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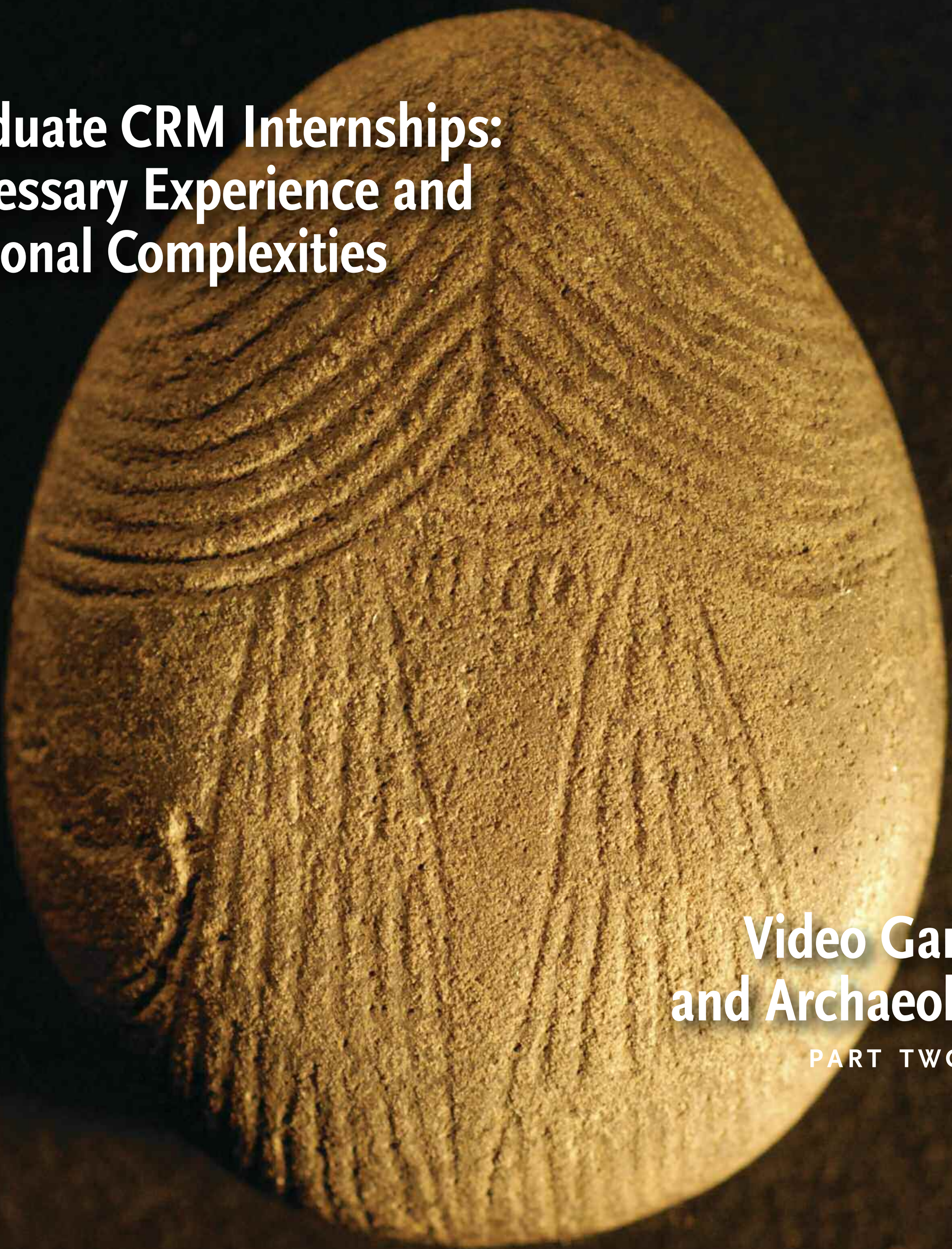

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# FROM THE PAST . . . A MORE SUSTAINABLE FUTURE?

