Shani Abromowitz
SOS - E4E Edible Landscapes
Week 8Upper Division Reading Notes
Winter 2016 w8

Hey y'all, Shani here. I left off last week wondering about plant growth curves, and how I could properly visualize when a plant needed what nutrient at what time. This information is usually displayed in a tables and graphs, usually logarithmic. Production Possibility Frontiers also help to calculate what the best intercropping mix is between two spp- this is something I'm very interested in as I'm thinking about doing an experimental intercropping between kale and lettuce with a clover n fixer. This week I took up two upper division articles and three chapters out of Huxley and Ong's Tree-Crop Interactions. These readings together have helped to inspire my lettuce/kale intercrop experiment. I'll begin with the book notes from Tree-Crop Interactions, only the most pertinent notes in relation to how the information added to my understanding of ecology and agroforestry, and how it's related to my business. I'll move onto a brief review and my take backs from the upper division articles I read. I'll end with my next week's goals.

Picking up from chapter 5 in Tree-Crop Interactions, my first notation begins on page 159: When intercropping between woody and non-woody plants, the basic factors at play are those moderating the energy balance of vegetative architecture and the plant water use productivity. Essentially what I'm looking at when I see an ecosystem is the methods of nutrient cycling, beginning with and powered by the sun, and the usage strategies of the plants found therein.

There's a picture on page 160, figure 5.1. It's a flowchart of what effects will come to with the introduction of trees into the field, or essentially, this flow chart shows how everything Huxley and Ong talk about in this book is related to each other. Check it out.

FIGURE 2: Fig 5.1

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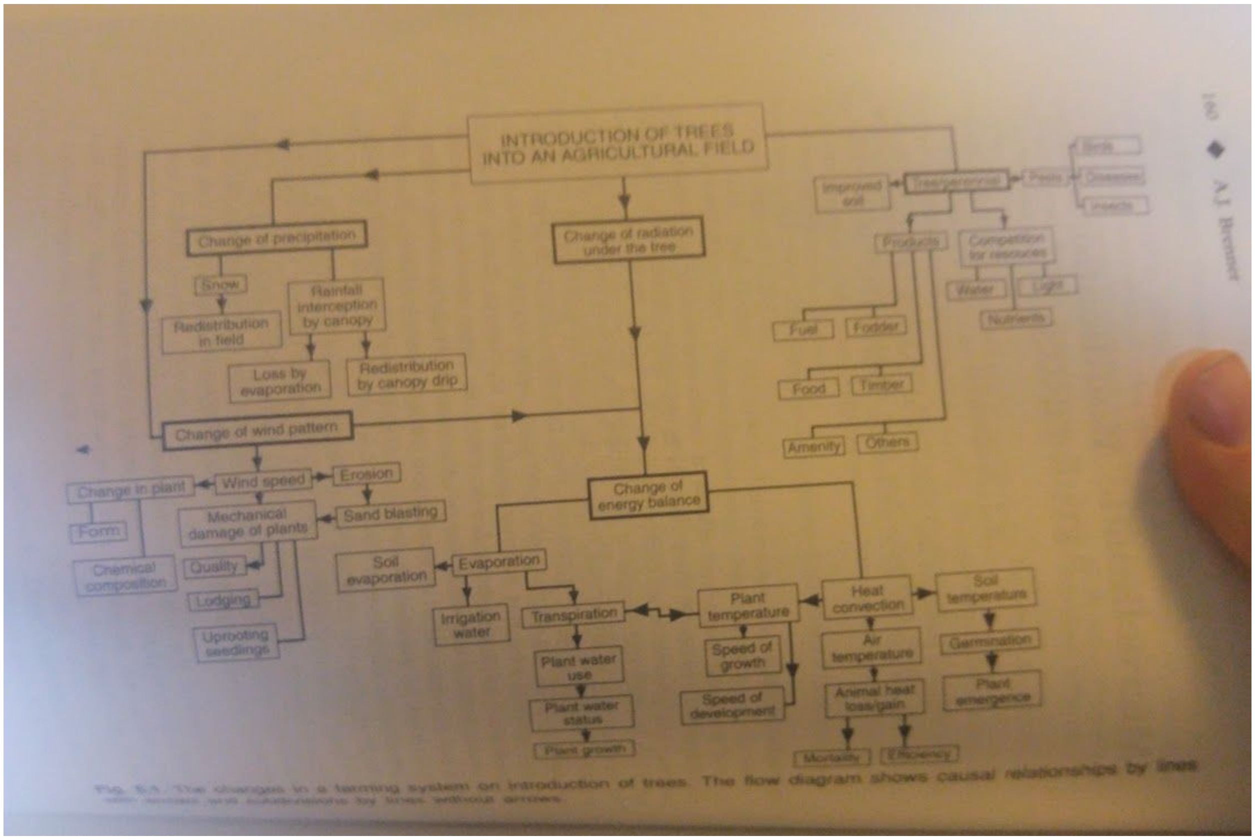

