Economic and Environmental Analysis of Milk Production in Israel – Efficiency and Environmental Regulation

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Abstract

This study examines the relation between economic efficiency and greenhouse-gas emissions in the operation of dairy farms in Israel. The analysis was done on a panel dataset of 98 dairy farms sampled in 2017 and 2019 as part of the Dairy Board's profitability survey. Greenhouse gas emissions were calculated by life cycle analysis of milk production. Using regressions and Frontier Analysis, we assessed the impact of climatic and managerial factors on the economic efficiency of dairy farms and their environmental damage.

Greenhouse gas emissions

It was found that an average Israeli dairy farms emits 1,170 grams of CO2-equivalents in the production of one liter of milk. Food consumption is responsible for 97% of total emissions, divided into 22% as a result of food production and its transportation, 45% from food digestion and 30% from handling and transporting the manure. According to a national production of about 1.6 billion liters per year, the annual emissions amount to 1.8 million tons of CO2. The overall greenhouse gas emissions in Israel are estimated at 79 million tons of CO2 equivalents (CBS 2019), of which agriculture emitted 2.23 million tons; the dairy sector is therefore the main factor in agricultural emissions. According to a market price of 67 euros per ton of CO2 emission cap in the EU (June 2024), the value of dairy farm emissions is about 31 agorot (NIS cents) per liter.

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Effects of dairy farms' characteristics on their performances

Milk quota – A positive correlation was found between the size of the dairy-farm's quota and its economic performance, and the reduction of greenhouse gas emissions. The average operating profit in the sample was 27.1 agorot per liter of quota. The operating profit increases by 13.8 agorot per liter of quota for every addition of one million liters of quota, but the contribution decreases with size until it is vanished at the level of 7.5 million liters of quota. The profitability improvement is attributed to a decrease in the production cost; this improvement is achieved mainly via increased efficiency of food consumption. On average, food consumption and production cost is 979 grams of dry matter and NIS 2.04 per marketed fat-protein corrected milk (FPCM) liter, respectively. It was found that an increase of 1 million liters of quota reduces food consumption and production cost by 17 grams of dry matter and by 15 agorot per marketed FPCM liter, respectively, with the marginal effect decreasing to zero by 7.5 million liters of quota. In addition, a positive correlation was found between the size of the quota and the degree to which farms deviate from their quota.

Heat stress – It was found that the heat stress (measured by the number of hours per year in which the Temperature-Humidity Index (THI) exceeds 75) harms the economic performance of the farm and increases its environmental damage. An addition of 100 annual heat-stress hours (about 5% of the sample-average hours) reduces the profit by 0.63 agorot per liter of quota, and increases, respectively, the food consumption and production cost by 2.7 grams of dry matter and 0.68 agorot per marketed FPCM liter. Food consumption in the coldest farm in the sample is 8.5% lower than that in the hottest farm. The profit per liter of quota in the coldest farm is 19.5 agorot higher than the hottest farm, of which one agora is attributed to an increase in the investment in cooling fans. It was found that the cost of investing in fans increases by NIS 2,300 per million marketed FPCM liters for every increase of 100 hours of annual heat stress. No significant effect of heat on the area of cowsheds was found. A negative relationship was found between heat load and the degree of exceeding the quota production.

Self food center – dairy farms that produced feed for themselves consumed on average 36 grams more per marketed FPCM liter, almost 4% increased consumption on average per liter. This has a significant environmental impact.

Managers' characteristics – a positive correlation was found between the professional seniority of the managers and their degree of consultation with institutional guidance and an increase in profitability per quota liter, a decrease in average emissions per marketed FPCM liter, and an increase in the deviation from the quota.

Frontier analysis

An average inefficiency of 24% was found relative to the optimum with respect to milk production cost, 8% with respect to food consumption and 21% with respect to greenhouse gas emission. A statistically significant correlation was found between inefficiency in the cost of production and inefficiency in food consumption, but not between the cost of production and greenhouse gas emission.

Conclusions and recommendations

Food consumption is the main factor affecting both the profitability of dairy farms (via production costs) and greenhouse gas emissions, so that the economic interest in reducing food consumption is consistent with the environmental interest of reducing emissions. To optimize the economic and environmental performance of dairy farms in Israel, it is recommended as follows:

1. Encourage milk production in large dairy farms and in areas with low heat stress.
2. Exploring the reasons for increased food consumption in farms that produce it themselves and act to reduce it.
3. Consider individual-cow feeding as a tool to improve food utilization (studies show a gap of over 20% between cows in the same herd).
4. Include a measure of food utilization as a criterion in herd breeding.
5. Consider the inclusion of food ingredients that reduce emissions in digestion and treatment and examine their impact on milk production.

6. Consider incentivizing the consumption of food ingredients whose production entails less environmental impact.
7. Consider incentivizing improvement in food utilization and output/input protein ratio, and in environmentally preferable food nutritional mix.