The Plight of Clint and his Monoculture Practices

Matthew Bisk\textsuperscript{1}, Lauren G. Hunt\textsuperscript{2,3} & Cerruti R\textsuperscript{2} Hooks\textsuperscript{1}

\textsuperscript{1}SESYNC intern, \textsuperscript{2}Graduate student and \textsuperscript{3}Associate Professor and Extension Specialist, University of MD Dept. of Entomology

The dark, gloomy sky seemed to mirror Clint’s mood as he stood before his barren field. The eggplant harvest had just been completed, but the usual joy and feeling of success after the completion of a hard growing season was absent. This year’s yield was at an all-time low, and may have been more displeasing if not for hefty doses of pesticide and fertilizer. Despite the realization that costly inputs did not result in a more lucrative crop, Clint tried to ignore the fact that the net profit he turned this season would not come close to the modest prediction he made at the season’s beginning. The knot deep in his stomach tightened; worsened by results of a soil test that had recently arrived indicating that his soil was of poor quality and health. In fact, Clint knew that if this trend continued, his land may not be farmable within the next decade. Clint had heard from the SESYNC intern (Matt Bisk), city girl (Nicole Rusconi) and graduate student (Lauren “White Wave” Hunt) that crop rotation and plant diversification was the key, but Clint never listened to them and it seems that years of rotating two similar plants, eggplant and pepper and applying high chemical inputs had worn out his land. Everything was at stake. What was he to do? Were there any other farming methods that could increase production while improving soil quality and health? Where should he begin to reverse this trend? Should he text Matt and ask for help?

Clint’s plight may become a reality for other farmers if the persistent use of monocultures and high chemical inputs are the norm. Monoculture plantings in which a single crop is planted consistently on the same land year after year may negatively impact the overall health of the farm and subsequently lower crop productivity and profits. Crop lands must be properly managed to maintain soil quality and health. Soil health may be measured by the diversity of organisms below the soil; and exposing soil microbes to roots of similar crops year after year reduces their diversity while promoting the establishment of soil-borne pathogens specific to that crop. Bacterial diversity has been found to decrease in soils with constant monoculture plantings, while properly managed rotated fields show bacterial diversity that more closely resembles that of natural grasslands. The initial response to lower yields may be similar to Clint’s, which
includes applying high input pesticide and fertilizer. An overabundant supply of fertilizer cannot be used by plants and the excess may enter in surface or groundwater and reduce water quality.

Continuous monoculture plantings are not only more susceptible to pathogens, but insect pest outbreaks can occur when field sites are exposed to similar crops year after year. This generally results in greater pesticide use, which may adversely affect the ability of non-target organisms to complete ecosystem services such as pollination. In light of these problems, growers worldwide may need to apply more sustainable production tactics such as using mixed plant species and beneficial (companion) plants within their cash crop system. Companion planting, a practice utilized for centuries by indigenous populations across the globe, has yet to be adopted on a large scale in modern agriculture (Figs. 1 and 2). Often referred to as intercropping when grown between crop rows, these plants can provide nutritional and structural support and help battle pests. This leads to potential increases in crop yield, quality and overall productivity with less chemical intervention. In a study involving intercropped systems of sorghum and a legume, intercropping produced a 63% increase in grain yield along with an 88% increase in plant height. In addition, intercropped plots had 89 and 85% reductions in weed emergence and pest damage, respectively, compared to mono-cropped plots. Diverse plant communities lead to greater biodiversity which subsequently creates a more natural ecosystem with greater stability and resilience.

Monoculture plantings are known to be more susceptible to failure from natural causes, such as the Southern Corn Leaf Blight Epidemic in the US in 1970. This pathogen cost growers over one billion dollars in losses with recorded losses of 80-100% in their fields. A more recent threat to crops, citrus canker which affects oranges, limes and grape fruits, caused the death of millions of trees in Florida shortly after 2000. Plum pox virus wiped out almost 1,000 acres of stone fruit producing trees in Pennsylvania and has been detected in several other North American regions. An intercropped system involving two cash crops lowers the financial risk associated with disaster and may provide growers a fallback in case one crop is lost. Thus, intercropping can better ensure longevity and put growers at greater ease in the face of potential catastrophe.

