A RE-EXAMINATION OF THE SLAVE DIET

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The genre of literature discussing the lives of slaves throughout United States history is vast and covers all aspects of slavery from the viewpoints of different researchers. The slaves' quality of life is a complex topic since each plantation had its own unique way of running, and slaves' experiences on the plantation differed in their access to food, housing and clothing, and treatment and punishments. The aspect of the slaves' life that is the focus of this study is the slaves' diet on the plantation. This study challenges the recent argument by Robert Fogel and Stanley Engerman that slave diets were calorically and nutritionally adequate.

Previous studies on the slaves' life have fit into several general categories. Some researchers have reported that the slaves' life was materially good. These researchers argue that slavery was oppressive, but it was not as cruel as past historians first thought and their material lives were comparable to free white laborers of the time.[1]

A second category of researchers describes the slaves' material lives as awful. This view paralleled that of abolitionists in the antebellum period. One source that supports this view on the quality of life is the journal of Fanny Kemble. In one publication of her journal, Kemble notes how the slave dwellings were filthy and cramped, and the slaves unkempt. She says, "Slavery is answerable for all the evils…from lying, thieving and adultery to dirty houses, ragged clothes and foul smells."[2] This description contrasts greatly from the view that life was quite good for the slaves in that period in history.

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[1] R.W. Fogel, & S.L. Engerman, *Time on the Cross: The Economics of American Negro Slavery*, 2 vols. (Boston: Little, Brown and Company, 1974), 77-78, 107-44.

[2] Ibid., 158-59; F.A. Kemble, *Journal of a Residence on a Georgian Plantation in 1838-1839* (New York: Alfred A. Knopf, 1961), 24; U.B. Phillips, *Life and Labor in the Old South* (Boston: Little, Brown and Company, 1963), 261.

The most recent research on the slaves' quality of life comes from economic historians, headed by Robert Fogel and Stanley Engerman.[3] The economic historians argue that slaves were considered an economic investment, and plantation owners were good businessmen who knew that they needed to protect their "property" in order to make a profit. Economic historians used quantitative methods to support their conclusions. Fogel and Engerman reasoned that plantation owners would not intentionally starve their slaves because the owners could not profit with slaves who were weak or susceptible to disease due to malnutrition. They point out that

> Slavery was not a system irrationally kept in existence by plantation owners who failed to perceive or were indifferent to their best economic interests. The purchase of a slave was generally a highly profitable investment which yielded rates of return that compared favorably with the most outstanding investment opportunities in manufacturing.[4]

This group of researchers argues that it would not be good business for owners to "damage" their property. This study focuses on the economic historians' view of the slaves' diet and nutritional health as it relates to slaves' quality of life.

The nutritional requirements of slaves in the 19th century are similar to what people require today. As with contemporary Americans, those in the 1800s needed a balanced diet; and, of course, dietary luxuries like enriched grains and processed foods were not available. Still, economic historians, like Fogel and Engerman, argue that the slave diet was adequate. However, different conclusions are reached when corrections are made for inedible portions of food and nutrient losses due to processing and storage, and more accurate estimates of slave energy expenditure are used. Although Fogel and Engerman used a

[3] Fogel, *Time on the Cross: The Economics of American Negro Slavery*.
[4] Ibid., 4.

quantitative scientific approach towards their analysis of the slave diet, the resources available to them in the 1970s were limited. One example is that economic historians used the disappearance method to find the amount of food available for consumption, assuming that all food "available" was consumed.

There are three main nutritional corrections that need to be applied to the methodology of economic historians in order to develop an accurate conclusion regarding the slaves' diet and nutritional health. First, economic historians based their conclusions on the analysis of raw foods. This method results in a reduced nutrient content of food when it is consumed because some nutrients are destroyed when they are cooked; additionally, processing reduces nutrient content. Secondly, these researchers did not consider inedible portions of food that had to be removed before the food was consumed, thus decreasing the amount of food available for consumption. Finally, economic historians did not evaluate the slaves' energy expenditure, a factor that greatly affected a slave's caloric needs.

Major Studies of Slave Nutrition by Economic Historians

Economists Robert Fogel and Stanley Engerman conducted one of the largest and most well-known studies on slavery. Through the analysis of census documents and other data and focusing on cotton plantations, they concluded that the slave diet provided 4,185 calories daily, calorically adequate by "modern" (1964) standards. These economists claimed that slaves were fed adequately and that their standard of living was quite similar to white laborers of that time.[5]

[5] Ibid., 97, 99, 111-15.

Dale Swan completed another study that examined the slave diet. Swan's study looked specifically at slaves on rice plantations, using agricultural and population census documents to construct the most cost-efficient diet. His diet, using the five main foods available to slaves at the time, met the range of recommended caloric intakes for an adult male slave, which he found to be 3,150-4,200 calories; but, Swan did not look specifically at the nutrient adequacy of the diet, since his main focus was to find the cheapest diet to fulfill caloric needs.[6]

This study uses much of the same methodology as Fogel and Engerman and Swan; however, different conclusions are drawn about the nutritional adequacy of the slaves' diet. Analyzing rice plantation documents from a nutritional historian's point of view brings a different understanding of the nutritional adequacy of the diet, a position that most economic historians do not share.

Methodology of Most Economic Historians

There are three main corrections that need to be made concerning the methodology that economic historians use when analyzing the slave diet. Economic historians calculate the amount of available food by the "disappearance method." To illustrate, the disappearance method takes the total amount of grain produced and subtracts the animal feed allowances and the seed kept for the next year's crop to find the total amount of food available. This method assumes that all of the available food is consumed. However, the total amount available is still not the amount of food actually

[6] D.E. Swan, *The Structure and Profitability of the Antebellum Industry 1859* (New York: Arno Press, 1972), 252-54, 58, 62-64.

consumed. For example, rotting and non-edible portions of produce were discarded and grains had to be milled before they were consumed.[7]

Another correction to be made is that most economic historians analyzed raw food for nutritional content. However, very little of the food was consumed raw, and the vitamin content of raw versus cooked foods is considerably different. Prolonged storage also decreases the vitamin content in grains and vegetables.[8]

The third correction that needs to be made is that economic historians do not accurately assess the energy needs of the slave. Energy expenditure varies greatly according to the specific work the slave does as well as the slave's gender and weight. Although Fogel and Engerman's high calorie diet of 4,185 calories seems generous, it would not have provided enough calories to meet the slaves' energy needs on average over the planting seasons. The high energy needs of slaves will be discussed more extensively in the following pages.

This study attempts to make those corrections and focuses on rice plantation slaves that lived along the coasts of Georgia and South Carolina in 1860.[9] The general contention that slaves had a calorically and nutritionally adequate diet stems from studies in the past few decades that were mainly focused on cotton plantations in the antebellum period, which was also the focus of Fogel and Engerman's study. This study concludes that the slave diet on rice plantations was calorically and nutritionally inadequate given

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[7] R. Macrae, R.K. Robinson, & M.J. Sadler, ed., *Encyclopaedia of Food Science, Food Technology and Nutrition*, 7 vols. (London: Academic Press, 1993), 3096, 321, 927; S.W. Souci, W. Fachmann, & H. Kraut, *Food Composition and Nutrition Tables*, 6th ed. (Stuttgart, Germany: medpharm GmbH Scientific Publishers, 2000), 12, 205, 07, 319, 28, 549, 635, 814.

[8] G.H. Beaton, & E.W. McHenry, eds., *Nutrition, a Comprehensive Treatise*, 3 vols., vol. 3 (New York: Academic Press, 1966), 249; P. Insel, E.E. Turner, & D. Ross, *Nutrition* (Massachusetts: Jones and Bartlett Publishers, 2002), 307-08.