## PREHISTORIC PLANT USE IN THE EASTERN WOODLANDS

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Among the many global environmental crises we face, one of the most certain is food production. The global food crisis has the potential to "explode within weeks and kill within days" (Cribb 2010:8). There are numerous examples in archaeology of how practices from the past can inform our future. Currently, the Sewanee Native Cultigen Project involves the reintroduction of a suite of wild plants indigenous to eastern North America that sustained hunter-gatherer groups before being domesticated or heavily cultivated between 5,000 and 3,400 years ago (Price 2009:6427; Smith and Yarnell 2009:6561) (Figure 1). These plants included amaranth (*Amaranthus retroflexus*), knotweed (*Polygonum erectum*), little barley (*Hordeum pusillum*), maygrass (*Phalaris caroliniana*), goosefoot (*Chenopodium berlandieri*), pepo gourds (*Cucurbita pepo*), sumpweed (*Iva annua*), and sunflower (*Helianthus annuus*). Today, most of these are largely considered tenacious weeds that we eradicate regularly.

Though important for thousands of years, these native cultigens were largely forgotten with the adoption of maize agriculture ca. 1,000 years ago. By the early 1800s, as the global population reached one billion (McClung 2014:699), economically important monocrops like rice, wheat, and corn were necessary to meet global food demand. Intensification of globally important monocrops provided the necessary means to feed growing global populations. Remarkable achievements over the past half century in technology and crop sciences (e.g., irrigation, fertilizer, pesticides, and farm equipment), beginning with the Green Revolution, has allowed for food production to keep pace with a human population that has more than doubled in size, from three to seven billion. During this time, global food output has increased by 178 percent and crop yields by 143 percent, while only expanding the total area of land under production by 11 percent (Pretty 2008:447; Pretty and Bharucha 2014:1573; Tilman 1999:5995). Today, while modern agricultural practices successfully produce more than enough calories to feed every person on the planet, the disastrous effects that they have had on the environment and human health have many people searching for more sustainable ways to produce food.

### The State of Modern Agriculture

#### Health

The successes of modern agriculture have allowed food production to outpace population growth. However, this increase has not provided food security for all. While we produce 25 percent more food per person today than in the 1960s, one billion people remain chronically underfed (Lundqvist et al. 2008; Pretty 2008:447; Pretty and Bharucha 2014:1573). Malnutrition kills nine million people annually and is responsible for almost half of the deaths in children under the age of five, or 3.1 million deaths annually (World Health Organization [WHO] 2015). While the aim of many global food initiatives has been the production of calories, questions remain about the nutritional value of the many monocrops that are mass produced today. Two billion people suffer annually from micronutrient deficiencies (McClung 2014:699; Pretty 2008:448). Micronutrient malnutrition, specifically vitamin A and iron deficiencies, most greatly affect the health of women and children in developing countries (United Nations Food and Agriculture Organization [UNFAO] 2012). In stark contrast to those who suffer from the effects of malnutrition, one billion people are overfed. A transition toward a calorie-rich diet in the developed world has resulted in an

*Figure 1. Sun setting on amaranth plants at the university farm, Sewanee, University of the South. Photo courtesy of Stephen B. Carmody.*

increase in obesity, type II diabetes, and hypertension, all of which have emerged as serious threats to global health. Today, most of the world's population live in countries where more people die annually from being overweight and obese than from malnutrition (WHO 2015).

## Land

The effects of modern agricultural practices have been equally as disastrous for the health of the planet, if not worse. Currently, more land is under production than is under forest canopies. Thirty-eight percent of all global ice-free land is under agricultural production, either being used as cropland or for livestock grazing, representing the largest use of land on the planet, affecting between 80 and 90 percent of all habitable land (Balmford et al. 2012:2714; Sanderson et al. 2002:891). Research has shown that our food system releases somewhere between 9,800 and 16,900 megatons of carbon dioxide into the atmosphere. Additionally, the release of nitrogen and phosphorous from heavily managed fields pollute and contaminate freshwater, estuarine, and marine ecosystems. It is estimated that as much as 80 percent of all nitrogen applied to farmlands finds its way into the water supply (Pretty 2008:449).

