etiolation of leaves & stems, greater Root:Shoot ratio
- Cool-season grass is most nutritious, shade provides a season extension
- Diversity above and below ground, build soil boost forage
Management Intensive Rotational Grazing

- also known as managed, rotational, planned or cell grazing

- Breaking up pasture into paddocks with mobile water & feed source, maximizes Quantity & Quality of Forage avoiding any bare-dirt areas

- Strip grazing between tree rows, 'Mob stocking' crimps stems, reduces weeds

- Graze at height of vegetative state, followed by a 14-28 day rest

- Stocking rate: carrying capacity of the land

- Avoid grazing when wet / frosty + graze cover crops and crop residue

- Take a grazing class, also Youtube is a reliable source for information

Thursday, September 5, 19
‘Hub & Spoke’ - waterer & paddocks

Perimeter electric fence and polywire (tree-protection)

Rotation, every day

Limit off-season access; winter feeding area

Feed at the top of vegetative state, rest period, mowing
Goats, not impossible

7 points to success:

1.) Tree protection, burlap wrap + individual wire cage

2.) fencing, 1 million volts minimum*

3.) feeding, keep them fed + at least 3 types of forage

4.) culling, get rid of the escape artist, they will teach the rest

5.) training, to a hot fence and regular feedings and rotations

6.) rotation, even & regularly spaced pasture changes

7.) cut & carry, keep penned in year round away from plantings
Persimmons

~ Ebonaceae, proof of Pangaea
~ wild, diecious, large tree
~ Asian types, zone 6 varieties Jiro, Great Wall, Saijo, Fuyu
~ For grafting: high on rootstock
~ American types, tasty sometimes seedy. Meader & Yates, many more. Hybrids: Nikita’s gift, Smith
Pasture Tree

- Long-lived gnarly
- Pollination, no problem
- Late-leafing, open canopy
- September-December*
  bearing
- Astringency -- ‘frost-ripened’ not exactly true
Mulberries

Leaves and fruit very nutritious with high digestibility

Diocious, 90% female

fast grower, fussy short-lived with beautiful yellow wood

Very good silvo pasture tree, Russian also (Morus alba ‘tartarica’)

May-July bearing
Tree Protection

~ Necessary? .. *STUN*
~ Polywire & posts
~ Shelter & stake
~ Individual fence
Benefits of diversity

- Improved water retention via shade, windbreak and diversification of root zone
- Disease resistance for trees, (example: apples), and better health for the livestock
- Shade improves cool-season grass production, reduces inedible weeds (ex. persimmon)
- Trees reduce erosion by wind and water, catch airborne silt and build soil
- Avian / Bovine synergy; wild turkeys
- Reduced risk of crop loss for the farmer
- Wind vs. insect pollination
- self-manuring, self-maintenance, auto-harvesting
Eco-system services of Agro-ecosystems

- **Prevents erosion:** staple food crops from locally-growing trees

- **Conservation:** High productivity reduces new habitat destruction and soil loss from inappropriate & unsustainable farming practices

- **Global impact:** High rate of carbon fixation while reducing wildland fuel consumption, habitat destruction

- **Synergistic self-maintenance:** Mycorrhizal (H₂O) and Rhizobial (N) associations, efficient nutrient cycling with ruminant livestock

- **Carbon fixation:** increasing fertility, increasing yields, reduction of carbon dioxide in the atmosphere
Silvo-pasture for timber

- Turning animals into the woods is NOT the same as an intentional and high-production silvo-pasture (Cronon, 1984)
- Same principles apply to manage for timber instead of high-value edibles & fodder crops; Larger-scale

- Developing pasture from cleared forestland: 1.) leave economical & beneficial species, 2.) Improve forage before letting stock on the land. 3.) Soil test, Amend

- High-value species Cherry*, Walnut, Oak, Hickory, Pine

Missouri Center for Agro-forestry
Alley cropping with agro-forestry, for farms focused on annual production:

- Vegetables, grain, potatoes, fiber crops
- Windbreaks for supplemental income, e.g. hazelnuts
- Incorporation of perennial N-fixing shrubs, mechanically coppicable, provide green manure, catch erosion and run-off
- Action of microclimate/shelter effect = better crops
- Row-spacing determined by existing management methodologies
- Root pruning of trees with subsoiler (chisel plow)
Alexander, NC
more, more, more!

