Blake Conrad

blake@bc-consulting.com

Abstract

In response to inquiry from Sole Pineapple Co., BC Consulting engaged in efforts to improve resource management and cost efficiency, while remaining within current company demands and guidelines. This technical report explains modeling details for recommended Sole implementation changes. These details include: problem decomposition, methods employed, mathematical modeling, assumptions, model output interpretation, anticipated benefits, and recommendations from technical insights.

Sole Pineapple CO. ResourcE management

Technical Report: Lead Analyst, Blake Conrad

Technical Report:

Sole Pineapple Co. Resource Management

Lead Analyst, Blake Conrad

# Contents

[Contents. 4](#_Toc505147445)

[List of Tables. 5](#_Toc505147446)

[List of Equations. 5](#_Toc505147447)

[Introduction. 6](#_Toc505147448)

[Problem Statement. 6](#_Toc505147449)

[Methods Used, Recommendation, and Benefits. 6](#_Toc505147450)

[Assumptions. 7](#_Toc505147452)

[Supplier. 7](#_Toc505147453)

[Product. 7](#_Toc505147454)

[Economic. 7](#_Toc505147455)

[Political. 7](#_Toc505147455)

[Analysis. 8](#_Toc505147452)

[Decision Variables, Sets, and Parameters. 8](#_Toc505147453)

[Objective Function. 9](#_Toc505147454)

[Constraints. 10](#_Toc505147454)

[Model Output and Interpretation. 13](#_Toc505147455)

[Conclusion. 14](#_Toc505147456)

[Recommendation. 14](#_Toc505147457)

[Appendices. 14](#_Toc505147456)

[Appendix A: References. 14](#_Toc505147457)

**List of Tables**

[Table 1. Optimal Acreage per Product. 9](#_Toc500756896)

[Table 2. Supplier Information, Standards, and Constraints. 16](#_Toc500756897)

[Table 3. Product Information, Standards, and Constraints. 17](#_Toc500756898)

[Table 4. Aggregate Optimal Acreage per Product. 18](#_Toc500756899)

**List of Equations**

[Equation 1. Decision Variables. 8](#_Toc500756909)

[Equation 2. System Decision Variable Combinations. 10](#_Toc500756910)

[Equation 3. Objective Function. 10](#_Toc500756911)

[Equation 4. Maximum Acreage Constraints. 11](#_Toc500756912)

[Equation 5. Minimum Product Quality Constraints. 11](#_Toc500756913)

[Equation 6. Maximum Canned and Sliced Pineapples Constraint. 12](#_Toc500756914)

[Equation 7. Maximum Juice Constraint. 12](#_Toc500756915)

[Equation 8. Maximum Whole Pineapples Constraint. 13](#_Toc500756916)

[Equation 9. Minimum Production Constraints. 13](#_Toc500756917)

[Equation 10. Non-negativity Constraints. 26](#_Toc500756918)

# Introduction

## Problem Statement

After a thorough discussion with Sole Pineapple Co. Chief Officer of Operations, specific problem patterns continue to arise; resource management. The company at large continues to struggle with fully utilizing its resources to maximize benefit. This causes Sole Pineapple Co. to lose out on a higher stream of income each fiscal year from its current operations. *Problem Statement* definitions from executives in Sole Pineapple Co. have resulted from this prolonged issue:

*“Sole Pineapple Co. must determine if current revenue, cost, and profit generation can be increased by better utilization of pre-existing field resources and pineapple products.”*

## Methods Used, Recommendation, and Benefits

The results from the analysis show a clear ability to better utilize Sole Pineapple Co. resources. With fiscal year 2017 profits yielding $10,000,000, BC Consulting projects with no additional resources and the exact same field suppliers, fiscal year 2018 profits can yield as high as $55,350,000 (see *Assumptions* for more factors to this profit). This shows a projected $5.5 dollar increase this year for every dollar of Sole Pineapple Co. profits last year; over a 500% change. These benefits can be leveraged by simply restructuring the amounts of acres used from each supplier for particular products. This is shown in *Table 1*.

