Final Project Proposal: Optimal Farming Schemes in Stardew Valley

Hailey Warner hlwarner@stanford.edu

AA222/CS361, Stanford University

1. Problem

Stardew Valley is a popular farming simulation video game where players begin with an empty plot of land and gradually grow their farm and through planting, watering, and harvesting crops. The player balances multiple competing objectives including plant diversity, immediate and long-term profit, and labor intensity. Here, we focus on the objective of profit maximization from crops across a single 28-day season. Though many optimal crop schedules have been proposed [1][2], they vary significantly and do not use formal optimization techniques nor show calculations.

Figure 1: Example Farm Layout.

Farming in *Stardew Valley* is a well defined process with several key characteristics and rules. These are summarized below.

Integer Program. Profits, crop counts, and miscellaneous costs are all finite, integer-valued quantities, necessitating use of combinatorial optimization techniques outlined in Chapter 22 of *Algorithms for Optimization* [3]. Fortunately, under a few simplifications, the profit objective function is a linear combination of design variables.

Stochasticity. Crop quality is the main source of stochasticity in *Stardew Valley*. Upon harvest, crops are randomly assigned regular, Gold, Silver, or Iridium quality, which increase profit. Probabilities of each quality are given below [4]. There is also a low chance of losing a crop to a crow, around 5%

$\text{P(Gold)} = 0.02 \cdot (\text{farming level}) + 0.2 \cdot (\text{fertilizer level}) \cdot ((\text{farming level} + 2)/12) + 0.01$
$\text{P(Silver)} = 2 \cdot \text{P(Gold)}$ (capped at 75%)
$\text{P(Iridium)} = 0.5 \cdot \text{P(Gold)}$

Multi-Harvest Crops. While most crop types allow a single harvest only after G days, certain crops have regrowth harvests after an additional R days, yielding higher profit over time with no additional cost.

Fertilizers. Players may choose to use fertilizers to (1) speed crop growth rates (affecting G and R, (2) improve crop quality (affecting P(Silver), P(Gold), and P(Iridium)), or (3) reduce labor costs. Nine types of fertilizer are available total, each with a unique cost per unit area.

2. Proposed Approach

Here is a preliminary formulation of the profit maximization problem as an integer program.

Day of season: $d \in \{1, 2, ...28\}$.

Crop types: $i \in \{1, 2, ..., n\}$ (n $\approx$ 50).

Crops planted: $\mathbf{x_d}$ (vector of length i where $x_{i,d} = \#$ crops of type i planted on day d).

Profit: $c_{i,d} = P_{survive} \cdot h_i \cdot \mathbb{E}[r_i] - s_i$ (where # harvests h_i depends on growth rates G_i and R_i, r_i is average crop i revenue, and s_i is seed cost).

$$\begin{aligned} \min_{x} \quad & -\sum_{i=1}^{n}\sum_{d=1}^{28} c_{i,d}x_{i,d} \\ \text{s.t.} \quad & x_{i,d} \geq 0 \quad \forall i, d \end{aligned} \tag{1}$$

With an additional constraints for F total plots and fertilizers.

3. Sketches of Solution

As the objective function $f(x)$ is multimodal, we will use a *branch and cut* algorithm, which introduces constraints until x^* is a unique solution. It is not yet clear whether an optimal solution can be constructed from overlapping subproblems, but if so, dynamic programming methods may be employed.

To save runtime, a simple programmatic farming simulation will be implemented (in Python or Julia). Optimal solutions will be verified in the game software itself.

References

[1] Forum Post. https://forums.stardewvalley.net/threads/complete-spreadsheet-of-crops-profit-including-jar-keg-and-cask-processing.298/
[2] Video Tutorial. https://www.youtube.com/watch?v=RS77GifFEYM
[3] Mykel J. Kochenderfer and Tim A. Wheeler. Algorithms for Optimization. MIT Press, 2025.
[4] Wiki. https://stardewvalleywiki.com/Farming#Complete_Formula_2