- Ripping/sub-soiling for water infiltration & ‘bottom-up’ soil building
- additional cash-flow: agri-tourism, education
- forage improvement by seed-drilling/frost seeding
- Testing new crops, example: Seaberry (Hippophae rhamnoides) anti-oxidant rich N fixer + Siberian Peashrub
- farm-scale nursery for profit and reduced planting costs
- Research & Plant Breeding
- Mushrooms
Foliar Sprays

- By-pass the normal plant chemical pathways
- Boost immune resistance by doping beneficial micro-organisms
Soil Amendements

- Soil Testing, Logan Labs $25/sample
- Advancing Eco-Agriculture
- Thorium KELP, Sea-90, Worm castings, Alfalfa pellets
Designing your Agro-Forestry Farm

Make your farm 7-10* times more productive** than the average corn field.
Working trees

- What are your goals? Profit, soil remediation, feed for animals, food for people, timber income for your children
- Best trees for animal feed: Mulberry & Persimmon
- Timber trees: Pine, Walnut, Oak, plenty more
- Food Trees: Chestnut, Oak, Apple, Pear, Goumi
- N+ Fixers: Locust, Redbud, Eleagnus, Alders
Your Goals

- knowing what you want, *helpful but not necessary*
- cost v benefit, *budget/capacity and maintenance/enjoyment*
- start small, *making small mistakes in out of the way places*
- observe the landscape in all seasons, *and interact with it*
- let go of stress, *independent of the need for income generation*
Design your site

- **Beauty spots**
- **Access, water, buildings,**
- **what plants you want,** and where to put them
- **understanding their needs;** fertility, spacing, management (pruning, ipm, amendments)
- **characteristics;** pollination, rooting, when they leaf-out, sensitivities (e.g. walnut)
- **Scalability,** to your budget and capacity
- **Start small,** you can always change things later and discover new functions for old stuff
- **Maintain an experimental zone & propagation zone**
- Using **PATTERN LANGUAGE**
Elements of a Site

- Slope and Aspect, *seasonal light saturation, sun angle and temperature*
  - bottomland vs. ridge - *difference between holler, hill and cove*
- Terrain type, *open/wooded*
- Distinguishable climate, e.g. -->
  - *rainfall: Brevard vs Weaverville*
Disturbance Regimes

Key to understanding succession

What are they?
Fire, flood, grazing, mulching, plowing, planting, harvest, hunting, all forms of land management also non-management + simply walking (seed introduction)

These = how your land is stewarded, aggregately = the whole human footprint on earth
Using Ecology

- Understanding specie characteristics and their interactions, *ruminants and fowl, grass and trees*

- Pioneer Species: using nurse trees for green manure, *CHOP & DROP method for on-site soil building*

- Management v non-management

- The Goal is *self-supportive nutrient cycling* for maximum output maintained with *timely & confident* inputs of labor
Books

- *Restoration Agriculture*, Mark Shepard
- *Trees Crops*, J. Russell Smith
- *The Holistic Orchard*, Michael Phillips
- *Changes in the Land*, William Cronon
- *Enriching the Earth*, Vaclav Smil
- *The Unsettling of America*, W. Berry
- *The Natural Way of Farming*, Fukuoka

- *Coppice Agroforestry*, Dave Jacke, Mark Krawsieck (Not yet published, but keep an eye!)
- *Carbon Farming*, Eric Toensmeier
- *All Flesh is Grass*, Gene Logsdon
- *Grass Productivity*, André Voisin

Web Links

- “Coppice Agro-forestry” youtube by Dave Jacke
- ‘VersaLand’, youtube by Grant Schultz
- world agroforestry center, propagate ventures, carbon farming institute
- watch ‘SYNTROPY’ on Vimeo
Contact, ravenridgefarm@gmail.com

Webpage, ravenridgeagroecology.com

2.4 Acre Edible Arboretum

AirBnB Experiences: ‘Tree ID of the Southern Mtns’ & ‘Growing Fruits and Nuts’
Design Prompts

- Sample Budget, investments, fence, trees, stock, infrastructure
- Years calendar of tasks, hours/week
- Holistic Planning http://holisticmanagement.ca/how-to-write-a-holistic-goal/
  - QoL Statement
  - Means of Production
  - Future Resource Base