[9] University of Virginia Geospatial and Statistical Data Center, *United States Historical Census Data Browser* (University of Virginia, 1998 [cited 31 May 2002]); available from http://fisher.lib.virginia.edu/collections/stats/histcensus/.

the amount of food that was available to the slaves and the amount of work the slaves were required to complete.

The Disappearance Method

The major drawback of the disappearance method is that the non-edible portions of the foods that had to be removed before consumption are not subtracted from the calculated available food. Census records are unclear if the grains were already milled or if the records account for the inedible portions of produce. Although some enumerators recorded only the "clean" rice produced, the amount that was already milled, it is unknown if that was a common practice with all goods enumerated in the census.[10]

The disappearance method does not correct for the inedible portions of produce, such as sweet potato peels, which had to be discarded, or the premature rotting or supply deterioration that occurred during storage. Small animals and worms may also have contributed to supply deterioration.[11] The following table represents typical foods that were likely main components of the diet and the percent of food lost due to processing.

[10] Swan, *The Structure and Profitability of the Antebellum Industry 1859*, 38.
[11] S.B. Hilliard, *Hog Meat and Hoecake: Food Supply in the Old South, 1840-1860* (Carbondale: Southern Illinois University Press, 1972), 51.

Table 1. Percent of food as inedible before processing.[12]

Food item	**Percent of food as inedible**
Pork	21.5 (if includes the bone)
Sweet potatoes	19 (skins, bruises)
Cowpeas	60 (remove pod)
Rice	20 (remove the hull)
Oats	28 (remove the husk)
Wheat	17 (milling)

Nutrient Losses in Food

Vitamin content can be considerably reduced when the food is exposed to light, changes in pH level, heat, and cooking fluids. Cutting produce into small pieces for cooking increases the surface area and allows for more of the water-soluble vitamins to leach into the cooking water.[13] The best way to avoid losing the vitamin content is to buy fresh foods and eat them raw the same day. Slaves usually did not have this option, so their nutrient intake would be reduced with cooking, and especially with prolonged storage.

Slaves had few cooking methods to use and no real form of food preservation. Most slaves boiled their vegetables, which can destroy 15-30% of the riboflavin. The thiamin in pork would be destroyed when the meat was smoked, cured in brine, and boiled. Prolonged storage of cornmeal can reduce the thiamin content by one-third to

[12] Macrae, ed., *Encyclopaedia of Food Science, Food Technology and Nutrition*, 3096, 321, 927; Souci, *Food Composition and Nutrition Tables*, 12, 205, 07, 319, 28, 549, 635, 814.
[13] Insel, *Nutrition*, 307-08.

one-half, and another 30% of the thiamin can be destroyed when the cornmeal is cooked.[14]

The amount of water-soluble vitamins lost in cooking also depends on the volume of water covering the vegetable. Vegetables completely covered with water lose 80% of the vitamin C; 60% if the vegetables are only half-covered, and 40% if the vegetables are only one-quarter covered with water.[15]

Vitamin C, or ascorbic acid, is also lost due to storage. If kale is stored at room temperature for 24 hours, it loses 30% of the vitamin C due to the chemical changes that occur with wilting. Green-leafy vegetables lose 5-18% of their vitamin C content within 2 hours after being harvested, and that value increases dramatically to 35-60% by 8 hours and up to 90% in 24 hours.[16]

Table 2 demonstrates the water-soluble vitamin losses of a range of foods due to cooking. When the potatoes were cooked, 40% of the thiamin, 25% of the riboflavin and niacin, and 60% of the vitamin C is completely lost. The cooking of white and sweet potatoes, whether baked or boiled, would have destroyed some of the nutrients available in those foods. There is no vitamin C lost in meats because there is no vitamin C to be destroyed—vitamin C is found mainly in fruits and vegetables.

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[14] P.A. David, H.G. Gutman, R. Sutch, P. Temin, & G. Wright, *Reckoning with Slavery: A Critical Study in the Quantitative History of American Negro Slavery* (New York: Oxford University Press, 1976), 279-80; T. Gibbs, K. Cargill, L.S. Lieberman, & E. Reitz, "Nutrition in a Slave Population: An Anthropological Examination," *Medical Anthropology* 4 (1980): 233.

[15] *Processed Food* (Nestle, [cited 22 October 2003]); available from http://www.nestle.co.uk/nutrition/articles/processed_food.asp.

[16] D.A. Bender, & A.E Bender, *Nutrition, a Reference Handbook* (New York: Oxford University Press, 1997), 446, 65.

Table 2. Average percentage of nutrients lost during cooking.[17]

Food	Thiamin	Riboflavin	Niacin	Ascorbic acid
Meats	35	20	25	--
Vegetables, leafy green and yellow	40	25	25	60
Tomatoes	5	5	5	15
Vegetables, other	25	15	25	60
Potatoes	40	25	25	60

The following table reviews the factors that influence a vitamin's stability. Table 3 shows that nearly all vitamins lose some of their availability when cooked, stored, dried, or exposed to light.

Table 3. General vitamin susceptibilities to destruction due to food processing and cooking.[18]

Vitamin	Conditions that enhance loss
Vitamin A	Readily lost by oxidation, heat, and light due to storage and preparation.
Vitamin C	Readily lost by oxidation and leaching in many steps of food preparation, drying, and cooking.
Thiamin	Readily lost by leaching, by removal of thiamin-rich fractions from native foods (e.g., flour milling) and by heating; losses as great as 75% may occur in meats, and 25-33% in breads.
Riboflavin	Readily lost on exposure to light (90% in milk exposed to sunlight for 2 hr, 30% from milk exposed to room light for 1 day), but very stable when stored in dark; small losses (12-25%) on heating during cooking.
Niacin	Leached during cooking of vegetables (≤ 40%), but very stable to cooking.
Vitamin B_6	Leached during food preparation; roasting of beef causes losses of about 50%.

Some sources report that slaves consumed nearly all parts of the foods that were cooked, as well as the water in which they were cooked. Most vegetables, including

[17] Beaton, *Nutrition, a Comprehensive Treatise*, 249.
[18] G.F. Combs, *The Vitamins: Fundamental Aspects in Nutrition and Health* (New York: Academic Press, 1998), 479; L.J. Machlin, ed., *Handbook of Vitamins: Nutritional, Biochemical, and Clinical Aspects* (New York: Marcel Dekker, Inc., 1984), 11.

turnips, peas, cabbage, collards, beans, and other greens, were boiled for hours. A few accounts suggest that a chunk of pork was put in the pot to add some flavor. When the vegetables were cooked, the "pot-likker" or broth was consumed with corn pone, which was often crumbled into the pot and mixed with the broth as part of the meal. This practice allowed the slaves to retain some of the food's vital nutrients, although the slaves were probably unaware of this vitamin recovery.[19] Since there is no substantial evidence to prove that the slaves consumed the broth, the magnitude of nutrient losses due to cooking cannot be precisely estimated. Even if the slaves consumed the cooking water, some vitamins were destroyed due to oxidation or heat damage. The possibility of these losses, however, should be acknowledged when explaining the slave diet and its adequacy because it could be a significant factor.

