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Written Report

In the background of FARMCO, the company plans to grow six types of crops, wheat, sorghum, soybeans, endive, romaine, and strawberries, in twenty distinctive fields, using various techniques, including monitoring, fertilizer, pollinators, labor, and water as options, in order to improve the total yields of crops. Each field can be planted with more than one crop with random proportion. The individual yield and cost for each combination of crop, field, and techniques is predicted without taking the costs of seeds into account, and restricted by the limitation of the fields size and the total amount of crops, limited usage of the technology and the consideration of profits. The goal of the company is to maximize the profit of yields of crops with the constraints and the usage of technology and fields.

The data file contains the data, including a set of crops, technologies, and fields, parameter of improvement including the amount of expected revenue of each technology on a single crop, maximum amount of usage of each single technology, expected revenues of each combination of field and crops when a field is filled with a single crop, and the total amount of technology used on a field.

The model file contains five major components: sets, objective function, variables, parameters, and constraints.

There are three sets in the model file, representing a set of crops (containing six types of crops), a set of fields (containing 20 distinctive fields), and a set technologies (containing five different technologies). The sets are set up in the aim of taking the data from the data file and doing the further calculation with the rest of the components.

There are six parameters in the model file. The parameter of yield is set up for taking the data of expected revenues of each combination of field and crops when a field is filled with a single crop from the data file, and each yield is nonnegative. The parameter of availability is set up for taking the data of the maximum amount of usage of each single technology from the data file, and each amount is nonnegative. The parameter of technology costs is the total amount of technology used on a field from the data file, and each amount is nonnegative. The parameter of improvement on crops is the amount of the expected revenue improved by using a single technology on a single crop from the data file, and the amount is nonnegative. The parameter of the probability of upper bound is the maximum proportion of each expected revenue of crops that cannot exceed 50% of the total expected revenue, while the parameter of the probability of lower bound is the minimum proportion of each expected revenue of crops that cannot be less than 10% of the total expected revenue.

There are two variables: grow variable is set up for each proportion of a single yield with a single crop, and usetechnology variable is set up for each proportion of a single yield in a single crop with a single technology.

The objective function is to maximize the total expected profit by planting crops with using technology to get improved and considering of the cost of technology. The profit is equal to the different between the total expected revenue and the total cost. Since the expected revenue is the basic yield of each crop with the technology improved, in this case is equal to the total yield of planting a single crop on a single field times the proportion of the field with this crop plus the total yield of 6 crops in 20 fields with 5 technologies of planting a single crop on a single field times the percentage of this field in the crop with using a single technology times the amount of the expected revenue improved by using a single technology on a single crop. The total cost is the percentage of this field in the crop with using a single technology times the total amount of technology used on a field.

There are five constraints, including the capacity of fields, diversity of crops, limitations of the usage of technology and the considerations of balance or expected revenue. The first constraint is the capacity of fields, the total percentage of crop planted in a single field cannot exceed 1 which is the greatest amount of the field capacity, so in each field, the total amount of crops which is sum of grow variables is less than or equal to 1. The second constraint is the limitations of usage of technology in each crop proportion of a single field – proportion of technology used on a particular crop on a particular field cannot be greater than the amount of crop planted, so in each field with each crop, the total amount of the technology usage which is the usetech variable is smaller than or equal to the grow variable. The third constraint is the limitations of the usage of each single technology, so for each technology used in 20 fields in each crops, it cannot exceed the amount of technology available: the percentage of this field in the crop with using a single technology times the total amount of technology used on a field is less than or equal to the availability parameter for a single technology. The last two are the constraints of considerations of the percentage of the revenue in each crop in the total revenue. The lower bound of the revenue (the lower bound constraint) is the expected revenue of lower bound for each crop accounts for at least 10% of the expected revenue. The revenue of each crop is equal to the difference between the total yield of planting a single crop on a single field times the proportion of the field with this crop plus the yield in 20 fields with 5 technologies of planting a single crop on a single field times the percentage of this field in the crop with using a single technology times the amount of the expected revenue improved by using a single technology on a single crop and the percentage of this field in the crop with using a single technology times the total amount of technology used on a field. The lower bound is less than or equal to the revenue of each crop divided by the total revenue found in the objective function. To transform it as a linear function, the revenue of each crop is less than or equal to the product of the lower bound and the total revenue. Thus, the upper bound of revenue (the upper bound constraint) is the expected revenue of upper bound (no crop accounts for more than 50% of expected revenue). The upper bound is greater than or equal to the revenue of each crop divided by the total revenue found in the objective function. To transform it as a linear function, the revenue of each crop is greater than or equal to the product of the lower bound and the total revenue.

As a result, the optimal solution is found as…