## Soil

Modern agricultural practices are considered to be the leading cause of global soil erosion and degradation. Today, one-third of all global lands are classified as marginal, meaning they are losing productivity, yet they support over 50 percent of the world's population (Glover and Reganold 2010:41). This degradation is being driven by farming, forestry, and grazing and has resulted in the release of approximately 1.1 billion tons of carbon into the atmosphere, not only affecting soil fertility but also driving climate change.

## Water

Water drives the production of every calorie that humans consume, making it inarguably critical to agricultural success. Since the 1950s global demand for water has tripled while supplies have diminished, leaving close to half a million people living

*Figure 2. Maygrass growing at the university farm. Photo courtesy of Stephen B. Carmody.*

in countries classified as water-stressed or water-scarce (Gleick 2003:1525). Irrigation agriculture uses 70 percent of all global freshwater resources and is responsible for 40 percent of all agricultural output (Balmford et al. 2012:2714; Rosegrant et al. 2002:1; Rosegrant and Cline 2003:1917), leaving only 30 percent for use in private homes and for energy production (Cribb 2010:31). Many see this balance as a major hurdle to sustainable agriculture in the future. Each calorie that we eat requires one liter of water to produce. People in more affluent countries consume approximately 792 gallons of water a day, 327,000 gallons annually (Cribb 2010:32). Depletion, pollution, and contamination of the world's freshwater supplies lead many to suggest that water and not land poses a much greater threat to food security in the future.

### Biodiversity

The greatest threat to the conservation of global biodiversity is agriculture. The expansion of monocrop agriculture has resulted in the largest replacement of the planet's natural ecosystems (Balmford et al. 2012:2714). Global biodiversity has also been adversely affected by poor management practices and through the use of pesticides and agrochemicals that harm natural diversity, including pollinator insects, bird populations, and soil fertility. Biodiversity is also adversely affected by population. One billion people today live within the world's 25 biodiversity hotspots, areas described as the most threatened species-rich areas of the planet (Myers et al. 2000:855).

This loss of biodiversity has resulted in the homogenization of the world's ecosystem, as well as our food supply. Over 7,000 wild plant food resources have been used as food over the course of human (pre)history (Bharucha and Pretty 2010:2916). As a result of agricultural intensification, 10 crops (wheat, maize, rice, soybean, barley, sorghum, millet, cotton, rapeseed, and beans) account for two-thirds of global croplands (Balmford et al. 2012:2715), while only 150 species are exploited commercially (Pretty and Bharucha 2014:1571).

## Agricultural Sustainability and the Future

With populations expected to exceed nine billion by 2050, our current system is both vulnerable and unsustainable (McClung 2014:699; Tilman 1999:5995). Today, the average consumer eats one-fifth more calories than in the 1960s (Cribb 2010:10). This increase in population and food demand means that food production will need to increase between 70 and 100 percent by 2050. So while food production is increasing 1 percent annually, population and demand are increasing 2 percent annually (Cribb 2010:10). The challenge for future generations will be to produce twice as much food using less water, land, fertilizers, and energy.

Soil erosion and degradation are widely considered to be the major obstacles to the sustainable growth of agriculture. By the year 2050, as a result of annual soil degradation, it is estimated that three billion people will live in deserts, meaning that new lands will need to be placed under production to meet future demands. We will need to feed twice as many people with half as much topsoil (Ruttan 1999:5962). Tilman et al. (2001) have suggested that an 18 percent increase of arable land will be required to feed a global population of nine billion. This increase will amount to an additional one billion hectares (3,861,021 square miles) of natural habitat, an area larger than the size of the United States (Tilman 1999:5997; Tilman et al. 2001:283). This trend will not only have a devastating effect on global biodiversity but would also require a tripling of nitrogen and phosphorous inputs, a twofold increase in water consumption, a threefold increase in pesticides, and a massive release of $CO_2$ from tillage and land clearing tremendously impacting the quality of soils, water, and air (Tilman 1999:5999). These data and projections make it clear that changes in the way we produce and consume food are crucial to human health and our very existence.