Energy Expenditure

The energy expenditure of a slave differed dramatically during different times in the planting season. For example, a male slave on a rice plantation would expend about 4,400 calories during an "easy" day of repair work when the rice was growing or already harvested. The slave worked on other tasks around the plantation, such as chopping down trees and carrying the logs back to the plantation, repairing cabins, scaring rice birds out of the rice fields, and tending their gardens. On a "hard" day during harvest time the slave would have burned about 8,700 calories (the slave usually spent about 15 hours harvesting the rice, leaving little time or energy to do other tasks at the end of the day). Rice harvesting took place during the fall months, so the high value for energy

[19] J.B. Boles, *Black Southerners 1619-1869* (Lexington: The University Press of Kentucky, 1983), 51; Fogel, *Time on the Cross: The Economics of American Negro Slavery*, 98.

expenditure likely only lasted for 3 months. Weighing the expenditure and the time under each kind of working conditions, the *average* energy expenditure for a male rice plantation slave over the year would be about 5,500 calories a day in order to maintain the slave's body weight and strength.[20] This average intake would probably have been enough for the slave during lighter months, but the slave would have needed a much greater caloric intake during the fall harvest season. Since the average energy need for a slave was about 5,500 calories, there may have been times throughout the year when the slave gained or lost weight as the amount of work changed seasonally. The following table estimates the amount of calories a slave could have burned as the planting season changed.

Table 4. The energy expenditure of an adult male rice plantation slave on "easy" and "hard" workdays.[21]

"Easy" Day					**"Hard" Day**			
Activity	**Time (min)**	**Rate (kcal/min x weight)**	**Kcals used**		**Activity**	**Time (min)**	**Rate (kcal/min x weight)**	**Kcals used**
Sleep	480	1.16	557		Sleep	360	1.16	472
Eat, sit	180	1.61	290		Eat, sit	180	1.61	290
Tend garden	180	5.74	1033		Harvest	900	8.82	7938
Chop trees	60	13.02	781					
Carry logs	60	9.24	554					
Scare birds	300	1.89	567					
Repair cabins	180	3.64	655					
TOTAL	1440		4437		**TOTAL**	1440		8700

[20] Gibbs, "Nutrition in a Slave Population: An Anthropological Examination," 236-48; W.D. McArdle, F.I. Katch, & V.L. Katch, *Exercise Physiology: Energy, Nutrition, and Human Performance*, 3rd ed. (Philadelphia: Lea & Febiger, 1991), 804-10.

[21] Gibbs, "Nutrition in a Slave Population: An Anthropological Examination," 236-48; McArdle, *Exercise Physiology: Energy, Nutrition, and Human Performance*, 804-10.

History of Rice Plantations

On rice plantations, 74% of male slaves and 90% of female slaves were field hands working under the task system.[22] The task system was a method of dividing the work force according to each slave's labor abilities. Each slave was assigned to a plot of land that had to be worked until the job was completed. The task system was efficient in utilizing the slaves' labor and providing an incentive to work hard and get the job done early. The pace of the work depended on the slave's skill with the assigned task. When it was not harvest season, a majority of workers were done by four o'clock in the afternoon, with the more productive hands often finishing their tasks by two o'clock and some even by one o'clock. The slaves then returned to their cabins to do personal tasks, like tending their garden.[23]

The season of rice planting lasted nearly the entire year, but the duration and amount of hard labor required by each slave varied with the season; therefore, the slaves' energy expenditure also changed with the seasons. The soil was broken in the fall, and by early spring the fields were smoothed and trenched with hoes. Between March and May, the fields were seeded and flooded for a week, commonly referred to as "sprout flow." Then the field was drained and kept dry until plant growth was flourishing. A week of "point flow" flooding occurred and was followed by two weeks of dryness for light hoeing and weed pulling. Next, the "long flow" flooding took two to three weeks, followed by vigorous hoeing, and the "lay-by flow" which lasted for two or three months.

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[22] J.F. Olson, "The Occupational Structure of Southern Plantations during the Late Antebellum Era" in R.W. Fogel, & S.L. Engerman, *Without Consent or Contract: The Rise and Fall of American Slavery-Conditions of Slave Life and the Transition to Freedom: Technical Papers*, vol. 1 (New York: W.W. Norton & Company, 1992), 143.

[23] F.L. Olmsted, *Journey in the Seaboard Slave States with Remarks on Their Economy* (New York: Dix & Edwards, 1856), 435; U.B. Phillips, *The Slave Economy of the Old South* (Baton Rouge: Louisiana State University Press, 1968), 102-03.

The crop was ready for harvest when it stood shoulder high and thick, with the rice bending the stalks with its weight. Just before the rice was ripe, the crop had to be guarded from ricebirds (bobolinks). The migration pattern of these birds coincided with the beginning of the harvest season; slaves were stationed in the fields to scare the birds away. Rice harvesting began in early September. After harvesting, thrashing separated the seeds from the straw. This was followed by the task of removing the rice grain from the husk in the mill. The rice was then sifted to be separated from its flour and broken parts, and the whole rice was removed and barreled for market.[24]

Some Aspects of the Slave Diet

Most sources state the allotment of meat for slaves was from two to five pounds of pork a week, averaging about three pounds. Corn dominated throughout most of the South as a staple in everyone's diet since it was cheap and could be grown in almost every region of the South. Rice consumption along the rice coast was high relative to other regions in the South. When the rice was produced, some of it was damaged or "broken," so this low-grade rice was kept for home consumption while the best rice was sold. The high production and low cost of broken rice made it another staple in the diets of slaves and free people in the rice region.[25]

The task system allowed the slaves time during the day to tend gardens, hunt, and fish during most of the year—they probably did not have the time or energy to do these

[24] L.A. Chamerovzow, ed., *Slave Life in Georgia: A Narrative of the Life of John Brown* (New York: Books for Library Press, 1971), 185-89; J.H. Easterby, ed., *The South Carolina Rice Plantation as Revealed in the Papers of Robert F.W. Allston* (Chicago: University of Chicago Press, 1945), 31-32; Olmsted, *Journey in the Seaboard Slave States with Remarks on Their Economy*, 466-77; U.B. Phillips, *American Negro Slavery* (Baton Rouge: Louisiana State University Press, 1966), 89-90.
[25] Hilliard, *Hog Meat and Hoecake: Food Supply in the Old South, 1840-1860*, 48-50, 105, 52, 58-59; J.F. Smith, *Slavery and Rice Culture in Low Country Georgia 1750-1860* (Knoxville: The University of Tennessee Press, 1985), 115.

things during the 3-month harvest season. Most slaves were able to have private gardens to grow produce and add supplemental foods to their diets. Most families had a garden, and if it was about one-half to one acre big, it could have supplied a family with enough vegetables for the year. The climate along the rice coast allowed the slaves to grow white potatoes and green vegetables such as cabbages, turnip greens, beans, and collards throughout the year. The vegetables grown in the garden plots augmented the slave's diet, but since there is no specific evidence about amount of food supplemented by the garden, these foods were not analyzed as part of the food available for slave consumption in this study. In addition, the planter usually gave rations of vegetables that may have included sweet potatoes, peas, or turnips along with the meat and corn. Other ways to supplement the diet included hunting fowl, deer, raccoons, and opossum in the forests around the plantation; turtles, alligators, crabs, fish, shrimp, and oysters could have been caught in the nearby swamps and creeks.[26] This supplementation allowed the slaves a more varied diet than just the rationed food they were given.

