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# Alternative Policies to Address Emissions in U.S. Dairy Farming

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A sharp build-up of Greenhouse Gas (GHG) levels in the atmosphere has coincided with a general change in the earth's ecosystem that is characterized by an increase in global average temperatures. According to the U.S. Environmental Protection Agency (EPA), average temperatures have risen 1.5°F over the past century and are projected to rise to 0.5°F to 8.6°F over the next one-hundred years (EPA, 2016a). Increasing temperatures have been accompanied by rising sea levels, flooding, extreme heat waves, drought, and frequent and intense storms.

Scientists who study the myriad issues associated with these extreme weather events, such as their frequency, intensity, duration, and timing, have been able to draw a causal link between these severe weather events and climate change (IPCC, 2014; EPA, 2016).

In the United States, concern about the impact of climate change has led to escalating public attention and rising interest from researchers, policy makers and other stakeholders regarding policy options that can promote adaptation and mitigation actions (for example, Mendelsohn, Nordhaus, and Shaw, 1994; Schlenker, Hanemann, and Fisher, 2005; Deschenes and Greenstone, 2007). Climate change is projected to have severe consequences in the U.S. agricultural sector. According to a recent U.S. Department of Agriculture (2013) report, temperature increases ranging from 1.0°F to 4.0°F are likely to cause significant declines in the yields of major U.S. farm commodities. This is noteworthy given that the United States plays a significant role in global food production as well as in world food markets. In 2015, the United States generated close to 35%, 33%, and 50% of the global supply of corn, soybeans and dairy products, respectively (USDA-ERS, 2016). Thus, continued changes in global temperature and precipitation patterns will have a negative effect on U.S. farm output and could have serious consequences globally.

## A Slow Policy Response: Authority and Facts

The above challenges notwithstanding, the EPA—which is the Federal institution charged with monitoring and regulating GHG emissions in the country—has only recently begun to take measures to address the global warming phenomenon. These efforts were borne out of two crucial determinations that the EPA made in 2003 that set in motion a series of events leading to a more proactive view of its role in tackling global warming. First, the EPA reasoned that it lacked the authority under the Clean Air Act to regulate Carbon dioxide ($CO_2$) and other GHGs as a response to climate change (U.S. Congress, 1990). Second, the agency reasoned that even if it had such authority, it had the discretion to defer any decision until more research on the causes, impact and significance of climate change was conducted. Following these decisions, the State of Massachusetts along with 11 other state and local governments argued, through the courts, that the EPA had abdicated its responsibility to regulate $CO_2$ and GHG emissions under the Clean Air Act (U.S. Supreme Court, 2007). By a five to four ruling in 2007, the U.S. Supreme Court, in the *Commonwealth of Massachusetts et al. vs. the U.S. Environmental Protection Agency et al.*, determined that $CO_2$ and other heat trapping gases that cause global warming are pollutants under the definition of the Clean Air Act. The U.S. Supreme Court also determined that the federal government had the authority to regulate $CO_2$ and other heat trapping gases.

Following this court ruling, and under the new administration in Washington D.C., in April 2009, the EPA declared that GHGs pose a threat to public health and welfare, and would regulate them under the Clean Air Act Amendments (1990). This Amendment seeks to control four major threats to the environment: acid rain; urban air pollution; toxic air emissions; and stratospheric ozone depletion. Specifically, the Act seeks to control these environmental threats by utilizing economic incentives through a market driven process that includes performance based standards, and by establishing a national operating permit program that includes emission banking and trading.

In 2009, the EPA launched a Greenhouse Gas Reporting Program (GHGRP) that imposed strict reporting standards on GHG emissions across all sectors of the economy. The objective of these reporting standards was to improve the understanding of emission rates, and actions that firms can take to reduce their emissions. In addition, the standards were aimed at improving the effectiveness of the design of programs, voluntary or mandatory, aimed at reducing emissions (EPA, 2009).

