

# An Overview of Sustainable Agricultural Waste Practices of West Texas

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## Abstract

This article returns to the topic of sustainability. West Texas, mainly known for its cotton and cattle production, is facing problems related to the dispensation of agricultural waste produced by these operations. The article looks at the ways of handling agricultural waste and the opportunities of dispensing it in West Texas. Since between 30 - 40 percent of food produced in the US is not consumed, reduction of food waste is another sustainability problem that, when solved, would lead to the reduction of agricultural production and, in turn, the reduction of agricultural waste. Waste reduction management practices of large food chain stores in West Texas are discussed, with a final goal of bringing waste to a zero level. Public sources of sustainable agricultural and non-agricultural waste handling are also mentioned. This research adds to the previous knowledge on sustainability by discussing agricultural waste practices of a specific local area, *i.e.* West Texas.

## Keywords

Agricultural Waste, Sustainability of Agricultural Resources, Food Waste, West Texas

## 1. Introduction

It is windy today on the giant side of Texas, cotton crops have been harvested and many agricultural fields appear empty and bare during the winter. West Texas is known for five major crops: cotton, sorghum, wheat, corn, and peanuts. It is also home to large cattle and swine production operations.

For the sake of this discussion, it is assumed the West Texas area includes the entire Panhandle region, Big Bend Country, and the small western part of the Hill Country (see **Figure 1**). The Panhandle is the area with the greatest agricultural production. Ranching is the primary industry of the Big Bend country and

is home to Big Bend National Park. The western part of the Hill country contains prairies and rangeland looking similar to the Big Bend area.

Agricultural producers in West Texas are familiar with the problems of scarce resources and they know the importance of conserving them and the environment. Water availability has been a major resource concern in West Texas over the recent decade. The Ogallala aquifer is the primary source of water for crops and livestock in West Texas. The entire regional economy depends entirely on Ogallala groundwater. However, water levels in the Ogallala aquifer are steadily decreasing. Since the aquifer's replenishment rate is below the level of water depletion, it makes water a non-renewable resource for West Texas.

West Texas also has red clay soils. Red clay derives its color from iron dioxide. Red clay soils are rich in minerals, like calcium, potassium, and magnesium, causing it to retain water well and are favorable for growing commodities requiring less irrigation.

The foremost concern of all agricultural producers in West Texas is to preserve all current water resources and to reduce potential contamination from runoff and chemicals during the production of major crops. Since the production of crops involves the use of insecticides and pesticides, production practices can harm the environment by polluting water, soil, and air. Many researchers investigate how agricultural treatments like fertilizers and pesticides applications



**Figure 1.** Texas regional divisions.

affect soil health, structure, and functionality [1]. Microbial abundance is usually at the intermediate level for the soils treated with fertilizers and higher on the plots treated with manure. Pesticides serve to sustain plant growth and protect crops from diseases and pests. However, most pesticides have a negative impact on microorganisms. In a literature overview of studies on the effect of mineral fertilizers on soil microorganisms, Allison and Martiny have found that as much as 84% of articles reported sensitivity of microbial soil content to nitrogen, phosphorous, and potassium [2]. Nitrogen-based fertilizers produce greenhouse gasses and contribute to waterways pollution. Another large source of pollution is animal production. Feeding, slaughtering and transporting billions of animals each year produce 13 times the waste of the entire US population [3].

Production may further cause soil erosion and studies show pesticide pollution can harm human health. Besides contamination and pollution of natural resources, crop and animal production practices can create waste which can also be of concern when implementing sustainable agricultural production.

As a consumer, we consider waste to be something left after consuming food or goods. We categorize waste into industrial waste handled by the companies creating it, household waste which is disposed of and handled by municipalities. Additionally, we understand some specialty waste like batteries, machine oil, or chemicals, is hazardous and must be handled separately from other waste. Subsequently, agricultural waste is often overlooked.

Agricultural waste is produced as a result of agricultural operations [4]. It mainly includes manure and other waste from farms, poultry houses, slaughterhouses, harvest waste, fertilizer run-off from fields, and pesticides entering the water, soil, or air. If agricultural waste is not disposed of properly, it could become harmful to the environment and humans.

