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# Dairy's environmental impact then and now

Compared to 1944, we're using just a fraction of the cows, feed, water, and land to produce 60 percent more milk. Our carbon footprint per gallon of milk is one-third as great.

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PICTURE, if you will, a 1940's farm . . . a small group of cows contentedly grazing, occasionally swishing their tails, their hides gleaming in the sunshine. In the background is a traditional gable-roofed red barn, chickens scratching in the dirt, and a team of horses plowing a field.

This idyllic pastoral scene contrasts sharply with the common misperception of modern dairy production where, according to groups opposed to animal agriculture, cows are confined in "filthy and disease-ridden conditions" and "tethered to milking machines three times per day." Based on this erroneous perception, some believe that agriculture was more sustainable in the "good old days," and modern practices have created significant environmental and welfare issues that could be avoided if the industry returned to "traditional" production systems.

Some claim that low-input systems are the solution to reducing the environmental impact of food production. However, this defies a fundamental physical principle which states that "energy can neither be created or destroyed, it can only change form." Carbon is the key unit of currency of energy use of living organisms. Just as we balance our checkbook every month, energy (carbon) inputs and outputs must be balanced against each other. Thus, a low-input system also typically is a low-yield system. The greatest opportunity to produce enough food while reducing environmental impact is achieved through improved productive efficiency. This leads us to question whether the "good old days" were really that good?

In 1944, the U.S. had 25.6 million cows producing a total of 117 billion pounds of milk annually. Pasture was the principal forage, supplemented with homegrown hay and limited grains. Manure, spread throughout the year, was the only source of nutrient renewal for the land. Manufactured fertilizers were not available, as N, P, and K were reserved for use in World War II munitions. Antibiotics, other pharmaceuticals, and chemical pesticides were unavailable. Draft horses were used for most cropping. Interestingly, many of these characteristics (pasture-based, no antibiotics, inorganic fertilizers, or chemical pesticides) correspond to requirements of modern organic systems.

In contrast to 1944, the 2008 U.S. dairy herd contained only 9.3 million cows but produced 190 billion pounds of milk . . . a four-fold jump in yield per cow. This huge improvement in milk yield has been achieved through a combination of higher genetic merit, improved ration formulation, and use of herd health and management programs to improve animal care.

Despite advances in genetics and management, the metabolic efficiency of nutrient use for maintenance has not changed significantly. In other words, a 1,450-pound cow in 1944 had the same maintenance nutrient requirement as a 1,450-pound cow today. However, getting more milk per cow dilutes out this maintenance requirement.

### *A different cow . . .*

Cows averaging 15 pounds of milk a day in 1944 used the majority of their daily energy intake (69 percent) for maintenance, whereas maintenance accounts for only 33 percent of energy use by cows yielding 65 pounds a day now. Diluting these maintenance needs (a fixed cost) over more pounds of milk reduces feed needs per unit of milk.

More milk per cow is only one form of the "dilution of maintenance" effect. It takes a herd to sustain a dairy farm . . . having more milking cows means having more dry cows, replacement heifers, and bulls. Therefore, higher milk production not only reduces cow numbers but reduces the population nutrient requirement for a given amount of milk. You need a whole-system analysis to account for the full impact of productive efficiency on resource use and environmental impact. Therefore, we chose to compare the resources required to maintain dairy populations producing 1 billion pounds of milk in 1944 and today.

The total dairy population needed to produce 1 billion pounds of milk in 2007 was only 21 percent of that required in 1944. (See Figure 1.) This reduction in population size indicates a considerable gain in efficiency. The same amount of milk could be produced today using only 23 percent of the feed and 35 percent of the water.

Advances in crop production between 1944 and now resulted in considerable yield increases for corn (from 33 bushels per acre to 151) and soybeans (19 bushels to 42). Modern rations also take advantage of the availability of by-products from the human food and fiber industries. The pasture-based 1944 system required considerably more land to support the dairy cow population, due to lower stocking rates (one cow per 2.4 acres) and reduced yield and nutritive value of native grass pastures. Consequently, the land needed to produce 1 billion pounds of milk today is only 10 percent of that required in 1944 as shown in Figure 1.

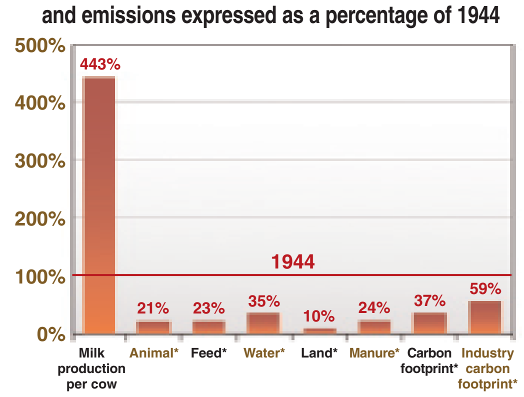
### *Manure output less . . .*

Today's dairy system produces considerably less manure (24 percent), methane (43 percent), and nitrous oxide (56 percent) per billion pounds of milk than the 1944 system. Carbon dioxide, methane, and nitrous oxide emissions are used to calculate the carbon footprint of dairy production. Compared to carbon dioxide, methane is 23 times and nitrous oxide is 298 times more potent as a greenhouse gas. Although present in relatively low atmospheric concentrations, methane and nitrous oxide are of particular concern because small rises in emissions (from enteric fermentation, manure, and soils) can have major effects on the total carbon footprint.

Previous environmental analyses have concentrated on site-based emissions (per cow, per acre, or per farm) without taking account of the amount of milk produced by the system. There is danger that this approach may be used to regulate emissions in the future. Significantly less methane will be produced from a 50-cow dairy than from a 5,000-cow dairy, but the amount of milk produced will be considerably lower. Ignoring milk output capability also effectively ignores the demand requirement. It is, therefore, essential to calculate environmental impact per unit of milk produced.

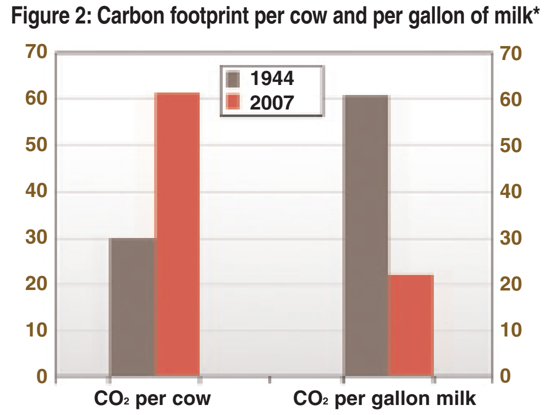
The greater carbon footprint of an average cow today compared to its 1944 equivalent (Figure 2) appears to prove the argument that modern-day intensive productive practices are less environmentally sustainable. However, this approach only considers part of the milk production process. When all system inputs and outputs are included and the footprint is correctly expressed per unit of milk, the carbon footprint of a gallon of milk produced today is only 37 percent of that in 1944. This translates into a current total dairy farm industry carbon footprint of 126 million tons, just 59 percent of the 214 million produced in 1944.

**Figure 1: 2007 U.S. milk production, resource use, and emissions expressed as a percentage of 1944**




*As measured per unit of milk as it leaves the farmgate

**Figure 2: Carbon footprint per cow and per gallon of milk***




*In pounds carbon dioxide equivalent

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