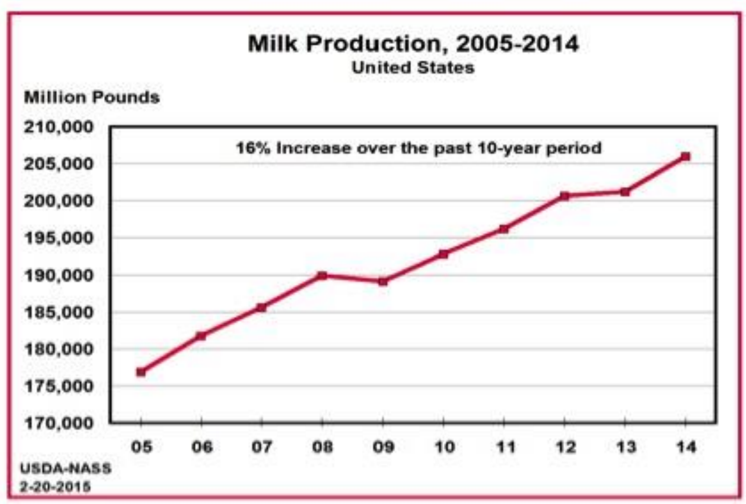
It is impossible to ignore the fact that the EPA's efforts aimed at addressing GHG emissions at the national level are subject to executive discretion and judicial interpretation. Nonetheless, we have begun to witness initiatives at the state level aimed at curbing emissions, with emphasis on the livestock industry, particularly the dairy sector. California, the largest dairy producer in the United States, has already adopted measures aimed at limiting GHG emissions emanating from the livestock industry. In September 2016, Governor Jerry Brown signed into law Senate Bill Number 1383, which mandates the livestock industry to cut methane emissions to 40% of 2013 levels by 2030 (State of California, 2016). Moreover, the Bill requires that 75% of such reductions come from dairy operations within the state.

Despite the far-reaching repercussions that additional regulatory measures might have on the long-term viability of the dairy industry, only a few recent peer-reviewed studies have examined the issue of GHG emissions in the U.S. dairy sector. Exceptions include Thoma et al. (2013) who investigates the evolution of GHG emissions on the fluid milk supply chain and more recently, Njuki and Bravo-Ureta (2015), and Njuki, Bravo-Ureta and Mukherjee (2016) who assess the cost of GHG regulation in the U.S. dairy sector. Other studies, notably Reinhard, Lovell and Thijssen (1999), and Fernandez, Koop and Steel (2002) evaluate GHG emissions in European dairy farms, while Gerber et al. (2013) examine GHG emissions from the livestock industry from a global perspective.

## The Structure of the U.S. Dairy Industry

In 2014, the United States was the single largest producer of fluid milk in the world, with an output of 206 billion pounds, which marked a 16% increase over the 10-year period going from 2005 to 2014. In addition, the U.S. dairy industry generated nearly $140 billion in economic activity of which $29 billion were in direct household earnings. The industry also accounted for roughly 900,000 jobs. Furthermore, there were approximately 51,000 dairy farms in operation, of which 97% were family owned—meaning the majority of farm assets are owned by the farm operator and his or her relatives. Dairy farming was the top agricultural activity in several states including California, Wisconsin, New York, Pennsylvania, Idaho, Michigan, New Mexico, Vermont, Arizona, Utah, and New Hampshire (USDA-NASS, 2016). Figure 1 illustrates the evolution of milk production in the United States over the years 2005 to 2014.