As rising global populations result in urban sprawl, demand for water is projected to increase 150 percent over the next few decades, placing an additional stress on water required for growing food. Inevitably, more scarce water resources mean decreased crop production and increased food costs for globally important crops, such as rice and maize, which could see price increases of 80 and 120 percent, respectively (Cribb 2010:38). Additionally, increasing median incomes across the globe will put added stress on water supplies, as demand for preferred cereals and proteins provided by meat, fish, and dairy is projected to increase in order to fulfill caloric requirements (Pretty 2008:448; Rosegrant and Cline 2003:1918).

## Our Project

Whereas the Green Revolution greatly reduced world hunger, advances in production over the next 50 years will require environmentally sustainable solutions that provide a sufficient food supply. Alongside researchers from around the world, the Sewanee Native Cultigens Project looks to the archaeological record for local solutions to a currently troubled system of food production.

*Figure 3. Cluster of sumpweed plants. Photo courtesy of Stephen B. Carmody.*

This project was initially inspired by the paleoethnobotanical and soils data from rockshelters (Early Archaic to Late Woodland) excavated on the southern Cumberland Plateau of Tennessee (Carmody 2014; Sherwood et al. 2012) and open-air sites in the Red River valley of Kentucky's northern Cumberland Plateau (Gremillion et al. 2008; Windingstad et al. 2008). Both projects were addressing (among other questions) the use and subsequent domestication of native cultigens in uplands settings across the midsouth. These studies found that native perennial plants were used widely throughout prehistory and eventually cultivated and/or domesticated on upland slopes. In light of these findings and the unsustainable nature of food

*Figure 4. Wild chenopod seed heads. Photo courtesy of Stephen B. Carmody.*

production across the globe today, we began to consider the potential for these "weeds" to again become a regional sustainable food source.

Today, over 80 percent of global croplands are devoted to annual crops that contribute 70 percent of human calories (Pretty and Bharucha 2014:1575). Perennial crops hold several advantages over heavily relied upon annual crops. Annual crops need to be replanted every season, require environmentally dangerous fertilizers and pesticides, do little to protect soils, and do not provide habitat for local wildlife. Conversely, native amaranth, chenopod, little barley, maygrass, and sumpweed resist drought, require little to no fertilizer and pest control, would increase local biodiversity, and could potentially help reestablish soil fertility (Tilman 1999:5998). These plants are reliable and nutrient-rich foods that produce substantial yields of both seeds and greens.

To date, our project has successfully grown between 50 and 100 of each of the five plants listed above at the University of the South's university farm (Figures 2, 3, and 4). This initial trial has allowed us to observe the growth patterns, productivity, and space requirements of each while allowing a baseline for comparison of these attributes in other growing conditions. They will also provide us with samples for nutritional and yield analyses. In addition, they have provided seed stock for our experimental plots. These plots, which will begin to produce this year, will be established in a variety of environmental settings, allowing us to measure the relationships between growth, yield, and nutrition on varying soil type, moisture, sunlight, aspect (temperature), and elevation. Understanding how these microclimates affect crop yields has important implications for archaeologists studying prehistoric systems of food production as well as researchers studying sustainable food production in the future. Upland environments were productive locations for food production in the past and may provide important locales in the future as more land will be required.

Our collaborative project currently involves faculty, staff, and students from across the University of the South, including the on-campus dining services, which plan to integrate these crops into dishes in the dining hall (Figure 5). In the future we hope to expand experiments to different regional settings through collaborative research projects with other university farms and gardens.

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*Figure 5. Farm manager Carolyn Hoagland teaching students and volunteers how to prepare trays of amaranth microgreens for research experiments. Photo courtesy of Stephen B. Carmody.*

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