Fogel and Engerman found some plantation references in literature sources that mentioned foods other than corn and pork that slaves were given. This list included other plantation products like fruits, meats, and vegetables, as well as purchased food items like molasses. Since these documents were not very specific in describing rations or amount of food available on the plantation, Fogel and Engerman decided to use a sample of census manuscripts to predict the slaves' food intake. The logic was that since the foods were enumerated in the census, they were likely to be eaten on the plantation. They assumed that 80% of the diet consisted of eleven principal foods and 20% of the caloric

[26] Hilliard, *Hog Meat and Hoecake: Food Supply in the Old South, 1840-1860,* 182-83; Smith, *Slavery and Rice Culture in Low Country Georgia 1750-1860,* 116, 18.

intake was provided from supplements such as hunting, fishing, or slave gardens. Their caloric estimates of the diet only used the 11 enumerated foods since supplementation amounts were not recorded (the assumed 20% of calories from supplemented foods would have resulted in an additional 1000 calories in Fogel and Engerman's diet of 4,185 calories). Since there is little recorded evidence stating specifically what slaves ate to supplement their diet, it is very difficult to draw any conclusions about the exact amount of extra food slaves consumed.[27] The diet analyzed in this study also does not calculate the caloric contribution of supplemental foods in the slave diet because the evidence on such foods was not recorded on plantation documents. See the appendix for further information about the diet.

Historical Concepts of Nutrition and Food Availability

Slave owners knew that their slaves' productivity, and therefore the owner's profit, was related to the slaves' diet. Although some slave owners cut costs by intentionally underfeeding their slaves, a large majority tried to feed their slaves adequately but did not understand basic principles of nutrition. One common theory about slave health was that some foods were "heat-producing" foods that produced muscle and helped the slaves work; the main "heat-producing" foods were corn and fatty cuts of pork. Few people understood what vitamins were and their connection to diseases. Hardly any slave owners knew how to create a balanced diet with appropriate amounts of nutrients, but many tried to add variety to the diet by producing other crops and distributing them in season. Although the slaves might have received a varied diet

[27] Fogel, *Time on the Cross: The Economics of American Negro Slavery*, 111-13. Steven Crawford found information that pertains to supplementation, but there are no conclusive results about food amounts that could be applied to this study.

during the growing season, deficiencies could have occurred during the winter months when fresh fruits and vegetables were not available and most of the stored grains and vegetables were depleted.[28]

An Analysis of the Nutritional Adequacy of the Adult Male Slave's Diet on Rice Plantations

The foods available for consumption were calculated from the 1860 census of 256 plantations along the rice coast of South Carolina and Georgia. This data set only included slaveholding plantations with 10 or more slaves. Plantations with less than 10 slaves were likely small family subsistence farms where only a few slaves worked closely with the owner, thus those slaves lived differently than slaves on large plantations. In order to compare this study to Fogel and Engerman's study, the diet was analyzed for an adult male slave. To determine food allocation, the adult male slave was considered a standardized unit. Female slaves and slave children were given a smaller proportion of food than the adult male slave, and the free white population was given a much larger portion than the adult male slave. To find the amount of food available to slaves, the animal feed and crop seed was subtracted from the total amount of food produced. The slave owners and other whites on the plantation were given twice the amount of food allocated to slaves. This approximation would therefore seem to overestimate the food eaten by the free whites and underestimate the food available for slave consumption. A more detailed explanation of the study's methods can be found in the appendix.

[28] K.M. Stampp, *The Peculiar Institution: Slavery in the Ante-Bellum South* (New York: Alfred A. Knopf, Inc., 1963), 282-85.

The adult male slave unit was used to compare to previous studies. The reference male is 23 years old; based on Swan's work, his weight was 154 pounds, and manifest studies reported an average height of five feet seven inches.[29] By age 23, the slave would likely have stopped growing and would have had a regular work schedule and diet, so it was an appropriate age to analyze.

The slave diet was analyzed two different ways. The first calculation ("Diet 1") follows the methodology of Fogel and Engerman and Swan and is based on the nutrient content of available raw foods. The second calculation ("Diet 2") adjusts Diet 1 for inedible portions of sweet potatoes, cowpeas, mutton, oats, and wheat; it is also analyzed raw. Diet 1 had a caloric value of 3,162 calories; Diet 2 was adjusted for inedible portions and resulted in 2,856 calories. According to the 2000 Recommended Dietary Allowance (RDA), the reference sedentary male requires an intake of 2,700 calories in relation to his weight and height.[30]

The "RDA are levels of intake of essential nutrients considered…to be adequate to meet the known nutritional needs of practically all healthy persons.[31]" After the average nutrient requirement is determined, that RDA value is set two standard deviations above the average to sufficiently meet the nutrient needs of 98% of the healthy population. However, the calorie requirement for an individual is set at the average.

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[29] R.W. Fogel, S.L. Engerman, R. Floud, G. Friedman, R.A. Margo, K. Sokoloff, R.H. Steckel, J. Trussell, G. Villaflor, & K.W. Wachter, "Secular Changes in American and British Stature and Nutrition," *Journal of Interdisciplinary History* 14, no. 2 (1983): 456; J. Komlos, & P. Coclanis, "On the Puzzling Cycle in the Biological Standard of Living: The Case of Antebellum Georgia," *Explorations in Economic History* 34 (1997): 443; R.H. Steckel, "A Peculiar Population: The Nutrition, Health, and Mortality of American Slaves from Childhood to Maturity," *Journal of Economic History* 46, no. 3 (1986): 724; R.H. Steckel, "Slave Height Profiles from Coastwise Manifests," *Explorations in Economic History* 16 (1979): 368; Swan, *The Structure and Profitability of the Antebellum Industry 1859*, 255.

[30] *Nutrition Analysis Tool 2.0* (Food Science and Human Nutrition Department at the University of Illinois, [cited 8 July 2002]); available from http://www.nat.uiuc.edu/nat.pdl.

[31] Committee on Dietary Allowances of the Food and Nutrition Board, *Recommended Dietary Allowances*, 9th revised ed. (Washington, D.C.: National Academy of Sciences, 1980), 1.

Since the RDA values are set high, there is no major concern unless the individual is receiving less than 75% of the RDA. When less than RDA recommendations are consumed, the body can redistribute nutrients when tissue is broken down so that some body functions can be maintained. It is also important to note that the body's ability to store fat-soluble and water-soluble vitamins varies greatly. A high intake of a fat-soluble vitamin, such as vitamin A, can be stored; it may take over a year for deficiency symptoms to surface. Excess vitamin C is excreted from the body and not stored; consequently, deficiency symptoms are obvious within a few months. If nutrient needs are not met on a certain day, a surplus of those nutrients consumed shortly thereafter can make up for the previous low intake; however, if a person's intake is insufficient for a prolonged period of time, nutrient depletion will occur despite the body's attempt to adapt.[32]

The diet analyzed in this study was a hypothetical diet constructed from the foods available on rice plantations in the southern U.S. according to the 1860 census. The methods used to calculate the amount of food available came from Fogel and Engerman's and Swan's studies on slave diets on cotton and rice plantations, respectively. To find the amount of food available, inedible waste, animal feed allocations, and plant seed kept for the next year were subtracted from the total amount of food produced on the plantations. Table 5 shows a sample daily intake of the 10 foods in the diet. Table 6 gives the actual caloric value of each diet and compares the percent of the RDA of each nutrient in each diet.

[32] Ibid., 3, 5, 7.

Table 5. The average daily intake of food in Diet 2.[33]

Food	**Amount**
Pork	1.8 oz.
Beef	3.2 oz.
Mutton	0.1 oz.
Milk	13.3 fl. oz.
Corn	0.98 c.
Rice	1.2 c.
Peas/beans	3.5 Tbsp.
Sweet potatoes	3.6 c.
Oats	2.5 tsp.
Wheat	0.02 tsp.