**Figure 1: U.S. Milk production 2005-2014**




Source: USDA-NASS, 2016

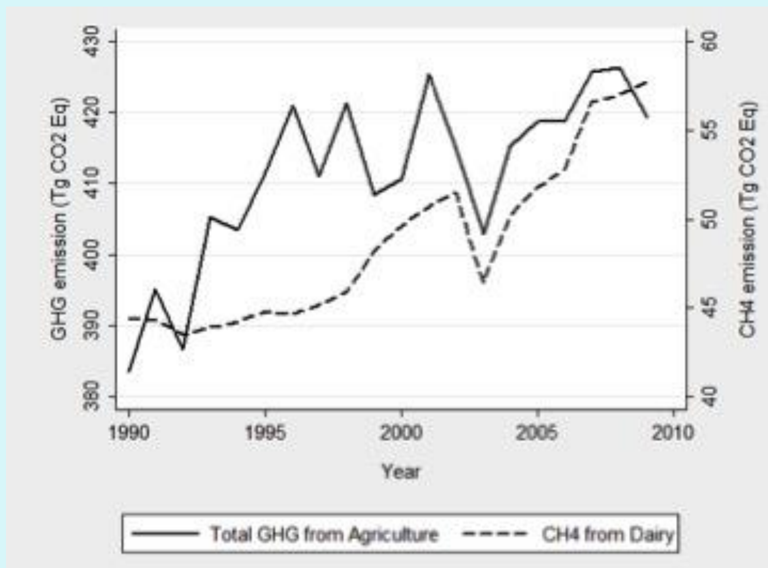
The U.S. dairy sector's important role goes beyond the direct economic benefits mentioned above. In the midst of rapid urbanization, dairy farming is critical to the preservation of rural landscapes and open-spaces (Johnston, 2002), while maintaining heritage values, rural vitality and ambience across regions where milk producers are located (Batie, 2003). Nonetheless, dairy farming faces a number of challenges. Economies of scale and rapidly changing technology are driving the consolidation into larger operations at the expense of smaller family operations (Mosheim and Lovell, 2009). The national trend is clearly towards larger and fewer dairy farms and this is evidenced by the fact that the total number of dairy operations has decreased by 33% since 2003 (USDA, 2016).

## Prevailing Environmental Regulation in the Dairy Sector

The Dairy industry is already subject to some environmental regulation. Agricultural operations where livestock are kept and raised in confined situations, defined as Animal Feeding Operations, are required to apply for and be issued permits from a designated regulatory authority within their state. Due to the risk of animal waste and wastewater being discharged into water bodies, such facilities are regulated under the National Pollutant Discharge Elimination System (NPDES). The NPDES is a program created under the Clean Water Act (1972) that seeks to protect the quality of groundwater and public health. Under the NPDES program, dairy operations that maintain more than 700 dairy cows or 1000 heifers are designated as large Concentrated Animal Feeding Operations (CAFO) and therefore must comply with NPDES rules (EPA, 2016b). Under this program, all CAFOs must implement a nutrient management plan that includes provisions for: ensuring adequate manure storage capacity; proper handling of dead animals and chemicals; keeping animals out of surface water; using site-specific conservation practices; and developing ways to test manure and soil (EPA, 2016b; Tao et al., 2016).

Of increasing policy concern is air pollution, primarily as a result of GHG emissions. Particular attention has been focused on livestock farming because this industry was responsible for generating 44 million metric tons of Carbon dioxide equivalent ($CO_2e$) (EPA, 2011), accounting for 7.5% of total anthropogenic Methane ($CH_4$) emissions, and for 4.7% of Nitrogen dioxide ($N_2O$) emissions. Within the U.S. dairy industry, environmental problems created by GHG emissions have raised concerns about the industry's environmental sustainability. Dairy farms are responsible for generating heat-trapping GHGs (EPA, 2011) and these emissions, which have been on an upward trend, account for a non-trivial share of total GHGs generated by the entire U.S. agricultural sector. Figure 2 depicts the evolution of total GHGs from U.S. agriculture as well as for Methane ($CH_4$) emissions originating from U.S. dairy farms.

**Figure 2: Trends in GHG Emissions from the U.S. Agricultural Sector**




Source: EPA, 2011

## Expected Effects of Greenhouse Gas Regulations on Dairy Farming

An environmental regulatory regime seeking to impose a limit on the emissions of GHGs could impose a cap on such pollutants or levy a monetary cost on emissions. The regulation of GHGs from dairy operations would result in two major tradeoffs:

1. farmers subject to the regulation may be forced to adjust their production of milk downwards in order to reduce emissions below some predetermined threshold; or
2. farmers may be required to incur additional costs of cleanup through fines, penalties or mandated installation of anaerobic digesters.

In either case, the internalization of emissions imposes downward pressure, at least in the short run, on farm profitability.