This information is exactly what I'll refer to when I'm thinking about integrating trees onto my client's land.

Page 163 talks about what a shade tree is and how it modifies a microclimate. Ever wonder why there's very little front under a shade tree? Or snow? Part of it is the fact that the canopy is intercepting precipitation, but it also has to do with the difference in radiation wavelength. The wavelengths filtering through the canopy to the ground is similar to the longwave wavelength emitting from the soil to the canopy. This creates a temperature microclimate because the rates of cooling are slower. As they say, "The sky is cooler than the soil or vegetation."

For my business I could measure (if I wanted) the radiation using a solarimeter or a pyranometer.

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Page 164 notes that plants need wavelengths between .66 & .70 micrometers for plant development and morphogenisis. It also talks about trees and how they interact with wind. Trees change the horizontal wind speed and turbulence of the wind. Because the absorb the momentum on impact, they force the air to go around them. The air gains speed the further away it gets from the trees that caused them to slow down. I can use a styrofoam cup anemometer to measure the wind speed. There's also a doppler based wind speed measurer called the sonic anemometer.

Page 169-171 describes humidity as the potential water holding capacity of the air- the actual vapor pressure of the air. They define dew point as the temperature of the air at which water will condense. Humidity can be measured using a psychrometer. To maintain homeostasis plants must thermoregulate the heat balance between the amount of heat they absorb to the amount of heat they re-emit via evaporation and convection. can measure temperature using a thermistor, thermocouple, platinum resistance thermometer, and infrared thermoment. These measurements all give dimension to the landscape I'm looking at, both in space and time. These data help me specify my plant selection for more informed choices.

173: <u>Amphistomatous:</u> To have stomata on both sides of leaf.

174: <u>Hypostomatous:</u> To have stomata on the lower side of the leaf only. Stomata respond to photosynthetic quantum flux densities, vapor pressure deficits, leaf water status, leaf temperature, and internal co2 levels.

175: There are a lot of biological processes which are regulated through temperature control, with fluxes increasing linearly after the base temperature has been established. Figure 5.7 shows the fluxes of stomatal opening when exposed to the different levels of: photosynthetic quantum flux densities, vapor pressure deficits, leaf water status, leaf temperature, and internal co2 levels.

