Biogas Location (Big Lab Project)

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1 Introduction

This problem can be modeled as a mixed integer linear programming (MILP) problem, where we need to decide which farms to locate the plants at and which farms to assign to each plant as suppliers.

2 Problem

Let's define the following variables:

- x_i: binary variable that is 1 if a plant is located at farm i and 0 otherwise.
- $y_{i,j}$: binary variable that is 1 if farm j supplies corn chopping to farm i and 0 otherwise.
- $z_{i,j}$: variable that represent the number of tons of corn choppings that farm j supplies to farm i.

The objective function is to maximize the total revenues of the association, which is the sum of the revenues from each plant. The revenue from each plant is equal to the energy produced by the plant multiplied by the unitary price of energy. The energy produced by each plant is equal to the sum of the energy produced by each ton of corn chopping burned, multiplied by the number of tons of corn chopping burned.

Therefore, the objective function can be written as:

$$\text{maximize} \sum_{i=1}^{n} \sum_{j=1}^{n} (Q \cdot b \cdot z_{i,j} - y_{i,j} \cdot d_{i,j})$$

We need to add constraints to ensure that each farm can only be assigned to at most one plant, and that each farm can only supply corn chopping to at most one plant. We can add these constraints as follows:

$$\sum_{i=1}^{n} x_i = p$$

$$\sum_{i=1}^{n} y_{i,j} \leq 1 \quad \forall j$$

$$z_{i,j} \leq y_{i,j} \cdot c_j \quad \forall i \quad \forall j$$

$$\sum_{j=1}^{n} y_{i,j} \leq 1 \quad \forall i$$

We also need to ensure that the percentage of dry matter of the corn chopping burned at each plant is within the required range. We can add this constraint as follows:

$$k_{min} \leq \frac{\sum_{j=1}^{n} z_{i,j} \cdot a_j}{\sum_{j=1}^{n} z_{i,j}} \leq k_{max} \quad \forall i$$

Finally, we need to ensure that each plant does not produce more than the maximum allowed amount of energy. We can add this constraint as follows:

$$\sum_{j=1}^{n} z_{i,j} \cdot Q \leq M \quad \forall i$$