These tradeoffs notwithstanding, there are difficulties in regulating GHGs. First, emissions of GHGs are difficult to measure because these gases belong to a class referred to as "uniformly mixed assimilative pollutants." That is, they disperse from their source over a large area and accumulate over time when the discharge rate exceeds the absorptive capacity of the environment (Tietenberg, 2006). Consequently, the sources of such pollution are difficult to inventory. Second, GHGs are not priced in markets; thus, making it is difficult to derive a monetary measure of their environmental impact. Therefore, any attempt to impose a uniform GHG environmental regulation policy across the dairy sector, without suitable analysis, would be arbitrary and could result in severe economic damage. Moreover, stringent environmental regulations may lead dairy farms to scale down their operations below a threshold that might trigger oversight, in order to avoid fines and penalties associated with air pollution. Alternatively, dairy operations may choose to migrate to areas with lax regulation. Such a scenario could lead to economic losses that include reduced profits, job losses and lower tax revenues to local communities.

## Environmental Regulation in the U.S. Dairy Industry: Two Recent Studies

Feed production and processing costs are estimated to account for 45% of GHGs from livestock operations (Gerber et al., 2013). Furthermore, digestion by cows and manure decomposition account for another 39% and 10%, respectively. The remaining GHG emissions can be attributed to the processing and transportation of animal products.

Other notable studies that investigate GHG emissions in dairy operations consider solely emissions originating from nitrogen surplus due to over application of fertilizer (Reinhard, Lovell, and Thijssen, 1999; Fernandez, Koop, and Steel, 2002). Thus, they fail to account for a sizeable portion of emissions, and in doing so they underestimate the true magnitude of pollution. However, recent studies have developed a more comprehensive pollution measure to analyze GHG emissions in the U.S. dairy sector as well as the associated economic costs of regulating these emissions (Njuki and Bravo-Ureta, 2015; Njuki, Bravo-Ureta, and Mukherjee, 2016). In particular, these recent studies consider the role of fertilizer and fuel, and livestock, which are the major sources of GHG emissions from dairy farms. The fertilizer and fuel components capture GHG emissions from the feed production and processing stages, whereas the livestock component accounts for emissions from the digestive process and manure decomposition in dairy operations. As such, they account for a sizeable portion of GHGs originating from the dairy farms.

In short, economic research finds evidence that the cost of environmental regulatory interventions aimed at reducing GHG emissions would vary considerably, by farm size and by region, across the United States. In fact, it could very well be the case that the cost of complying with federal and state regulations might be offset by cost advantages stemming from economies of scale (McDonald, McBride, and O'Donoghue, 2007). In particular, there is evidence that the average dairy farm in the Midwest and the East, which tend to be smaller than their counterparts in the Pacific, Mountain and the Southwest, would find abatement of GHGs relatively more expensive. Similarly, larger farms within the Northeast would experience cost advantages in GHG abatement due to economies of scale. Nevertheless, these cost advantages may dissipate due to the multiplicity of Federal and State regulations, such as the CAFO requirements.

## Moving Forward

The survival of the dairy industry is critical given the role that dairy farms play in generating household earnings, preserving rural landscapes, heritage values, and open spaces. Research suggests that policy makers should consider carefully the cost-effectiveness of policies designed to curtail emissions from dairy farms before implementation. Imposing a command-and-control approach is both inflexible and costly, and will only exacerbate losses to some regions and farms in the country. On the other hand, a cap-and-trade regime may result in unequal benefits because large dairy farms, compared with their small counterparts, enjoy cost advantages. In addition, recent research results suggest that policy interventions should be directed towards assistance programs such as direct subsidies, cost sharing of digesters, loan guarantees, tax exemptions, and accelerated depreciation. Other mechanisms include a carbon-offset system that compensates dairy operations for $CO_2$ reductions.

Finally, promoting renewable energy and supporting voluntary mechanisms that encourage the widespread adoption of anaerobic digesters could be viable options (Mukherjee et al., 2015). Anaerobic digester technologies are good for the environment because they transform methane that would have otherwise escaped to the atmosphere. Though digester systems have multiple benefits, they have not been widely adopted in the United States because of their relatively high costs (Bishop and Shumway, 2009). Furthermore, the high financial outlays required to install digester systems makes this technology suitable for larger operations because of pronounced economies of scale in both their construction and maintenance (Key and Sneeringer, 2012). Attention should also be given to centralized anaerobic digesters (CADs), which can make this technology economically viable to groups of small-scale dairy farms by pooling resources (Mukherjee et al., 2015). These proposals could go a long way in enhancing the long-term viability of both small and large dairy operations in the United States, while slowing down the shift towards fewer and larger farms.

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