In addition to agricultural waste pollution, oil and gas industry operations may also pollute water, soil, and air in West Texas. The area of Permian Basin accounts for 40 percent of US oil production and 15 percent of its natural gas [5] (see **Figure 2**). At the current rate of environmental pollution, it is estimated by 2050 the Permian Basin region will account for 39 percent of the world's new oil and gas emissions [5].

The main objective of this paper is to identify the existing sources of agricultural waste in the region, to describe how agricultural waste is currently handled in West Texas, and to discuss the ways to reduce and eliminate waste bringing it to a zero level.

## 2. Sustainability of Agricultural Resources

Sustainability has been the buzzword of the recent decade. Sustainable production in agriculture means “using natural resources more efficiently and responsibly to secure a sufficient supply of food while meeting growing demands” [6]. Prevention and reduction of pollution is one way to preserve the quality of natural resources. Waste derived from agricultural production contributes to pollution



**Figure 2.** Permian Basin area.

in the area. Raw agricultural waste in West Texas has two sources: crop production and livestock production. The mainstay of West Texas crop producers and residents is cotton. Texas is the largest producer of cotton in the US. In 2019, upland cotton production was estimated at 19.2 million 480-pounds bales in the US [7]. A total of 11.4 million acres were used in cotton production that year. In 2020, US production of cotton decreased to around 15 million bales, including Texas production of 4.57 million bales of cotton [8]. Therefore, Texas produced over 30 percent of the total national cotton production in 2020. However, the flip side of cotton production is pollution. Cotton is also known as a "dirty" crop. Conventional production practices of cotton involve the application of agrichemicals. Pesticides threaten the quality of soil and water, affect biodiversity and the health of farmers and the population residing around cotton-producing areas. Runoff of pesticides, fertilizers, and minerals contaminate rivers, lakes, and underground aquifers. Contamination of water sources occurs not only immediately, but also by the accumulation of contaminants over time. Production of cotton leads to degradation of soil due to high water use and soil salination.

To remedy the potential negative consequences of cotton production on the environment, the state and the entire country should take action to prevent and reduce pollution of natural resources. One such action is the US participation in the 2025 Sustainable Cotton Challenge (SCC). This challenge calls on textile manufacturers and retailers to source only sustainable cotton. It strives by the year 2025 to convert more than 50% of the world's cotton to more sustainable growing methods [9]. Textile Exchange is a global non-profit organization working for all players in the textile supply chain. It manages, develops, and promotes industry standards. Textile Exchange has a list of companies whose commit-

ments and performances are aligned with the goals of SCC. Here are just some programs from their list: Organic Cotton, Recycled Cotton, Fair Trade, Organic Fair Trade, Field 2 Market, and the US Cotton Trust Protocol (CTP).

The US Cotton Trust Protocol was launched by the US National Cotton Council. Currently, there are 300 cotton growers, 37 brands and retailers, and 525 mills and manufacturers belonging to the US CTP. This protocol measures the commitment of US cotton producers to fulfill the goals set. These ambitious 2020 goals across six metrics were set to be achieved by 2025, include improvement of water efficiency through water use reduction by 18%, soil loss per acre by 50%, reduction of energy use by 15%, reduction of greenhouse gasses by 39%, increase soil carbon by 30% and land-use efficiency by 13%. Other goals related to optimization of water management and reduction of runoff pollution include the establishment of measurable standards to track and report water, energy, and materials consumed. Over the past 35 years, cotton growers in the US have already reduced water use by 82%, reduced GHG by 30%, energy use by 38%, and soil loss by 44% [10]. The US Cotton Trust Protocol opened its enrollment in October of 2020 and after six months it has reached 300 members of the cotton supply chain. Plains Cotton Cooperative Association (PCCA) located in Lubbock, West Texas is a part of the US Cotton Trust Protocol. PCCA administration encourages its members to enroll with US Cotton Trust Protocol. Therefore, some West Texas cotton producers are already part of the US CTP and with time their participation will increase, so they can grow sustainable, renewable, and biodegradable cotton in the future.

