Sets

Y: Set of planning years, indexed in t
A: Set of wine ages, indexed in i
T: Set of terrains, indexed in j
IP: Subset of planted terrains, indexed in j
NP: Subset of not planted terrains, indexed in j

Parameters

$PROFIT_i$: Profit of wine i
$SIZE_j$: Size of terrain j
$PRODUCTIVITY_j$: Productivity of terrain j
IP_j: Is the j terratin planted?
SP: Seed price
$BUDGET$: Budget to operate
IW: Initial workers
AS: Annual Salary
HC: Hiring Cost
FC: Firing Cost
MW: Maintenance workers needed
PW: Planting workers needed
$BP_{i,t}$: Bottle production limit for wine with age i in year t
$CASK1_0$: Initial amount of wine with age one year
$CASK2_0$: Initial amount of wine with age two years
$CASK3_0$: Initial amount of wine with age three years

Variables

$$y_{j,t} : \begin{cases} 1, \text{if terrain } j \text{ is planted in period } t \\ 0, \text{otherwise} \end{cases}$$

x_t :Production of wine at period t
b_t :Amount of available budget at period t
$v_{i,t}$:Sales of wine with age i at period t
h_t :Amount of hired employees at period t
ie_t :Amount of available employees at period t
$mant_t$:Maintenance workers in terrain j
$cask_{1,t}$:Amount of wine with one year age at period t
$cask_{2,t}$:Amount of wine with two years age at period t
$cask_{3,t}$:Amount of wine with three years age at period t

Model

$$PROFIT = \sum_{i \in A} \sum_{t \in Y} (v_{i,t} \cdot PR_i + b_{|t|})$$

$$PEOPLE\_COST = \sum_{t \in Y} (f_t \cdot FC + h_t \cdot HC + ie_t \cdot AS)$$

$$SEED\_COST = \sum_{j \in NP} \sum_{t \in Y} (y_{j,t} \cdot SP \cdot SIZE_j)$$

$$Maximize: PROFIT - PEOPLE\_COST - SEED\_COST$$

s.t

People Constraints

Available Employees

$$ie_t = ie_{t-1} - f_t + h_t \qquad \forall t \in Y$$

Hired Employees

$$h_t = \sum_{j \in NP} y_{j,t} \cdot SIZE_j \cdot PW \qquad \forall t \in Y$$

Each planted terrain has maintenance employees

$$mant_j = MW \cdot SIZE_j \cdot IP_j + \sum_{t \in Y} y_{j,t} \cdot MW \cdot SIZE_j \qquad \forall j \in T$$

Budget Constraints

Operational cost cannot exceed the budget

$$\sum_{j \in NP} \sum_{t \in Y} (y_{j,t} \cdot SP \cdot SIZE_j) + \sum_{t \in Y} (ie_t \cdot AS + h_t \cdot HC + f_t \cdot FC) \leq BUDGET$$

Available Budget

$$b_t = b_{t-1} - \left(\sum_{j \in NP} (y_{j,t} \cdot SP \cdot SIZE_j) + (ie_t \cdot AS + h_t \cdot HC + f_t \cdot FC) \right) \qquad \forall t \in Y$$

Production Constraints

Production for each period

$$x_t = \sum_{j \in IP} PRODUCTIVITY_j + \sum_{j \in NP} y_{j,t-1} \cdot PRODUCTIVITY_j \quad \forall t \in Y$$

A terrain can be planted only once

$$\sum_{t \in Y} y_{j,t} \leq 1 \qquad \forall j \in NP$$

Casks and sales constraints

Transition of wine from terrains to casks

$$cask_{1,t} = CASK1_0 \qquad \forall t \in Y | t = 2012$$
$$cask_{1,t} = x_{t-1} - \sum_{i \in A} v_{i,t} \qquad \forall t \in Y | t > 2012$$
$$cask_{2,t} = CASK2_0 \qquad \forall t \in Y | t = 2012$$
$$cask_{2,t} = cask_{1,t-1} \qquad \forall t \in Y | t > 2012$$
$$cask_{3,t} = CASK3_0 \qquad \forall t \in Y | t = 2012$$
$$cask_{3,t} = cask_{2,t-1} - \sum_{i \in A} v_{i,t} \qquad \forall t \in Y | t > 2012$$

Relation between casks and sales

$$\sum_{t \in Y} v_{i,t} \leq \sum_{t \in Y} cask_{1,t} \qquad \forall i \in A | i = 1$$
$$\sum_{t \in Y} v_{i,t} = \sum_{t \in Y} cask_{3,t} \qquad \forall i \in A | i = 3$$

Sales and bottle production

Wine sales cannot exceed bottle production

$$v_{i,t} \leq BP_{i,t} \qquad \forall i \in A, \forall t \in Y$$

Variables nature

$$y_{j,t} \in [0,1] \qquad \forall j \in T, \forall t \in Y$$
$$x_t \geq 0 \qquad \forall t \in Y$$
$$b_t \geq 0 \qquad \forall t \in Y$$
$$v_{i,t} \geq 0 \qquad \forall i \in A, \forall t \in Y$$
$$h_t \geq 0 \qquad \forall t \in Y$$
$$ie_t \geq 0 \qquad \forall t \in Y$$
$$mant_t \geq 0 \qquad \forall t \in Y$$
$$cask_{1,t} \geq 0 \qquad \forall t \in Y$$
$$cask_{2,t} \geq 0 \qquad \forall t \in Y$$
$$cask_{3,t} \geq 0 \qquad \forall t \in Y$$