the past 50 years have supported a single type of agriculture.

For the twenty-first century, diversified farm model to become a reality, the role of the farmer must be expanded beyond that of producer of food and fiber (Thompson, 1991):

- Producer of food and fiber.
- Primary steward of the land.
- Major citizen leader.

It is possible that sustainable agriculture is an initial catalyst in a greater societal transition to an age of sustainable development. This even could be of the magnitude of the fourth major societal transformation in the history of humankind (Table 2).

If we are in the early stages of transitioning to an age of sustainable development, then the overall strategies related to the industrial growth age of the past 250 years are inappropriate. This must be recognized or our agricultural institutions will be frustrated as they misread, confuse, or ignore the signals from most aspects of the world around us.

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Landscape Sustainability: Environmental, Human, and Financial Factors

Lynn Ellen Doxon¹

ADDITIONAL INDEX WORDS. environmental damage, cultural practices, costs, human activity

SUMMARY. When determining whether landscaping is sustainable, we should consider environmental, financial, and human factors. Environmental factors include the capacity of the landscape to damage or heal the system in which it is placed, the environmental effects of the cultural techniques and products used to install and maintain the landscape, and the ability of that landscape to endure without environmentally damaging inputs. Financial factors include the cost of the landscape compared to the economic return in terms of increased property values, the ability to attract and hold industry in the neighborhood, and user fees paid by people attracted to an area by the landscaping. Human factors include the effects on the landscape on mood, employee retention, and health and activity of the individuals who interact with the environment. The ideal landscape would be sustainable in all three of these areas, meaning there is more benefit than cost environmentally, financially, and humanly.

Sustainability started out as an environmental issue in production agriculture and perhaps even as a compromise between “we are destroying the earth” alarmists and “production at all costs” extremists. It has been carried into a number of other fields, like industrial development, but has not yet made the full step from production agriculture to landscaping. Sustainability looks at a system, rather than being

¹Formerly with the New Mexico Cooperative Extension Service. Current address: 1002 Montclair, N.E., Albuquerque, NM 87110.

over-specialized. That is one reason I am particularly interested in it and in applying it to the concept of landscaping.

I live in Albuquerque, N.M., where covering the yard with lava rock is sometimes considered landscaping. People insist they do this for environmental reasons. They want to save water. After all, we live in an arid region. They also do it for economic reasons. They want to save on water bills. I have more than 3000 square feet of a fully landscaped city lot and have yet to pay more than \$50 on my city water/sewer/refuse bill. The water rate in Albuquerque is \$0.6824 for 100 cubic feet or 748 gallons of water, so rates are not particularly high. And some people cover their yards with lava rock because they don't want to work in the yard and don't have time to maintain it.

Actually, a rock landscape is environmentally detrimental. In 1988, the summer flash floods in Albuquerque were worse than usual. There were three city lots in a row along the street where I drove to work. One was covered with weeds, one with rocks over black plastic, and one with well-tended turfgrass. After a flash flood sent a 15-foot wall of water down the street, the weedy area was slightly eroded. On the rock covered lot the rocks and plastic were rolled back and 2 feet of soil was washed away. The grassy area was covered with several inches of extra soil that had been washed from the other lots. In this environmental emergency, the lawn area proved the most stable. But what about sustainability when there are no emergencies?

I believe there are three basic ways to look at the environmental effects of landscaping. One is the capacity of the landscape to damage or heal the system. The natural system in this part of Albuquerque was sandy, alkaline soil covered by grass, with multiple drainage areas and alluvial fans deposited where these drainage areas come out of the mountains. The 12 inches of precipitation per year comes in rapid downpours, mostly between July and September. On a city-wide scale, the reaction to the natural system has been to pave the arroyos and get water out quickly and efficiently. This provides excellent graffiti canvases and skateboarding ramps and results in children and teenagers being washed away each summer. They might be playing in a dry arroyo, but a downpour a few miles away has filled the arroyo with water that comes rushing down to the river. The rainwater that falls on Albuquerque helps fill the recreational lake behind Elephant Butte Dam and irrigate cotton, alfalfa, and other crops in Texas. The Texans appreciate the concrete arroyos. But it was discovered that, if we leave the arroyos natural, shore them up with pieces of concrete that act more like rocks where they are damaged by construction, and put plants along them, the water moves more slowly as it comes out of the mountains, soaks into the soil, replenishes the small aquifer from which Albuquerque gets its drinking water, and flash floods are less common. While natural disasters in other areas include tornadoes, hurricanes, and earthquakes that are less easily controlled by simple landscape measures, there are ways the landscape can mitigate the effects of weather extremes in any climate. The selection of plants, hardscapes, irrigation techniques, and other landscape features and practices can heal the natural environment whether it is caused by nature or human activities.