Waste generated from cotton ginning is called Cotton Gin Waste (CGW). The early traditional methods for dealing with CGW include incineration, adding waste back to the soil, and landfill of waste. In addition, it has been added to cattle feed as roughage. The general manager of one of the two Lubbock's cotton gins, Mr. Butman indicated the CGW is returned to the members of his coop to be used for the above-mentioned purposes. During the last decade, additional uses of CGW have been developed. Since 2009 CGW is used in packaging and insulation products. Today a variety of CGW uses are applied in the cellulose industry. With government support programs, such as the renewable fuel program CGW became a valuable component of ethanol production. Beck and Clements [11] showed that 37.8 gallons of ethanol can be produced per ton of cotton trash.

Syngenta is a leading global provider of innovative products for crop production. This global company has 28,000 employees and offices in more than 100 countries. The company is working to transform the crop production process through intense research and development. Syngenta offers crop protection, seeds, and seed treatments to growers. Syngenta also develops and offers herbicides, insecticides, fungicides, and seed treatment products which promote strong and healthy plant growth. The company uses monitoring techniques, precision application, digital technologies, and new breeding techniques to assist produc-

ers with successful operations. Syngenta is a global developer and producer of seeds. New innovative hybrid varieties and biotech crops allow farmers to grow food with less water, using less land and fewer inputs. As a global leader, the company has strong commitments to sustainability through boosting resource efficiency, reducing the environmental footprint, and rejuvenating ecosystems. In 2017 Syngenta set sustainable development goals at the United Nations (UN) Sustainable Development Summit. These goals include the following: zero poverty and hunger, clean water and sanitation, responsible consumption and production, climate change, and life on land. Syngenta is committed to minimizing soil erosion and enhancing biodiversity, reducing the carbon intensity of its operations by at least 50% and water and waste intensity by 20% by 2030. The West Texas regional specialist from Syngenta, Mister Riley, offers assistance and training to crop producers using the AgriEdge program. This whole-farm management program offers farmers advanced precision and digital technology to assess their conservation practices and identify areas for yield improvement.

West Texas is not only known as a leading producer of cotton, but also for cattle production. Cattle are raised across West Texas using four different farming systems including grass-fed, grain-finished, cow-calf farms, and feedlots. Livestock waste management is one of the environmental challenges, especially for feedlots. Waste management typically deals with solid waste by drying or composting it. Then the dried waste is used as fertilizer and as fuel for combustion to obtain energy. Slurry waste is treated by liquid composting or methane fermentation. Wastewater can be treated by special processes producing clean water or liquid fertilizer.

There are many feedlot operations in the High Plains of West Texas, in Hereford, Dalhart, and Tulia. Cactus Feeders is one of the world's largest feedlots in West Texas. The company feeds and slaughters 1.2 million steers and heifers annually. Just one of their 10 feedlots has a 50,000 head capacity and is located near Tulia [12]. When cattle reach slaughter weight and are shipped out, pens are scraped, and manure mounds are built. Then the manure is sold to companies for further processing/composting or spread on pastures by neighboring farmers.

The Back to Nature company located in Slaton, Texas buys cattle and chicken manure from cattle feedlots and chicken farms to produce composted manure. They also use cotton gin waste to produce cotton burr compost. These products are sold to tree, lawn, and garden nurseries and dealers around West Texas.

McCracken Farm Services of Hereford, TX buys manure and compost from local feedlots. In turn, the company offers local farmers the service of manure application. Manure is applied using manure spreaders equipped with GPS navigation and minimum compaction. Compost is another product this company offers. It is 100% composted feedlot manure with added lagoon water. Compost, besides giving a slow release of nitrogen, offers phosphate, potassium, and millions of beneficial bacteria for soil. Other micronutrients of compost include zinc, magnesium, and calcium. The third product offered by McCracken Farm

Services of Hereford, TX is silage. The company owns choppers, tractors, and operators to produce silage.

Water pollution and overconsumption are other problems related to feedlots. A water usage study was performed over two years at a 50,000 head beef cattle feed yard in the Texas High Plains [13]. The study showed around 66 percent of the total water used was for drinking water, 2 percent was used in the feed mill to process feed, and 32 percent was used for overflow activities to prevent freezing. The study estimated 22 percent of the total annual water use could have been conserved if measures such as installing more efficient water troughs, repairing existing troughs, and installing an overflow recycling system were taken. Potential uses for recycling the overflow water were irrigation of crops, sprinkling pens for dust and temperature control, and use in the feed mill to steam grain, were proposed [13]. After more than 20 years, some of the problems mentioned in this research persist and need adoption at the feedlots.

