Test Assignment

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Introduction

A new pesticide has been developed that is effective in controlling corn, soybean, and wheat pests. As a result of the field experiments, the following crop yields have been obtained:

Pesticide Application (kg/ha)	**Soybean Yields** (kg/ha)	**Wheat Yields** (kg/ha)	**Corn Yields** (kg/ha)
0	2900	3500	5900
1	3800	4100	6700
2	4400	4200	7900

Annual production costs, **excluding pesticide applications**, and selling prices for the crops are given in the table below.

Crop	**Annual Production Costs** ($/ha-yr)	**Selling Prices** ($/kg)
Soybeans	350	0.36
Wheat	280	0.27
Corn	390	0.22

Moreover, pesticide application costs are $70/ha-yr for any crops at all application rates greater than zero. Recently, environmental authorities have expressed concern over the pesticide's ecological impacts and have ruled that a farmer's *average* application rate on corn, soybeans, and wheat cannot exceed 0.6 kg/ha, 0.8 kg/ha, and 0.7 kg/ha, respectively.

A particular farmer wants to know how to allocate the crops and the pesticide treatments across their 130 ha to maximize their profit while remaining in compliance with these regulations. The demand for each crop (the maximum that will be purchased in the marketplace) is 50,000 kg.H

Questions

Question 1: Model Formulation

Specify a linear programming model for the farmer's decision in standard form. You should include clear definitions of the decision variables (which could be presented in a table, for example), the objective function (including whether you are trying to minimize or maximize the objective), and all relevant constraints. Include any necessary information about how the objectives and constraints are derived.

Question 2: Solution Analysis

After solving the optimization problem using `JuMP`, answer the following:

- What is the optimal allocation of land and application of pesticides?
- If the farmer allocates their land and applies pesticides in this way, what will be their profit?
- What constraints are binding?
- Based on an analysis of shadow variables, how much would an extra 10 ha of land be worth to the farmer?

Question 3: Analysis of Alternative Regulatory Regime

Regulators are considering modifying the pesticide application regulation to allow an overall average pesticide application rate of 0.7 kg/ha over the entire crop-growing area. What will the implications be for the farmer's decisions and profits?

External Resources

Include a section where you list any external resources you consulted, including classmates and websites. You do not need to reference `Julia` or `JuMP` documentation.