Another factor that helps determine the environmental sustainability of landscaping is the effects of cultural techniques and products on the environment. Pesticides have been and are being studied extensively for their effects on the environment. The results are mixed and often presented in misleading fashion by the media. The "Don't Bag It" program in Texas is an environmentally sustainable cultural technique, yet many people resist it. In talking with people in the southwestern United States about leaving their lawn clippings on the lawn I was told, "Well, that might work where it is humid and the clippings can decompose quickly, but it won't work here." I described the program to a visitor from Missouri who said, "Well that might work out here where the clippings just dry up and disappear, but it won't work back home." The truth is, it will work anywhere. If there is enough moisture to keep the grass alive, the clipping will decompose. But people resist new ideas even if they are good new ideas and it is our job to present new ideas in ways that will encourage their adoption if we feel they are good and should be adopted.

Another factor to be considered, and one that was once considered the entire definition of sustainability, is the ability of our landscapes to endure. How many of the plants used in landscapes could survive without our input? Throughout the eastern U.S. mountains and midwestern United States, there are abandoned farm-

steads surrounded by apple trees, lilacs, iris, and other flowers that continue to spread and bloom without additional care. As we plant more and more hybrids and imported plants, fewer can be expected to become naturalized. Yet, sometimes imported plants show a greater ability to survive in our environments than native plants. Kudzu is an example. Many plants in Hawaii provide additional examples of imported plants taking over an environment. The mere endurance of a plant in the landscape may or may not be a desirable characteristic.

Financial sustainability

Economics have entered into the definition of sustainability. Although it started out as an environmental concept, it soon became apparent that, in our world economy, nothing can survive that does not have some economic benefit. But

what is the economic benefit of landscaping? Most of us certainly don't sell crops from our front yards. Yet, we invest a lot in seeds, plants, water, fertilizer, and other inputs to keep them landscaped. Back to our rockpile. One reason people cover the yard with rocks is to save on water bills. And they do. They might save as much as \$20 a month. But they spend more on their electric bill because the rocks heat up, reflect the heat to the house, and increase air conditioning bills by 10% to 40%, depending on the location. Because electricity is more expensive than water, their overall utility bills go up. Landscaping can reduce overall utility bills if done properly. Large shade trees reduce the need for cooling, and, where there is water close to the surface, as in river valleys, or where rainfall is adequate, supplemental water is not necessary. Turf and shrubs act as evaporative coolers.

Landscaping can also increase the value of

property. How much depends more on the appraiser than on any established standard in the real-estate trade, but it can be between 5% and 30%. For a \$200,000 home, even a modest 10% increase can result in an additional \$20,000 in sales price. According to realtors associations, landscaping is the home improvement that provides the greatest return when selling a home, followed by kitchen remodeling.

When selecting an office location, business persons with a choice will choose an office in a landscaped area rather than a barren, paved area. Landscaping attracts customers and contributes to employee retention. A prime example of the economic benefits of plants can be seen at Lake Erie College in Ohio (Zampini, 1972). A beautification program started at this college has been credited as a major factor contributing to a 55% increase in enrollment. Another example can be seen at Opreyland Hotel (Evans and Malone, 1992). The plants in the Garden Terrace are valued at more than \$1 million. The average annual horticulture budget is \$1.2 million. Yet, the hotel charges more for rooms on the Garden Terrace and they have a higher occupancy rate than other local hotels. That translates into an additional \$7 million in room revenues annually.

In low-income areas, parks and street trees have been listed second only to education in perceived value of governmental services (Getz et al., 1982). For beautification programs, street tree plantings, and parks to increase property values, neighborhood satisfaction and perceived value of services, community involvement in the planting, and proper maintenance is essential. A poorly maintained landscape or hazardous tree is more detrimental than beneficial. During the Los Angeles riots, building, cars, and all sorts of other property were destroyed, but trees that were planted as part of a community planting effort remained standing amid the rubble. Those trees are valuable to the people who planted them.