Clean Earth, Inc. is a company offering sustainable waste solutions, environmental compliance expertise, and business efficiencies to a wide range of industries, including retail, chemical, and energy since 1990 [14]. The company advances customers' sustainability by treating recycling and repurposing specialty waste. Among the services related to agricultural sustainability, they offer landfill and incineration, turning waste into energy, solidification, and stabilization of waste. Distillation, tolling, and several Solve35 sustainable technologies allow this company to recycle, clean, degrease and repurpose used solvents. Clean Earth company does soil testing and treatment of contaminated soil. The process of solidification and stabilization of waste treats a broad range of contaminated materials to stabilize hazardous components, so the waste can be buried without harming the soil. Among their retail industry customers are supermarkets, grocery stores, distribution centers, and retail stores. One of their service centers is located in Snyder, West Texas.

The American Land Company located in West Texas is committed to sustainable agriculture and caring for the land and its natural resources. The primary goals of this company are to enhance environmental quality and the resource base; satisfy the human need for food, fiber, and biofuel needs; sustain the economic viability of agriculture, and improve the life of farmers and society as a whole. The company purchased several aquifers in West Texas, trying to grow plants and animals with optimal water use and minimum pollution. The company has developed many bio-products for exports, including paper, biofuels, bioenergy, biodegradable plastics, soil, and water remediation [15].

BASF is a multinational corporation with a major presence throughout the world. One of BASF's associated companies is located in Lubbock. On November 19, 2021, BASF Agricultural Solutions announced the expansion of the Lubbock Field Research Station by adding the Cotton Breeding Nursery Services and Trait Development of Cotton Seed Production teams. These teams will develop high-quality cottonseed which addresses the company's sustainability goals.

JBS USA Holdings, Inc. is an American food processing company and a wholly-owned subsidiary of the Brazilian company. It has three plants located in the panhandle of Texas. The beef processing operation is located in Cactus, TX, the live pork operation is located in Dalhart, TX, and the third transportation company is in Cactus, TX. JBS USA released its 2020 Sustainability Report, which states that the company completed its 2020 sustainability goals, set in 2017. This global food company reduced its greenhouse gas emissions by 20 percent, reduced electricity intensity by 14 percent, and reduced water intensity by 10 percent [16]. New vision and goals for 2030 include: reduce emission intensity by 30 percent, reaching 60 percent renewable electricity, reduce water use intensity by 30 percent, invest \$1 billion in emission reduction projects, invest \$100 million in R&D regenerative farming practices, etc. The company also plans to develop global animal welfare scorecards. The three companies located in the panhandle of Texas will take part in the implementation of these global targets.

In January of 2020, the US Roundtable for Sustainable Beef (USRSB) set a framework for aligning JBS's supply chain with the US Beef Industry. The framework outlined key issues of sustainability and opportunities for improvement across the beef value chain. JBS USA's nine beef-producing facilities were recognized, including the Texas facility in Cactus. JBS USA, Texas Beef Producers, and 79 feed yard partners tested the applicability of the USRSB feed yard metrics at scale. With the completion of this project, metrics for 2.9 million head of cattle from more than 90 feed yards were completed. This project accounted for 56 percent of JBS USA's fed cattle supply.

Many federal and state organizations in West Texas, such as Texas A&M Agri-Life Extension, Texas Agricultural Irrigation Association, Texas Alliance of Groundwater Districts, Texas Water Resources Institute, just to name a few, offer effective and efficient agricultural programs including efficient irrigation technologies, conservation planning and assistance to benefit the soil, water, air, plants, and animals.

### **3. Sustainability of Food Waste**

It is known that food production in the US requires 80 million acres of farmland, uses 25 percent of all freshwater consumed, and accounts for 13 percent of total carbon emissions [17].