Table 6. A comparison of the percent of the RDA achieved in Diet 1 and Diet 2.[34]

		Diet 1	Diet 2
Basic Components	Calories (kcal)	3162 kcals	2856 kcals[35]
	Protein (g)	76.5	63.5
	Carbohydrate (g)	89	78.5
	Fat (g)	69.5	68.5
Vitamins	Vitamin A (RE)	596	484
	Vitamin C (mg)	154	125
	Thiamine (mg)	177	132
	Riboflavin (mg)	174	151
	Niacin (mg)	123	110
	Vitamin B_6 (mg)	218	180
	Folate (mcg)	179	91
	Vitamin B_{12} (mcg)	71	71
Minerals	Calcium (mg)	75	67[36]
	Phosphorus (mg)	235	197
	Potassium (mg)	104	80
	Zinc (mg)	80	65
	Iron (mg)	194	141
	Magnesium (mg)	132	103

[33] Although an average of 13.3 fl. oz. of milk was available, most adult slaves were lactose intolerant. The milk produced on the plantation could likely have gone to the slave children because they were not yet lactose intolerant. Boles, *Black Southerners 1619-1869*, 92; M. Paubert-Braquet, C. Dupont, & R. Paoletti, ed., *Foods, Nutrition and Immunity: Effects of Dairy and Fermented Milk Products* (Paris: Karger, 1992), 49.

[34] The slave's protein requirements would have been higher than the RDA recommends for the general population. The RDA for protein is 0.8g/kg body weight, but due to the limited calories in the diet and the high exercise demands of the slave, he would have required a protein intake closer to 1.8g/kg body weight, which is calculated to be 126g of protein daily. G.M. Wardlaw, *Perspectives in Nutrition*, 4th ed. (Boston: WCB/McGraw-Hill, 1999), 327.

[35] This is the average caloric intake, but the actual intake would have varied with the season during the year.

[36] The calcium intake includes the consumption of 13.3 fl. oz. of milk. The milk accounts for 72% of the slave's total calcium intake, so Diet 2 would have achieved only 19% of the RDA (187mg) for calcium if the milk were not consumed due to the slave's lactose intolerance.

The RDA are based on the needs of a fairly inactive person, so the slave's activity level would have required a much higher caloric intake than the 2,700 calories the RDA suggests. Table 6 shows the comparison between the two diets. Since Diet 2 is adjusted for waste, a quick observation reveals some significant differences; for example, there is a marked drop in the percent of the RDA for protein and carbohydrate due to processing and the removal of inedible waste. Sweet potatoes must be peeled and peas hulled before consumption; the reduced edible portion results in a loss of 14 grams of protein and 70 grams of carbohydrate, representing a loss of 300 calories in the diet.

Some nutrients appear to exceed RDA levels, but the analysis was based on raw foods to allow comparison to previous slave diet studies. A raw analysis was done because Fogel and Engerman's only option for diet analysis was to analyze the nutrient content of food in the raw state. When foods are cooked, the actual nutrient intake is much lower due to the destruction and loss of vitamins in the cooking process. Most of the water-soluble vitamins (vitamin C, thiamin, riboflavin, niacin, and vitamin B_6) levels were near or above 100% of the RDA in the raw state, but cooking the food would have greatly reduced the amount of these vitamins.[37]

The adjusted diet, Diet 2, corrects for the removal of non-edible portions of the food before consumption; intake levels of vitamin B_{12}, calcium, and zinc are below RDA levels. All of the major components of the diet—calories, protein, carbohydrate, and fat—are 20-35% below recommended levels.

[37] Beaton, *Nutrition, a Comprehensive Treatise*, 249.

Deficiencies resulting from the slave diet

Vitamins are susceptible to destruction when the food is cooked, stored, processed, exposed to light, or the pH is altered. The diet analysis of raw foods reveals inadequate levels of three nutrients, but with the effects of cooking and storage, many more vitamins could be deficient.

A deficiency of nutrients can result in an increased susceptibility to various nutrient-related diseases. Protein-calorie malnutrition results from regular deficiencies of energy and protein; it predisposes the body to infections and diseases, can cause liver damage, and can possibly result in death.[38]

Vitamin B_{12} is a water-soluble vitamin that can be stored in the liver for over a year, so the slave may have had enough of this vitamin stored during times of deprivation. However, the vitamin intake was below recommended levels and some of it would have been further destroyed when the food was exposed to light, so over time a deficiency could have occurred. A deficiency in vitamin B_{12} can result in megaloblastic anemia and peripheral neuropathy, characterized by a numbness in the hands and feet, memory loss, and dementia.[39]

The diet is also deficient in calcium and zinc. A calcium deficiency can lead to deformed teeth. The slave's primary dietary sources of calcium were milk, sweet potatoes, and black-eyed peas. As previously noted, adult slaves probably did not consume milk because they were lactose intolerant, which would have created a greater deficit of calcium in the slave's diet. When the plantation stores were depleted of sweet

[38] K.F. Kiple, & V. H. King, *Another Dimension to the Black Diaspora: Diet, Disease, and Racism* (Cambridge: Cambridge University Press, 1981), 111; Wardlaw, *Perspectives in Nutrition*, 179.
[39] Megaloblastic anemia is the result of abnormally large red blood cells. Combs, *The Vitamins: Fundamental Aspects in Nutrition and Health*, 396, 408, 16; Machlin, *Handbook of Vitamins: Nutritional, Biochemical, and Clinical Aspects*, 503, 33; Wardlaw, *Perspectives in Nutrition*, 448.

potatoes and peas, the slaves would have gotten very little calcium. The amount of calcium absorbed in plant sources is also lower than in fluid milk; the body absorbs 25-75% of dietary calcium, with plant sources at the lower end of that range. There is no RDA for sodium, but a minimum intake of 500 mg/day is necessary under comfortable environmental temperatures and when the person is not working hard enough to sweat. Slaves were given a ration of salt and meats were cured, so the actual intake of sodium would have been much higher than the raw foods suggest; for example, the slave's daily allotment of 1.8 oz. of salt pork provides 730 mg sodium and one teaspoon of salt has 2000 mg sodium. Zinc, a trace mineral in the body, is a cofactor for more than 300 enzymes, including those enzymes involved in growth and immunity. A zinc deficiency can result in many symptoms, including diarrhea, skin rash, hair loss, poor growth, decreased appetite, and poor wound healing.[40]

Vitamin C, thiamin, riboflavin, niacin, vitamin B_6, and folate are all vitamins that appear to be at adequate intake levels in Table 6, but they are susceptible to damage when the food is cooked. Vitamin C is very unstable to heat, drying, and oxidation, so it is possible that a deficiency could have occurred in the slave population. A mild deficiency of vitamin C would have resulted in muscle pain, fatigue, an increased susceptibility to infection, and anorexia. A severe deficiency of vitamin C results in scurvy, accompanied by a weakening of collagen in bones and cartilage, and swollen and bleeding gums, resulting in the loss of teeth (See Figure 1[41]).[42] Evidence of possible vitamin C

[40] R.B. Flanders, *Plantation Slavery in Georgia* (Connecticut: John E. Edwards, 1967), 156-57; Insel, *Nutrition*, 424; Kiple, *Another Dimension to the Black Diaspora: Diet, Disease, and Racism*, 118.
[41] D.S. McLaren, *A Colour Atlas and Text of Diet-Related Disorders*, 2nd ed. (England: Wolfe Publishing, 1992), 173.
[42] Combs, *The Vitamins: Fundamental Aspects in Nutrition and Health*, 266, 479; Machlin, *Handbook of Vitamins: Nutritional, Biochemical, and Clinical Aspects*, 224.

deficiencies in the slave population can be extracted from historical accounts that report frequent dental problems. One source explained, "you will find but few negroes who are not subject to tooth-ache" and "an examination of the physicians' accounts reveals that a large portion of their practice was extracting teeth."[43] There were several references to scurvy in antebellum medical literature "scurvy condition among slaves" often recognized by physicians as a result of a diet that relied mainly on high fat pork and cornmeal, but too few vegetables.[44]

Figure 1. This picture shows symptoms of scurvy: swollen and bleeding gums and tooth loss.