Human sustainability

Because the systems we are talking about are all created by humans, human factors are important in any discussion of sustainability but are perhaps even more important in the discussion of sustainable landscaping. Landscaping is created not for physical survival but for psychological and social survival. Research documents that the strongest indicator of life satisfaction is marital role (married people are happier and live longer than unmarried people). The second strongest indicator is ease of access to nature (Fried, 1982). The landscapes of yards, parks, and offices are the easiest access to nature most of us have and may be as important as our relationships with spouses. One study showed that workers who have a view of natural elements through their office window experience less job pressure, were more satisfied with their jobs, and reported fewer ailments and headaches than those

Human, environmental, and economic interrelationships in a sustainable landscape.

who had no outside view or could see only manmade elements (Kaplan et. al, 1988).

Because much of our work is mechanized and we spend our days at computer keyboards or behind desks reading and signing papers, we have to seek ways to use our muscles, ways to relax, and ways to relieve our stress. One of the most common ways is through gardening. Working in the landscape can provide the physical and emotional release we need after a day at the office. If the landscape does not provide human benefits, it is not sustainable simply because we will not continue to maintain and improve it.

A sustainable environment is one that can function in the environment in which it is planted and provides real or perceived economic benefit and emotional and physical benefit to the individual or community. There are several factors that can contribute to the creation of sustainable landscapes. One is developing a regional landscape style. This can be unique and appealing and give special character to the area that local people and visitors treasure. It translates into communities that attract industry, increased tourism, and other benefits of landscaping.

The realization that perceived value and therefore real value of industrial parks, subdivisions, apartment complexes, public buildings, and streetscapes can be increased by landscaping will help ensure that plants continue to be an important part of our cities. The fact that landscaping provides the highest return of any home improvement and that it can reduce crime and vandalism if properly presented and installed upholds the concept that landscaping is not just something extra for the rich. Landscaping is an integral part of the

continued prosperity of our country.

Most definitions of sustainability include human factors, although in production agriculture they are generally called sociological factors. Horticulture and production agriculture affect the sociology of a community and the psychology of those engaged in the practice, although psychological factors have been studied more thoroughly in ornamental horticulture (see Figure). Even in ornamental horticulture, however, we have barely scratched the surface.

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The Greenhouse Wastestream

Gale L. Arent¹

The 1990s have emerged as a decade of the environment. An important dimension of this is a societal focus on reducing the volume of materials that are landfilled.

The initial focus of the regulatory community was to reduce the volume of solid wastes generated by large firms. The present focus is community-based, with many local units of government developing recycling and other programs to reduce the volume of household wastes. These efforts will be followed by greater governmental focus on wastes generated by small businesses, including the greenhouse industry.

The significance of this societal focus is that many communities are developing recycling alternatives for several components of the household wastestream that are also present in the greenhouse wastestream. The composition of the United States household wastestream is illustrated in Fig. 1. In contrast, a year-long survey including predisposal visits to greenhouse waste containers in western Michigan revealed the wastestream composition illustrated in Fig. 2. Clearly, several smaller-volume greenhouse waste components such as metal, wood, and scrap paper may be recycled through a community-based option.

The big four

That which remains in the greenhouse wastestream are four materials representing 85% of the total waste volume. Greenhouse growers who want to reduce the volume of their wastestream and their disposal costs should develop a recycling program for hard plastic, plastic sheets, organic materials, and cardboard.

HARD PLASTICS. Most hard plastics that are used to make plug trays, flats, pots, and hanging baskets are either no. 6 polystyrene or no. 2 high-density polyethylene. This distinction is important to some recyclers. Another option that may be available to some growers is to incinerate these plastics in a waste-to-energy facility or sterilize and reuse the growing containers.

SHEET PLASTIC. Many recyclers will require that sheet plastic be cleaned, which requires that it be cut above the ground level. An obvious way to reduce the volume of sheet plastic in the wastestream is to use multi-year, ultraviolet-stabilized

¹Regional director, Michigan State University Extension, Southwest Region, 201 W. Kalamazoo, Kalamazoo, MI 49007.