There are many large and small food retailers throughout the region. The largest chains include Wal-Mart, Costco, Sam's, and Target. Close to 30 Wal-Mart stores are located throughout West Texas. As one of the largest retailers in the world, Wal Mart continues to build and expand sustainability efforts by adopting replenishing practices in agriculture and forestry, and by eliminating waste along the product chain, and decarbonizing its operations. Wal-Mart entered a commitment to protect, manage and restore at least 50 million acres of land; to source more sustainably at least 20 key commodities, within the row crops, meat and dairy, packaged food, and textiles categories, by 2025 [18]. It is working to-



ward zero waste in its operations in key markets. By 2020 corporation had diverted 81 percent of waste away from landfills and incineration and donated 627 million pounds of food in the US. Wal-Mart aims to reach 100 percent recyclable, reusable, compostable private brand packaging to achieve a 15 percent reduction in plastic use by 2025.

Another international retailer, Costco, is also committed to sustainable development. Costco identified a set of sustainable development goals (SDGs) based on the United Nations SDGs, which include clean water and sanitation, responsible consumption, and sustainable treatment of land, water, and air, among others. The programs implemented by Costco include charitable contributions, food donations, food security, non-food donations, community investments, community supplier, etc. In 2021 Costco contributed \$58 million to disaster relief and charitable organizations with a focus on children, education, health, and human services. Of this sum, \$1 million was donated to the Vaccine Equity Initiative, which expands vaccination efforts in underserved communities. In the same year, Costco contributed \$3.5 million in cash grants and 70 million pounds of food to Feeding America.

Costco is committed to diverting 80 percent of its food waste. This retailer participates in two programs related to food donation—Feeding America and the World Vision programs. In 2021 besides food donations, 179 warehouses sent around 14 million organic foods to feed cattle and hogs [19]. Organic waste like chicken grease produced from a rotisserie chicken is recycled and turned into biofuel. Other organic waste is converted into certified organic liquid fertilizer or recycled to create energy. Some organic food is sent to composting facilities to create a nutrient rich soil conditioner. At Costco non-food waste is reduced by donation, recycling, and recycling to repurposing. In 2021 Costco repurposed 2.1 million pounds of foam by densifying. It can then be used to manufacture picture frames, crown molding, and other polystyrene products. There are two Costco stores located in West Texas, one in Lubbock and another in El Paso.

All local and international retailers understand their responsibilities to minimize waste and greenhouse emissions caused by the large amount of food waste produced during their operation. The Center for Biological Diversity evaluated the ten largest US supermarkets based on their commitment and performance on the path to achieving zero waste. Three supermarkets from the lists that have operations in West Texas are Wal-Mart, Costco, and Target. Wal-Mart scored highest among them in terms of commitment, tracking, transparency, and prevention. In fact, Wal-Mart is the only one out of these three chains committed to achieving zero food waste by 2025. Target scored grade B and Costco grade D based on the same criteria [17].

#### **4. Public Sources of Sustainable Agricultural and Non-Agricultural Waste Handling**

In general, all waste can be divided into four types: agricultural waste, hazardous

waste, industrial waste, and municipal solid waste. There are well-known methods of handling public waste, such as landfill, recycling and reuse, incineration, converting waste to energy, and special waste disposal for hazardous materials. A sustainable waste management strategy includes broader options for dealing with waste. The main priority of sustainable waste management is avoiding and reducing the amount of waste.

The guidelines of sustainable strategy led to the deliberate process of purchase and use of products. This strategy applies as follows. If consumption of a product cannot be avoided, then purchase a product that can be reused or repaired. If a product cannot be reused or repaired, then use a recyclable product. The next available alternative to the avoidance or reduction of waste is energy recovery by turning a product into heat, electricity, or fuel. The last and least desirable alternative is the treatment and disposal of waste through landfills and incineration.

The Texas A&M AgriLife Extension Service periodically offers agricultural pesticide waste collection in partnership with the Texas Department of Agriculture (TDA). Unwanted, outdated, discontinued, and surplus agricultural pesticides, insecticides, herbicides, fungicides, and other agricultural waste can be tested and disposed of then.

Companies like Llano Waste and Happy Trash provide construction waste solutions in the North Plains [20]. These companies offer a wide range of waste containers to handle construction waste loading, filling, and cleanup of the area; and recycling pickup.