A thiamin deficiency is found in places where unenriched polished rice is widely consumed; it is characterized by cardiac enlargement, anorexia, and muscular weakness, a condition known as beriberi. An acute thiamin deficiency would have resulted in edematous beriberi. Edema is a condition that masks the wasting away of tissues, and causes a rapid heart rate with possible heart failure.[45] One account of slaves likely suffering from beriberi reported "bondsmen who would suddenly swell in every part of the body, and in five or six days the case would invariably prove fatal."[46]

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[43] Kiple, *Another Dimension to the Black Diaspora: Diet, Disease, and Racism*, 118; W.D. Postell, *The Health of Slaves on Southern Plantations* (Baton Rouge: Louisiana State University Press, 1951), 85; Stampp, *The Peculiar Institution: Slavery in the Ante-Bellum South*, 305.
[44] Kiple, *Another Dimension to the Black Diaspora: Diet, Disease, and Racism*, 123.
[45] Combs, *The Vitamins: Fundamental Aspects in Nutrition and Health*, 290; Machlin, *Handbook of Vitamins: Nutritional, Biochemical, and Clinical Aspects*, 281.
[46] Kiple, *Another Dimension to the Black Diaspora: Diet, Disease, and Racism*, 122.

Riboflavin deficiency symptoms include poor appetite and growth, muscular weakness, and extreme sensibility to touch and temperature. Changes in the mouth and mucous membranes, known as cheilosis, stomatitis, and glossitis, are also characteristic of a riboflavin deficiency. These dermatitis symptoms generally develop gradually as the deficiency worsens (see Figure 2[47]).[48]

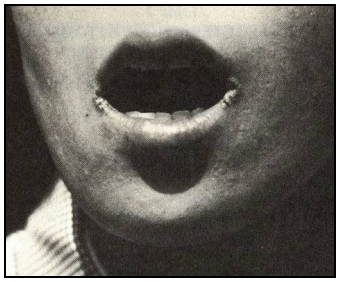
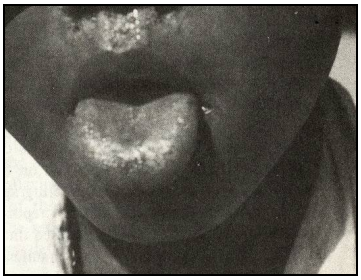


Figure 2. These two pictures show symptoms of riboflavin deficiency, as evident by the stomatitis and cheilosis (left) and glossitis (right).



Niacin is relatively stable to cooking and heat, but can be lost due to the vitamin leaching into the cooking water. Pellagra results from a niacin deficiency, and is characterized by skin lesions—skin that is cracked, scaly, is darker in color, and hardened (see Figures 3 and 4[49]). Other symptoms include delirium, depression, anxiety, and fatigue.[50] Pellagra was a very new disease during the antebellum period, so the disease was often misdiagnosed. Over time, doctors recognized this "new" disease as the same disease called "black tongue" in dogs because its main superficial symptom was having a brown coating on the tongue. One Georgia doctor described black tongue symptoms as

[47] M. Rechcigl, Jr., ed., *C.R.C. Handbook Series in Nutrition and Food, Section E: Nutritional Disorders*, vol. III (West Palm Beach: CRC Press, Inc., 1978), 17.
[48] The symptom of cheilosis is lip lesions, the symptom of stomatitis is lesions around the corners of the mouth, and the symptom of glossitis is tongue inflammation. Combs, *The Vitamins: Fundamental Aspects in Nutrition and Health*, 297, 306; Machlin, *Handbook of Vitamins: Nutritional, Biochemical, and Clinical Aspects*, 304-07, 13; Rechcigl, *C.R.C. Handbook Series in Nutrition and Food, Section E: Nutritional Disorders*, 18-19.
[49] McLaren, *A Colour Atlas and Text of Diet-Related Disorders*, 145; Rechcigl, *C.R.C. Handbook Series in Nutrition and Food, Section E: Nutritional Disorders*, 25.
[50] Combs, *The Vitamins: Fundamental Aspects in Nutrition and Health*, 314, 24.

skin inflammation, lethargy, chills and fever, delirium, and a decreased strength and mental ability, all characteristic of pellagra. Historical accounts also mention the incidence of delirium with a higher than normal number of insanity cases among the slaves and there are reports that many masters owned slaves who were "mentally unsound."[51]

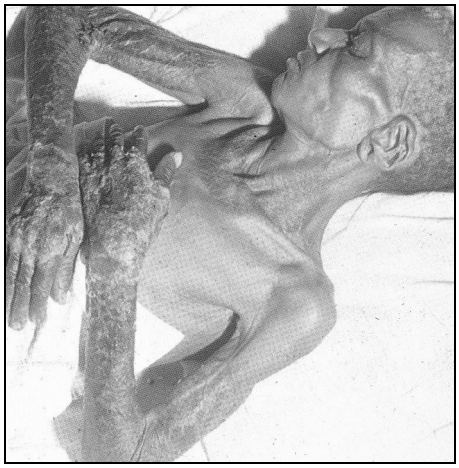


Figure 3. A woman with severe dermatitis on her arms and neck as a result of pellagra (left).

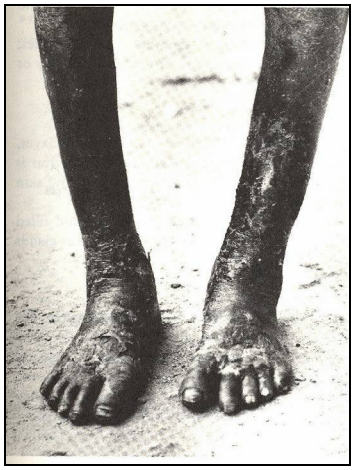


Figure 4. An adult's legs with severe pellagrous dermatitis (right).

The first recorded outbreak of pellagra occurred in the Alabama State Asylum for Negroes in 1906. This outbreak was probably noticed because the population in the asylum was very homogenous—adult males who ate the same foods and did the same activities. On a plantation, slaves could also have suffered from pellagra, but since they had different dietary intakes and labor demands, not everyone got pellagra at the same time. The reason for the outbreak in 1906 was mainly economic; the inmates' diet was based on the cheapest food available—mainly corn meal and some salt pork.[52] If the

[51] Kiple, *Another Dimension to the Black Diaspora: Diet, Disease, and Racism*, 125, 27, 28, 31; Postell, *The Health of Slaves on Southern Plantations*, 86-87; Stampp, *The Peculiar Institution: Slavery in the Ante-Bellum South*, 305.
[52] K.Y. Guggenheim, *Nutrition and Nutritional Diseases: The Evolution of Concepts* (Lexington: D.C. Heath and Company, 1981), 255-56.

inmates' diet was like the slaves' diet during the mid- to late 1800s, cornmeal and salt pork, it is probable that pellagra was just as prevalent during slave times but not recognized as an extensive problem because its sufferers were dispersed all over the southern plantations.