Deciding on the proper combination of crop and companion plant is challenging and requires careful consideration of multiple factors, perhaps none more important than plant biology. Plant features can be crucial when choosing a companion plant system. Traits such as leaf structure, pollen or nectar production, presence of wax, flower size, structure, and color influence the
interactions between pests and their natural enemies. To choose the best combination, one must familiarize themselves with the main crop, companion plant and associated arthropod fauna. For example, some plants emit chemicals that repel certain pests and/or attract beneficials. A combination of plants can be used in the “push-pull” method, where one plant repels a pest from the field while another draws them to the periphery (Fig. 3). In other instances, companion plants may draw pests away from a crop (known as a trap crop) while attracting their natural enemies (known as an insectary plant). Some systems such as a lettuce and alyssum intercropping used to manage aphids have equaled or exceeded the amount of pest suppression offered by pesticides.

Using a companion plant as a physical barrier can reduce pest colonization, serve as a windbreak, or provide other services that directly benefit cash crop growth and productivity (Fig. 4). To develop the appropriate planting schedule, growth patterns of the cash crop and companion plant should be coordinated. Other growth factors such as depth of root exploitation, nutrient affinities, water demand and nutritional requirements should be considered also. The key is identifying companion plants that will optimize the cash crop’s utilization of environmental resources (Fig 5). For example, maize and cereal grains will mature at similar times and compete for resources, which may lower quality and size of the crop plant. Nitrogen fixed by leguminous plants can provide a nutritional boost to cash crops and subsequently replace or supplement their fertility needs. The legume *Leucaena* improved soil water retention and served as a sufficient substitute for nitrogen fertilizer when intercropped with maize and wheat. Indeed, carefully choosing a companion plant can go a long way in reducing pest colonization, attracting natural enemies and aiding cash crop growth.

Hearing about the world of companion planting offered Clint new hope and helped loosen the knot in his stomach. He promised himself that he would institute a better crop rotation scheme and find the right companion plants to diversify and ultimately convert his farm into a well-functioning agricultural ecosystem. However, Clint has some important, lingering questions. What would be the economic toll to maintain additional plants in his field? How could he determine the best layout for intercropping to maximize production? How much extra labor would be required? Could he even afford the initial startup cost? Would the benefits of intercropping outweigh the potential risks? What will he plant in addition to peppers and eggplant? Who will Clint call on to help him revise his farm? Will it be Matt, the former stuntman of Jersey Shore who traded in his beachwear for a thinking cap; Nicole, a lover of
eggplant, energy drinks and fast utility vehicles or Lauren G., who lives on the edge by mixing the flavors of her coffee beans?

Lucky for Clint, University of MD researcher Cerruti R² Hooks is looking for farmer participants in 2015 who are interested in instituting more sustainable and IPM (Integrated Pest Management) friendly tactics on their vegetable farms. However, he understands that the concerns of other farmers may differ from Clint’s. Thus, if you have a production idea that you think will make life easier on your farm and would like to test it, please contact Cerruti at crrhooks@umd.edu. He is willing to cover the cost of supplies, help you design the study, and pay an intern to help you maintain your plots and gather data.

Figure 1. Yellow tree foil/white clover intercropping (From Cotswold Seeds)
Figure 2. Taro and Corn Intercropping (From Biodiversity Conservation Blog at the Australian National University)

Figure 3. Example of the “Push-Pull Technique” (From Push-Pull.net)
**Figure 4.** Secondary Plant serving as a pest barrier (From agLe@rn.net)

**Figure 5.** Companion Planting Combinations (From Garden365.com)