South Plains Association of Governments (SPAG) developed a short and long-range report on solid waste management facilities and practices. This report assessed the current state of facilities and practices, specified deficiencies in resource recovery, household hazardous waste collection, and household hazardous waste areas. This report discussed ways of source reduction and waste minimization, reuse, and recycling of waste. Some suggested solutions like partnering with commercial vendors to develop a collection of waste, encouraging citizens to compost, grind/chip yard waste into reusable mulch or fertilizer, offering additional collection facilities, educate the general public on recycling/reuse of some waste were proposed [21]. SPAG offers grant money to local municipal and county governments, school districts for recycling and waste reduction projects.

Department of solid waste management in cities offers different options of disposal to private citizens and companies. It is free of charge unless large amounts of disposal are taken to landfills. Rates provided are per ton at the city's solid waste management site. The city of Lubbock, for example, has two landfill disposal sites, a site for commercial landscape waste disposal, and household hazardous waste which can be disposed of through appointments with the city waste management department [22]. Each city has citizens' convenience stations for the disposal of bulky items, such as furniture, appliances, fencing, tires, etc. Citizens can also bring used oil, filters, and used anti-freeze to these stations.

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## 5. Conclusions

The problem of agricultural waste is not new and has been dealt with increasingly over the last two decades. The concept of sustainability in waste management focuses precisely on the prevention of waste/pollution and the reduction of waste/pollution to zero.

The main source of water for agriculture in West Texas, the Ogallala aquifer, is closely monitored by researchers of Texas A&M University (TAMU) and Texas Tech University (TTU). The level of pollution and depletion of water in the aquifer due to production agriculture is monitored and studied by the Extension Services of TAMU and TTU.

National agencies also currently monitor and observe public water sources and air quality components and make recommendations. They also have the power of establishing and enforcing punitive actions against the violators in the form of paying for damages or fines as happened with West Texas Gas Inc., in Odessa. In October 2020, the Chapter NAACP and seven environmental organizations in Odessa, West Texas filed a petition for the US Environmental Protection Agency (EPA) to address unhealthy levels of air pollution in the Permian Basin [23]. Five subsidiaries of West Texas Gas Inc. will pay \$5 million on compliance measures in the gas and oil industry in West Texas. They will also pay \$3 million in civil penalties to resolve claims from accidents and violations of the accidents prevention program [23].

EPA findings and recommendations are shared with the public. Based on the results from research of institutions of higher education and national agencies, production methods are advancing to utilize new seed varieties that require less water, and more water-efficient irrigation techniques and equipment. Although livestock production feedlots are still problematic, some companies use new technologies that offer new products derived from feedlot and cotton production waste.

Another area warranting attention is the food industry. The Economic Research Service (ERS) of USDA estimated between 30 - 40 percent of the food produced in the US is not consumed [24]. This translated into \$162 billion worth of wasted food in 2010. Therefore, eliminating food waste would be an important step toward sustainable use of our resources—land, water, climate, and others. Companies should focus on the reduction of supply chain and in-store food and non-food waste. Making a zero-waste commitment is an ambitious goal, but it can be achieved through the creation of measurable deadlines for zero waste and comprehensive prevention programs. Currently, such programs include better ordering practices, clearer labels, using inventory distribution and tracking technology, promotion of imperfect produce, and minimizing daily waste of meat and dairy products.

Therefore, the main findings of this work show that companies of West Texas are moving in the right direction. More and more farms and companies are considering and turning to alternative methods of processing waste products instead

of sending them to landfills. More and more companies find ways to segregate, process, and sell agricultural waste for profit. The speed of this transition is concerning. Therefore, the role of Federal and State agencies, local governments, educational institutions, and individual companies involved in the processing of waste is in educating the public, companies, and industries by offering tools and resources to handle the waste and create alternatives to current practices. EPA, for example, created comprehensive guidelines to help businesses purchase recycled materials, develop sustainable material management to recover food, handle electronic recycling, reduce the environmental footprint, and overall reduce waste [25]. The Texas Department of Agriculture (TDA) has detailed instructions on how to handle agricultural waste pesticides [26]. Permits, authorizations, and requirements for air quality, wastewater, and process water and storm-water discharges from animal feeding and other agricultural operations can be found on the Texas Commission on Environmental Quality site [27]. Another national agency, the Natural Resources Conservation Service (NRCS), offers technical information, models, and data related to soil, water, air, plants, and animals.

### Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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