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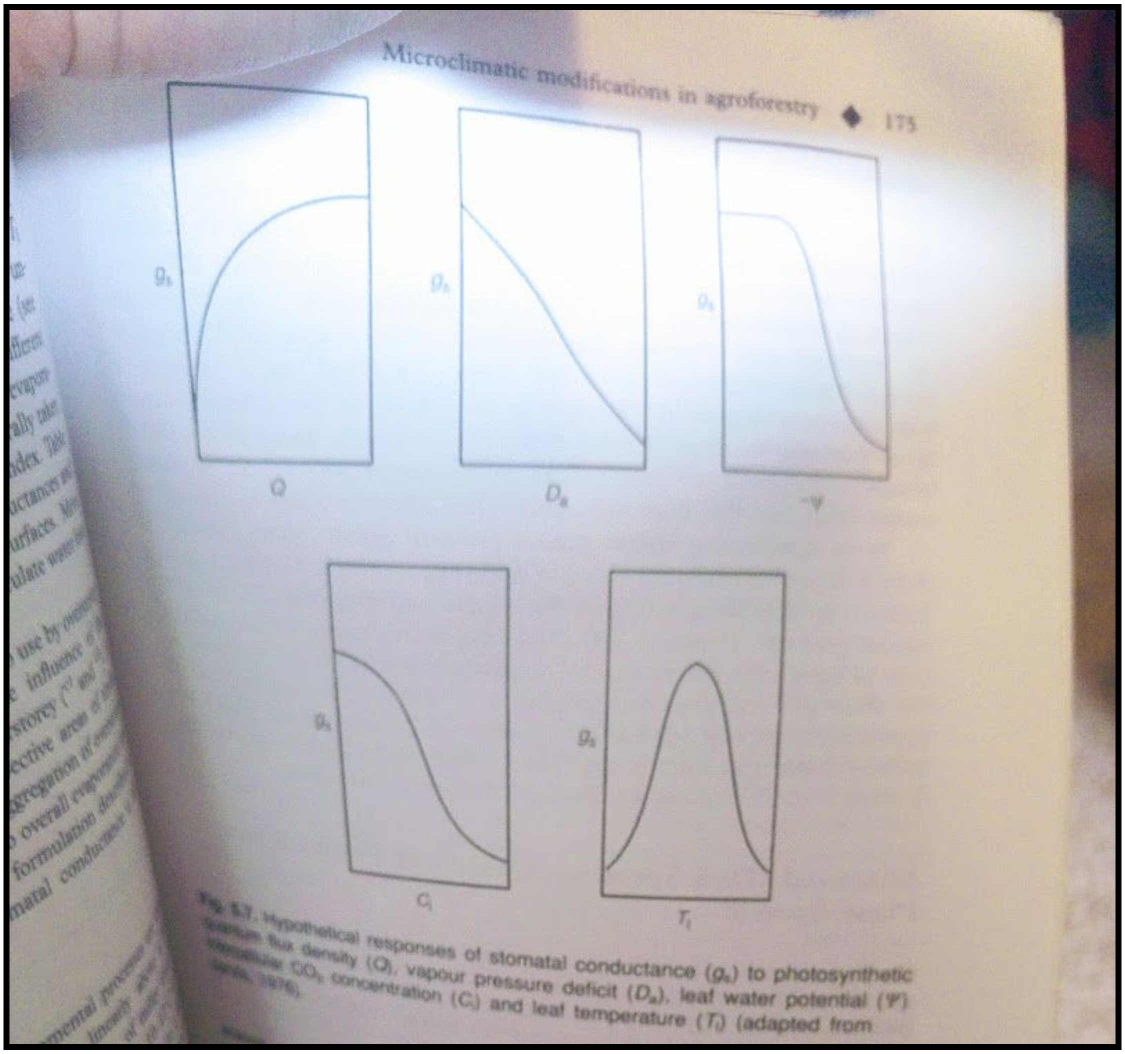
FIGURE 1 Fig 5.7



Moving on to chapter 6 where we look at the water balance between tree and crop intercrops. Page 189 explains that successful intercropping happens when the intercropped spp are evolved to make better uses of the resources by either using more of the resources, or using the resources more efficiently, i.e creating more biomass with less water.

Trees within an intercrop have direct and indirect effects on the annual crops. They directly use more of the annual water supply by tapping into the deeper sources of water, extending their reaches to refugia water sources, reducing runoff of water, and using rainfall outside of the growing season. Indirectly trees will improve the soil conditions of the microclimate within their reach by shading the ground to reduce soil evaporation, and improve evapotranspiration rates by regulating the temperature and vapor pressure deficit under the canopy.

