Capturing Critical Agri-environmental Linkages of US Livestock Production: The USDA-ERS REAP Model

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Abstract

The current efforts to rebuild the REAP model are focused on capturing some critical linkages between crop/livestock production and the environment.

- The previous REAP versions linked crop outputs and food co-products to feed rations of animals in detail
- The allocation of rations were balanced with requirements of energy/protein/amino acids, etc.

We now want to create a better linkage between livestock diets and their manure production so that the environmental impacts of alternative manure-nutrient management practices can be more effectively modeled.

This way we can ascribe the greenhouse gas (GHG) implications of livestock to both enteric emissions and handling practices for waste products.

Methods

REAP is a mathematical programming model that optimizes economic net benefits over crop and livestock production choices subject to constraints on resources, market conditions and key outcomes (i.e., emissions)

REAP is U.S.-focused (48 States) - with sub-national disaggregation for crops/ livestock (~330 spatial units)

Per-animal feed requirements, enteric GHG emissions and manure output are consistent with biophysical modeling outputs.

The schematic shows how the various crop/livestock components are linked.

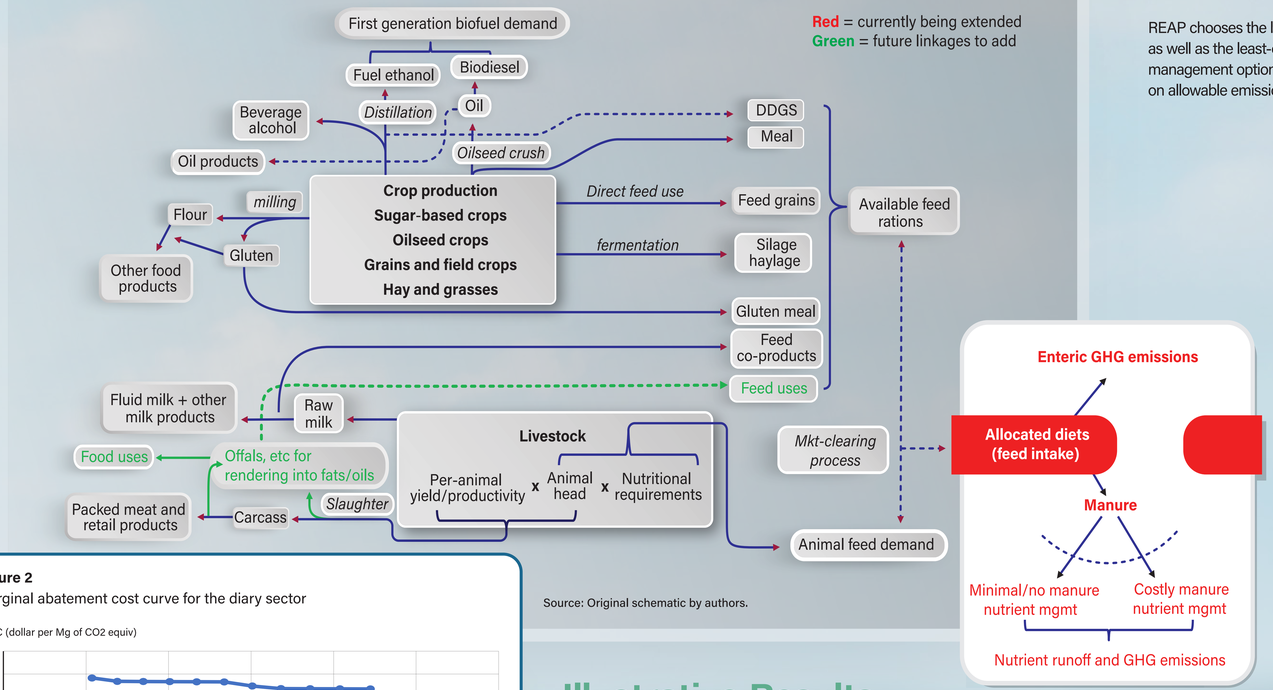
Data Sources

U.S. Census of Agriculture, NRI, and CEAP databases

Simulated model outputs from APEX model (crops) and RNS model (livestock)

A synthesis of behavioral parameters (e.g., elasticities) from cited sources and expert opinion.

Figure 1
Current/Future crop-livestock linkages in REAP

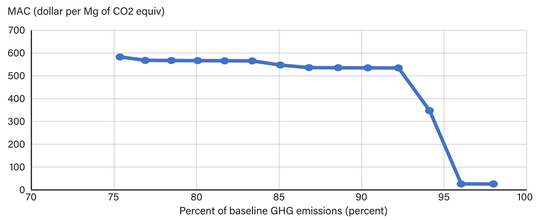


Source: Original schematic by authors.

REAP chooses the least-cost feed ration as well as the least-cost manure nutrient management option subject to constraints on allowable emissions/effluents.

If environmental standards become more stringent more expensive options for nutrient management will have to be chosen.

Figure 2
Marginal abatement cost curve for the diary sector



Source: USDA, Economic Research Service replication of results by Hawkins et al. (2015).

Illustrative Results

We will expand upon the approach to capturing GHG emissions and control costs used in Hawkins et al. (2015). This shows the marginal abatement cost curve of dairy production considering just GHG emissions. This will be expanded to cover water quality impacts and manure handling options.

Future Work and Considerations

- Doing more on extensive systems (especially rotational grazing options)
- Adding more detail on the land management of grazing areas
- Incorporating aquaculture where feed competition is relevant
- Expanding to consider feed additives that reduce enteric GHG

References

Hawkins, J., A. Weersink, C. Wagner-Riddle, G. Fox. 2015. Optimizing Ration Formulation as a Strategy for Greenhouse Gas Mitigation in Intensive Dairy Production Systems. *Agricultural Systems*, 1-11.

*The views presented here are those of the author(s) and should not be construed to represent any official USDA or U.S. Government determination or policy.

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