Vitamin B_6 is very sensitive to changes in pH, heat, light, and storage, so much of the vitamin could have been lost before the food was consumed. A deficiency of vitamin B_6 can result in muscle weakness, peripheral neuropathy, impaired immunity, and hypochromic microcytic anemia.[53] Folate is another vitamin that is extremely sensitive to high temperatures and leaching, especially with excessive cooking. A folate deficiency can lead to megaloblastic anemia, muscle weakness, neuropathy, and dermatitis. Since the symptoms of a folate deficiency are also found with other deficiencies, slaves might have had several different deficiencies without all of them being recognized.[54]

In summary, the symptoms of nutrient deficiencies overlap. Dermatitis can result from deficiencies of zinc, riboflavin, or niacin (see Figures 2, 3, and 4). Muscle weakness and fatigue are symptoms of vitamin C, riboflavin, niacin, vitamin B_6, and folate deficiencies. A loss of appetite can be the result of many different vitamin deficiencies. Mental problems can occur with a niacin or vitamin B_{12} deficiency. Inadequate protein intake on a regular basis would have led to a protein deficiency,

[53] Hypochromic microcytic anemia is the result of lighter-colored and smaller red blood cells. Combs, *The Vitamins: Fundamental Aspects in Nutrition and Health*, 333, 44; Machlin, *Handbook of Vitamins: Nutritional, Biochemical, and Clinical Aspects*, 389.
[54] Combs, *The Vitamins: Fundamental Aspects in Nutrition and Health*, 380, 97; Machlin, *Handbook of Vitamins: Nutritional, Biochemical, and Clinical Aspects*, 482; Wardlaw, *Perspectives in Nutrition*, 448.

resulting in a weakened immune system; a vitamin C deficiency also results in a weakened immune system and an increased susceptibility to infection.[55]

The skin problems could have been worsened by the wet conditions that the slaves worked in throughout the planting season, making the slave more susceptible to infection. The need for rice to be harvested in wet land promoted illness. While the fields were flooded, slaves were working knee-deep in the foul-smelling stagnant water, contributing to sickness and fever. The slaves' feet suffered greatly from being in water for extended periods of time, causing the skin to crack and develop sores.[56] Considering all of the nutrient deficiencies that produce skin lesions and negatively affect the immune system, there was an increased risk for infection when an open wound is in contact with swamp water.

Muscle weakness, loss of appetite, and fatigue could have also worsened the slave's health because they could have added to the caloric deficit experienced by the slave. If the slave was too tired to work in his garden or hunt for supplemental foods, he would be eating less than if he were healthy and physically able to gather supplemental food and boost his caloric intake. If the slave had no appetite, he might not have eaten his food even if there was enough food for him to eat.

Conclusion

Fogel and Engerman, Swan, and other economic historians concluded that slave diets were adequate by utilizing the only methods of nutritional analysis that they had

[55] A protein deficiency would have been more likely than the diet analysis suggests because the slave needed a protein intake closer to 1.8g/kg, which is higher than the amount analyzed in the diet. Wardlaw, *Perspectives in Nutrition*, 327.
[56] Chamerovzow, ed., *Slave Life in Georgia: A Narrative of the Life of John Brown*, 186-87.

available to them. However, these researchers did not consider waste, cooking losses, or differences in the caloric need of slaves due to their energy expenditure. This study attempts to make these corrections, and the result leads to a different conclusion about the nutritional adequacy of the slaves' diet. The historical importance of this study goes back to the question of how the slave's diet affected his quality of life. This study concludes that slaves from rice plantations likely had an inadequate diet, which may have contributed to many other health problems.

This study proposes many more possible nutrient deficiencies than suggested by previous diet studies. Deficient levels of nutrients would have added to other health problems that the slaves already endured as a result of their working conditions. Slaves contracted fevers, inflammation in the joints and muscles, and other infections due to their often-watery working conditions; these health problems would likely have worsened if they were combined with nutritional deficiencies.[57]

The slaves' caloric intake was also probably lower than the slaves' workloads required, and the slaves' protein requirements were higher than the needs of the general public.[58] There is some evidence suggesting that slaves had stunted growth due to a protein-calorie deficiency. A study of Civil War soldiers in the South examined their height relative to their pre-war occupations. It appears from this study that slaves were shorter on average than their white farming counterparts. Southern farmers were 68.5 inches tall on average, 1.5 inches taller than the average male slave born in about the

[57] Ibid.
[58] A protein deficiency would have been more likely than the diet analysis suggests because the slave needed a protein intake closer to 1.8g/kg, which is higher than the amount analyzed in the diet. Wardlaw, *Perspectives in Nutrition*, 327.

same location at about the same time. The farmers' taller height might be due to having access to a higher quality and a larger quantity of food compared to slaves.[59]

Fogel and Engerman's study created a diet to explain how the slavery investment was supported by a diet that appeared adequate, but their work focused on cotton plantations. Evidence indicates that slave labor on rice plantations was more intense than on cotton plantations due to nature of the work and the conditions in which the slaves worked. The increased susceptibility to disease that rice plantation slaves encountered while working in water for much of the season, as well as their high energy expenditure, would result in those slaves needing more nutrients, especially calories, to maintain their work level throughout the day. The rice plantation diet could have left the slaves tired, susceptible to diseases, and undernourished given the amount of work they had to do. Slaves who were at peak physical health might have been functional, but gradually wearing down their bodies.

This study suggests a different picture of the quality of the slaves' diet, specifically in terms of the rice plantation slaves. If Fogel and Engerman's study were to be re-examined by taking into account food waste and processing losses, different conclusions about the cotton plantation slaves' diet would be reached. This study takes a unique perspective of a long-studied topic—the slave diet—in that it accounts for food losses other than those calculated in the disappearance method and it looks at a relatively understudied type of plantation. The results of this study question previous slave diet studies which argued that slaves had an adequate diet. Although this study has methodological limitations due to the amount of information documented about slavery

[59] R.A. Margo, & R.H. Steckel, "Heights of Native Born Whites During the Antebellum Period," *The Journal of Economic History* 43, no. 1 (1983).

that pertain to the slave diet, it gives a more accurate depiction of slave diets because it builds on previous studies and improves the methodology of the researchers of those studies. This study is important to the annals of knowledge regarding slavery and the slave diet as it relates to quality of life because it challenges modern research results that declare the slave diet as having been adequate.

Appendix

The following four tables tabulate the results of Diet 1 (all available foods) and Diet 2 (all available foods with inedible portions removed). The diet in Tables A1-A4 was constructed from the 1860 census data of rice plantations, with Tables A3 and A4 being adjusted for inedible waste. Subsequent tables and equations explain how the meat and grain allotments were calculated (Tables A5-A6). The final three tables list the RDAs for an adult male slave (Tables A7-A9).

Table A1. Amount of food available for slave consumption in Diet 1.

Foods Available	Annual Food Production Available for Consumption Per Adult Slave Consuming Unit
Pork	41.21 pounds
Beef	73.50 pounds
Mutton	3.50 pounds
Milk	303.18 fluid pounds
Corn	2.78 bushels*
Rice	3.50 bushels
Peas/beans	1.51 bushels
Sweet potatoes	12.57 bushels
Oats	0.21 bushel
Wheat	0.003 bushel

*A bushel is the equivalent of 32 quarts or 128 cups.

Table A2. The nutritional value of Diet 1 per day.

Basic Components	Calories	3161.92
	Protein	88.78
	Carbohydrate	500.46
	Dietary Fiber	36.48
	Total Fat	89.38
Vitamins	Vitamin A (RE)	5959.39
	Vitamin C (mg)	138.22
	Thiamin (mg)	2.13
	Riboflavin (mg)	2.26
	Niacin (mg)	19.62
	Vitamin B6 (mg)	2.84
	Folate (mcg)	714.24
	Vitamin B12 (mcg)	1.60
Minerals	Calcium (mg)	754.86
	Phosphorus (mg)	1645.58
	Sodium (mg)	1128.84
	Potassium (mg)	3629.93
	Zinc (mg)	12.00
	Iron (mg)	19.36
	Magnesium (mg)	526.07

Table A3. Amount of food available for slave consumption in Diet 1 and Diet 2.