As I'm thinking about this information and how I apply it to my business, I visualize myself choosing the appropriate trees for a pieces of land. According to this information, I want the overstory trees and canopy to have a low light saturation, high albedo, with early stomatal closure and limited h2o use until the end of the growing season (heat sensitive). The summer light can be more efficiently refracted to the lower canopy and ground cover if a tree satisfied these requirements. The refracted light would hit the lower canopy plants which too had a low light sensitivity.

Page 192, fig 6.1, show the water balance within an intercropped system. They offer a calculation to help quantify the water supply at given steps of a small portion of the hydrological cycle.

$Tt + Tc = Pg - It - Ic - Et - Ec - Dt - Dc - Rt - Rc -$ h20Content of Tree Root Zone-H2OContent of CropRootZone

or

The Transpiration Rate of the Trees and Crops =

the Gross Precipitation

- the Interception Rate of the Trees

- the Interception rate of the crops

-the Evapotranspiration rate of the trees

-the Evapotranspiration rate of the crops

-the Drainage rates of the tree soil

-the Drainage rates of the crop soil

-the lateral subsurface water movement

FIG 4: Fig 6.1

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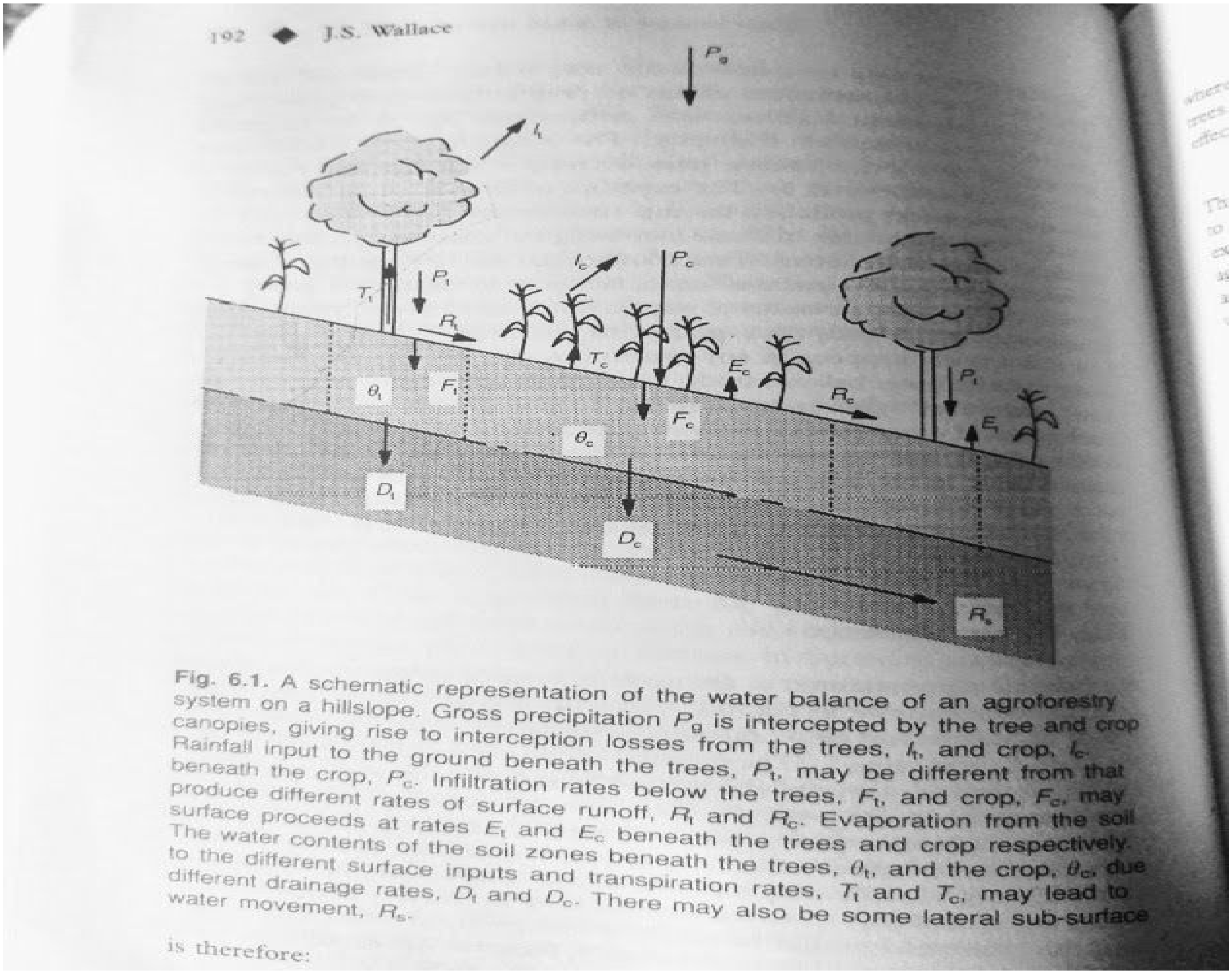

