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GLOBAL SENSITIVITY ANALYSIS OF THE DECARBFARM GREENHOUSE GAS DECISION SUPPORT TOOL

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SUSTAINABLE LAND USE
AGRICULTURAL DECARBONIZATION

KEY RESULT

Global Sobol analysis attributed most output variance to heat energy (S1 0.65, ST 0.57) and steam (S1 0.33, ST 0.34). Morris confirmed the importance of energy and fuel inputs and also identified high influence fertilizer parameters.

MODEL AND ANALYSIS

DecarbFarm accounts for Scope 1 and Scope 2 greenhouse gas emissions using IPCC 2019 and GHG Protocol methods. Its ten pages cover farm information, emission accounting and potential decarbonization measures. The structure supports mixed livestock and crop farms as well as specialised systems.

75	**INPUT PARAMETERS TESTED**
128	**BASE SAMPLE SIZE PER METHOD**
0–200	**UNIFORM STRUCTURAL TEST RANGE**

SENSITIVITY WORKFLOW

SOBOL First screened each input page using S1 and ST. The three leading parameters per page then entered a global analysis that also estimated pairwise S2 effects.

MORRIS Screened all eligible inputs using mean effect, absolute mean effect and effect variability. The method supports rapid ranking across a large parameter set.

The manure management page required constrained compositional sampling and was excluded from both analyses.

WHAT THE INDICES MEAN

S1 Variance explained by one parameter.

ST Total contribution, including interactions.

S2 Variance linked to a pair of parameters.

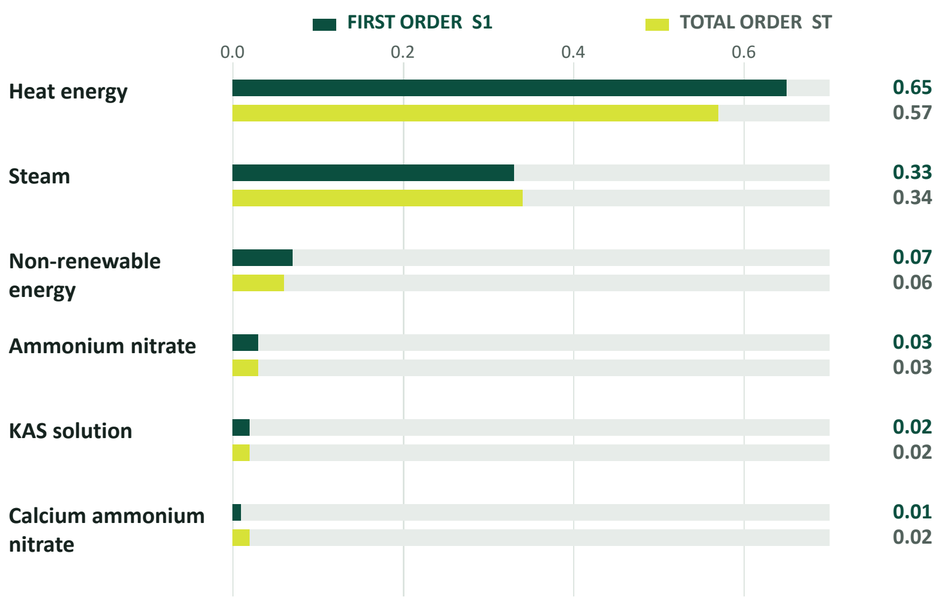
μ* Absolute Morris effect used for ranking.

σ Variation in effects across the sampled space.

MODEL BEHAVIOUR

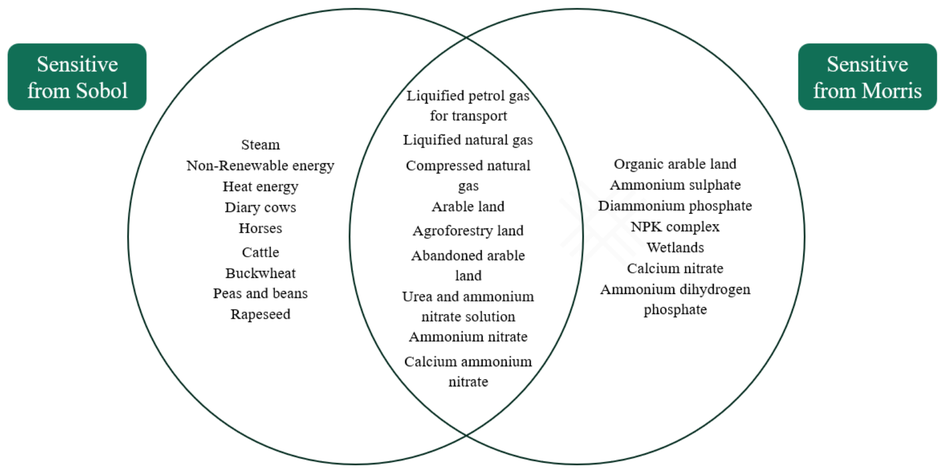
Small differences between Sobol S1 and ST, negligible S2 values and Morris σ values of 0.0000 indicate a predominantly additive and linear accounting model within the tested range. This supports traceability, while real farm systems may contain interactions that the accounting structure does not represent.

GLOBAL SOBOL RESULTS



Heat energy and steam dominate the full model variance. The overlapping confidence intervals around S1 and ST estimates mean that small differences between them should not be overinterpreted.

SENSITIVE PARAMETERS BY METHOD



The methods share several fuel, land and fertilizer priorities, while Sobol emphasizes variance contribution and Morris captures large absolute effects across the screening range.

IMPLICATIONS FOR MITIGATION

ENERGY Accurate heat and steam data should receive early attention when estimating farm emissions and evaluating energy measures.

FUELS Transport LPG, LNG and CNG showed large Morris effects, which supports careful fuel activity data collection.

AGRICULTURE Fertilizer, land and livestock parameters remain important for module-level screening and for selecting farm-specific abatement measures.

PLANNING The rankings can focus data quality work and connect farm mitigation choices with rural land use and climate planning priorities.

MORRIS SCREENING

σ = 0.0000

All parameters showed linear elementary effects within the test range.

HIGHEST μ* VALUES THOUSANDS

1	Transport LPG	88.4
2	LNG	68.1
3	CNG	29.5
4	Ammonium nitrate	19.0
5	KAS solution	17.8
6	Calcium ammonium nitrate	15.1

HOW TO USE THE RESULTS

FARM USERS Prioritize accurate records for high sensitivity energy, fuel and fertilizer inputs.

ADVISERS Use the ranking to focus mitigation discussions on the parameters that most affect model output.

DEVELOPERS Improve influential modules first and consider automated data capture where manual entries create uncertainty.

PLANNERS Connect farm level priorities with regional land use and climate resilience strategies.

LIMITATIONS AND NEXT STEPS

INPUT RANGES Uniform 0–200 ranges test model structure, not realistic farm conditions or mitigation potential.

MANURE Future work should use compositional sampling for interdependent manure management shares.

FARM TYPES Repeat the analysis for representative crop, livestock and mixed farm typologies.

VALIDATION Use real farm data and formal statistical checks to confirm stability and exclude computational bias.

Interpret the rankings as structural priorities within DecarbFarm, not as measured real farm emission reduction potential.

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Source: DecarbFarm sensitivity analysis using SALib 1.5.1 with Python 3.13.5