Foods Available	Annual Food Production Available for Consumption Per Adult Slave Consuming Unit (Diet 1)	Annual Food Production Available for Consumption With Waste Removed (Diet 2)
Pork	41.21 pounds	41.21 pounds*
Beef	73.50 pounds	73.50 pounds
Mutton	3.50 pounds	3.03 pounds
Milk	303.18 fluid pounds	303.18 fluid pounds
Corn	2.78 bushels	2.78 bushels
Rice	3.50 bushels	3.50 bushels
Peas/beans	1.51 bushels	0.60 bushel
Sweet potatoes	12.57 bushels	10.18 bushels
Oats	0.21 bushel	0.15 bushel
Wheat	0.003 bushel	0.002 bushel

*The meat was assumed to be clear of bone.

Table A4. Nutritional value of Diet 2 per day.

Basic Components	Calories	2855.84
	Protein	74.01
	Carbohydrate	440.02
	Dietary Fiber	27.25
	Total Fat	88.05
Vitamins	Vitamin A (RE)	4839.990
	Vitamin C (mg)	112.12
	Thiamin (mg)	1.58
	Riboflavin (mg)	1.97
	Niacin (mg)	17.67
	Vitamin B6 (mg)	2.34
	Folate (mcg)	365.48
	Vitamin B12 (mcg)	1.71
Minerals	Calcium (mg)	669.72
	Phosphorus (mg)	1378.91
	Sodium (mg)	1105.12
	Potassium (mg)	2799.18
	Zinc (mg)	9.79
	Iron (mg)	14.14
	Magnesium (mg)	413.57

The amount of edible meat available from the livestock was approximated using a series of equations. Each type of livestock on the plantations was multiplied by an animal-specific slaughter-to-live ratio to find the gross carcass weight.[60] This value was

[60] The slaughter-to-live ratio gives the proportion of the entire livestock population that is slaughtered. For example, 83% of the entire hog population is slaughtered each year (see Table A5).

then multiplied by the animal's average live weight and live-to-dressed ratio.[61] The resulting value was the total meat available for consumption for each type of livestock.

Total meat availability equation

inventory of livestock
× slaughter-to-live ratio
× average live weight
× live-to-dressed ratio
total meat available for consumption

Table A5. Values used to find the total meat available for consumption.[62]

Animal	Slaughter-to-Live Ratio	Average Live Weight	Live-to-Dressed Ratio
Hog	0.83	160 pounds	0.53
Oxen	0.17	750 pounds	0.55
Milk cow	0.17	750 pounds	0.55
Other cattle	0.20	750 pounds	0.55
Sheep	0.23	70 pounds	0.48

The amount of milk produced in the South was also calculated using Fogel and Engerman's methodology. The milk produced was calculated by multiplying the number of milk cows in the sample by the average fluid weight production typical of the area. In the South, the average fluid weight produced annually was 1200 fluid pounds per cow.[63]

Fluid milk produced equation

milk cows
× 1200 fluid pounds
total fluid milk produced

[61] The live-to-dressed ratio gives the proportion of edible meat left after the animal is slaughtered. For example, a 160 lb. hog would produce 85 lbs. of meat (see Table A5).
[62] R.W. & S.L. Engerman Fogel, *Without Consent or Contract: The Rise and Fall of American Slavery-Conditions of Slave Life and the Transition to Freedom: Technical Papers*, vol. 2 (New York: W.W. Norton & Company, 1992), 527; R.W. Fogel, R.A. Galantine, & R.L. Manning, *Without Consent or Contract: The Rise and Fall of American Slavery-Conditions of Slave Life and the Transition to Freedom: Evidence and Methods* (New York: W.W. Norton & Company:, 1992), 208, 25.
[63] Fogel, *Without Consent or Contract: The Rise and Fall of American Slavery-Conditions of Slave Life and the Transition to Freedom: Evidence and Methods*, 207-08.

To find the amount of grain available for human consumption, the total crop production was calculated, and then the amount used for feed and seed was subtracted. Since rice was produced for profit, all of the high-quality rice was sent to market to be sold, and only the broken rice was kept for consumption on the plantation. The approximate amount of broken rice can be calculated using a conversion equation. The amount of broken rice produced per 1000 bushels of whole rice is 3243 pounds.[64] The following table gives values for the percent of the total food production that was available for consumption after feed allowances and seed requirements were subtracted.

Table A6. Gross production percentages available for human consumption.[65]

Grain	Percent available for human consumption
Corn	17.5
Wheat	85.5
Peas/beans	60.0
Oats	28.0
Sweet potatoes	91.0
Rice	5.4

*The sweet potato is a storage root and cannot produce its own plants. The sweet potato is used as seed by cutting branches off of the vine and rooting them. Therefore, the seed allowance should be zero (rather than 8.3%), making the amount available for humans 99.3%. There is an assumed feed allowance of 0.7%.[66]

The recommended intake levels of vitamins and minerals depend on a person's age and gender. Since the reference slave is a male between the ages of 18 and 39, his

[64] Olmsted, *Journey in the Seaboard Slave States with Remarks on Their Economy*, 477.
[65] Fogel, *Without Consent or Contract: The Rise and Fall of American Slavery-Conditions of Slave Life and the Transition to Freedom: Evidence and Methods*, 208; M.W. Towne, & W.D. Rasmussen, "Farm Gross Product and Gross Investment in the Nineteenth Century," *Trends in the American Economy in the Nineteenth Century* 24 (1960): 294-304.
[66] Fogel, *Without Consent or Contract: The Rise and Fall of American Slavery-Conditions of Slave Life and the Transition to Freedom: Evidence and Methods*, 208; Hilliard, *Hog Meat and Hoecake: Food Supply in the Old South, 1840-1860*, 175; Olmsted, *Journey in the Seaboard Slave States with Remarks on Their Economy*, 477; *Sweetpotato: Treasure for the Poor* (Centro Internacional de la Papa, [cited 14 June 2002]); available from http://www.cipotato.org/projects/sweetpotato.htm.

nutrient requirements are different from children and females. Therefore, the diet analyzed and its adequacy is dependent on the adult male's needs.

Table A7. Basic components of the diet.[67]

Calories	2,700 kcals*
Protein	109-124 g
Carbohydrate	526-601 g
Dietary fiber	36-41 g
Total fat	121-138 g

***** The RDA is based on the average calorie needs of an inactive person.

Table A8. Recommended vitamin intakes.[68]

Vitamin A	1000.0 RE[69]
Vitamin C	90.0 mg
Thiamin	1.2 mg
Riboflavin	1.3 mg
Niacin	16.0 mg
Vitamin B6	1.3 mg
Folate	400.0 mcg
Vitamin B12	2.4 mcg

Table A9. Recommended mineral intakes.[70]

Calcium	1000.0 mg
Phosphorus	700.0 mg
Sodium	2400.0 mg
Potassium	3500.0 mg
Zinc	15.0 mg
Iron	10.0 mg

[67] From the 1998 RDA, taken from *Nutrition Analysis Tool 2.0*.
[68] Ibid.
[69] Vitamin A is measured in RE (retinol equivalents) because there are three active forms of vitamin A. Retinol can be easily converted to retinal, the form needed for night vision. Retinal can be converted to retinol or retinoic acid, which is needed for cell differentiation and growth. Carotenoids are the precursor to vitamin A. RE conversions are as follows: 1 RE = 1 mcg retinol = 2 mcg beta-carotene (supplemented) = 12 mcg dietary beta-carotene = 24 mcg dietary carotenoids. Insel, *Nutrition*, 331, 37.
[70] *Nutrition Analysis Tool 2.0*.

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