Fig. 6.1. A schematic representation of the water balance of an agroforestry system on a hillslope. Gross precipitation P_g is intercepted by the tree and crop canopies, giving rise to interception losses from the trees, I_t, and crop, I_c. Rainfall input to the ground beneath the trees, P_t, may be different from that beneath the crop, P_c. Infiltration rates below the trees, F_t, and crop, F_c, may produce different rates of surface runoff, R_t and R_c. Evaporation from the soil surface proceeds at rates E_t and E_c beneath the trees and crop respectively. The water contents of the soil zones beneath the trees, θ_t, and the crop, θ_c, due to the different surface inputs and transpiration rates, T_t and T_c, may lead to different drainage rates, D_t and D_c. There may also be some lateral sub-surface water movement, R_s.

is therefore:

Page 193 says that the evaporation rate, runoff rate, and drainage rate should be minimized. But if you minimize the drainage rate, than what happens to the water table recharge rate?

Also, when considering trees, consider their canopy size and shape, as these factors will modify the intensity of the rain as it falls to the soil. This is called the canopy edge effect. Essentially, relative to the intensity of the storm, the water drops collecting on the leaf surface will either hit the ground with more or less intensity depending on their starting intensity. If the rainstorm is strong and the tree canopy slows the raindrops down before they hit the ground, they have reduced the intensity of the raindrops, and vice versa. The effects of this could be different depending on the soil type and tree size, shape, height. The size and velocity of the raindrop can be measured with a disdrometer.

On page 194 the authors tell us that in the beginning when trees are just getting established and have shallow roots, their water demands will be higher than in later times of their lives, thus necessitating the use of irrigation lines. Good to know.

On page 196, Huxley talks about the interception rate of the tree canopy during a rainstorm. Whatever water is left on the canopy after evaporation reaches the soil either by dripping through the canopy (throughfall), or flowing down the stem (stemflow). Interception can be tentatively measured via the calculation:

Interception= gross rainfall - throughfall + stemflow

Page 199 says that runoff will occur when rainfall is greater than infiltration rate.

Further, on 200, the infiltration rate is a dynamic value, which changes depending on the soil, storm, slope of the land, and interception rates of the above canopies, soil crusting, soil water holding capacity, saturated hydraulic conductivity, and plant residue levels.

Page 202 shows figure 6.6- a favorite diagram of mine, it’s the terracing steps of a contour hedgerow and keyline design. I love the idea that you can terraform so easily.

Fig 3: Fig 6.6

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Page 209 talks about the zero-flux plane. This is the plane under the soil profile level where water is evaporating out of the soil, and over the soil profile level where water is draining downwards. On the zero-flux plane, water does nothing but sit there, and this plane will be different at every location.

Page 212 emphasizes that mulches can either add to or take from the water holding capacity of the soil. A mulch will either hold the water above the soil and allow it to evaporate from there, or it can let the water soak into the soil and prevent it from evaporating, which is the ideal scenario.

That concludes my book notes. Now onto my first article: **Ecological Interactions, Management Lessons and Design Tools in Tropical Agroforestry Systems** by Garcia-Barios and Ong (2004). This, for one, frustrates me. There's so much information on tropical agroforerstry systems because of the year around growth. It's hard finding the applicable information for the pacific northwest. Alas, there's some good takeaways from this article. Barios and Ong separate the effects on intercrops, specifically woody on non-woody plants, to be either competitive or complementary. To study how ecological, physiological, and agronomic factors interact with each other is to study agroforestry. These considerations can be visualized within Production Possibility Frontiers (PPFs).

As the authors say, "Competition occurs when two overlapping plants reduce one or more growth resources to the point where the growth, survival, or reproductive performance of at least one of them is negatively affected. Overlap increases as a consequence of growth and/or increased density. Plants differ greatly in size, life form, phenology, and capacity to capture and use efficiently above and below ground resources."

The degree of these complementary or competitive effects will differ depending on if these effects are interspecific (between two+ spp) or intraspecific (within the same spp). These are a few considerations to have before planting intercrops. Additionally, it use to be believed that the best way to limit the competition was to exploit the most amount of niches, (this is something I believe as well). While this is partly the case, temporal, and spatial complimentarity is also at play. Sometimes plants just work well together.

Trees could be considered a complementary component of the system because once they're established they're exploiting different resources than the annual crops, and possibly modifying the environment in favor of the crops. Due to the limited sun and lower light intensity, evapotranspiration rates of the understory crops is lessened, and thus water resources are in less demand. Trees also favor weeds which are less aggressive and slow growing (3). This paper concludes by describing the history and many methods of assessing intercrop yields. This information will become more pertinent in spring quarter, at which time I'll look more closely at these calculations.

The last article of the week is by Radha Ranganathan, who was referenced a number of times by Huxley and Ong. His paper **Production Possibility Frontiers and Estimation of Competition Effects: The Use of *A Priori* Information on Biological Processes in Intercropping** looks at the PPFs of three intercropping studies and analyzes the results. Ranganathan defines population ecology as the study of interactions in plant communities based on temperature, sunlight, wind, water, and nutrients. While intercropping has been the method of farming for most indigenous cultures for a long time, who believe that doing so is a better exploitation of a single space, reduces risk, controls weeds, spreads the labor out, and meets dietary requirements, there have been many instances where the interactions of two crops results in less biomass for both. This is not to say that the combined biomass of both does not make up the difference- indeed that is the appeal in intercropping. This process can also be a replacement series, where spp A overtakes spp B temporally, the total yield of which can be calculated with the relative yield equation, which is similar to the Land Equivalent Ratio.

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This is the paper that inspired my Kale/Lettuce/Clover intercrop. I'd like to do an experiment where kale and lettuce are planted as an intercrop with decreasing numbers of each starting at their highest densities at opposite ends and decreasing in the middle. I'm going to use most of the equations from this paper within the experiment to calculate biomass and yield. I'd also like to measure nutrient values throughout the growing season, but we'll see.

I think for next week I'm going to look into the details of this experiment and see what information is already out there. I'll also be continuing with Huxley and Ong's Tree-Crop Interactions- I hope to finish the book by the end of the quarter.

Until next week~

Shani A

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García-Barrios, L., & Ong, C. K. (2004). Ecological interactions, management lessons and design tools in tropical agroforestry systems. *Advances in Agroforestry New Vistas in Agroforestry,* 221-236. doi:10.1007/978-94-017-2424-1_16

Ong, C. K., & Huxley, P. (1996). *Tree-crop interactions: A physiological approach*. Oxon (UK): CAB International.

Ranganathan, R. (1992, 07). Production Possibility Frontiers and Estimation of Competition

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Effects: The Use of A Priori Information on Biological Processes in Intercropping.

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