*Table 1:*

Optimal Acreage per Product.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Amount of Acres for each Product** | **Juice (Gallons)** | **Whole (Pounds)** | **Crushed (Pounds)** | **Sliced (Pounds)** |
|
| **Field 1 (High-Quality)** | 11666.7 | 20000.0 | 4000.0 | 4333.3 |
| **Field 2 (Mid-Quality)** | 13333.3 | 0.0 | 8000.0 | 8666.7 |
| **Field 3 (Low-Quality)** | 35000.0 | 0.0 | 0.0 | 0.0 |

# Assumptions

## Profit Factors

Factors involved in the ability to obtain a consistent profit for fiscal year 2018 as 2017 include: supplier, product, political, and economic fluctuation. Supplier fluctuation may occur when costs by field, shipping costs, maintenance, labor costs, or the ability to obtain new suppliers fluctuate by any degree. Product fluctuation may be any cost involving the products themselves, these charges may occur in the event pineapples or the processes that induce pineapple change. Examples of product flux could include risk in the ability for a product to actually contain the quality the supplier issued or additional products available for creation and purchase to the general public. Political and economic fluctuation can cause more ripple effects than any, including FDA restrictions on pineapples, minimum wage standards changes, cost of living, increase CO2 emissions placing restrictions on food industry standards, competition in the food industry, inflation or any other legal changes that influence the way people can or choose to do commerce in the food industry. Perhaps the greatest assumption of all is that the pineapples produced are sold with a consistent demand in the future; no excess, spoilage, or inability to sell. Any and all of these ripple effects will either directly or indirectly influence the costs, revenues, and profits. All of these varying degrees of risk, change, and influence have been scoped out of the analysis to enable a robust and quantifiable solution on the current problem statement.

# Analysis

## Decision Variables, Sets, and Parameters

The process to solve this problem begins with the *Problem Statement*,

“*Sole Pineapple Co. must determine if current revenue, cost, and profit generation can be increased by better utilization of pre-existing field resources and pineapple products.”*

After decomposing this problem, we were able to acquire more information about the suppliers and products; pre-requisite information is listed in *Table 2* and *Table 3*. Before beginning, a single tableau was constructed to represent all information to be input into the *LINGO* model, a product from *LINDO Systems*. Initial efforts involved *Excel Solver*, a product of *Microsoft Excel*, however this approach was abandoned due to the succinct mathematical representation of the LINGO model.

*Table 2:*

Supplier information, standards, and constraints.

|  |  |  |
| --- | --- | --- |
| Field Information | **Grade** | **Maximum Acres** |
| **Field 1** | 9 | 40000 |
| **Field 2** | 7.5 | 30000 |
| **Field 3** | 7 | 50000 |

*Table 3:*

Product information, standards, and constraints.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Product  Information | **Juice (Gallon)** | **Whole**  **(Pound)** | **Crushed**  **(Pound)** | **Sliced**  **(Pound)** | **Pineapple Per Acre** |
| **Scale** | 0.5 | 1 | 1 | 1 | 1000 |
| **Cost** | 0.2 | 0.05 | 0.3 | 0.25 |  |
| **Revenue** | 1.5 | 1.75 | 1.25 | 1.25 |  |
| **Average Quality** | 7.5 | 9 | 8 | 8 |  |
| **Maximum Production** | 30000000 | 20000000 | 50000000 | |  |
| **Minimum Production** | 10000000 | 10000000 | 10000000 | 10000000 |  |

Acquiring sufficient information for the problem, representing decision variables came next. First, clear understanding of how many fields and how many products at hand must be understood. Alongside fields and products, understanding what must change across any given combination of products and fields became essential. Both of these representations are defined in *Equation 1*, which will be referred to for the remainder of this report.

*Equation 1*:

Decision Variables.

Decision variable is nothing more than the amount of acres we want to assign from to . Throughout the report we will show combinations of these variables and how they will represent total amounts of products, pineapples, and acres. More derivation of the explicit definitions listed in *Equation 1 are* defined in *Equation 2* to address more detailed information.

*Equation 2*:

System Decision Variable Combinations.

After seeing definitions in *Equation 2* to represent total amounts of products produced and fields used, costs and revenues can become defined to represent an objective function which will display how each decision variable interacts with the whole.

## Objective Function

An objective to the problem reflects the current problem statement. We can say that we want to maximize the total amount of profit made from products across all fields of production. This is represented as a two-fold equation with revenue and costs. The total revenue must represent the amount of positive cash flow brought in from each acre given to a product. Contrarily, the total cost must represent the amount of negative cash flow incurred from each acre given to a product. We represent both and their corresponding relationship in *Equation 3*.

*Equation 3*:

Objective Function.

## Constraints

The objective function allows for a robust definition of what exactly we want to solve; the optimal amounts of acreage for each product, however without proper constraints we cannot bound the problem appropriately within Sole demands and guidelines. There are several key pieces we must recognize. First, want to make sure that the total amount of acres we assign from each field does not exceed the total amount current Sole Pineapple Co. supplier’s thresholds (See *Equation 4* and *Decision Variables, Sets, and Parameters*). Second, we know Sole customers have a quality product in mind, so we must keep the minimum quality threshold as the current standard. This can be done by determining the ratio of the weighted sum of grade in pineapples from each field for each product and the total amount of pineapples from each field above or at the standard (See *Equation 5* and *Decision Variables, Sets, and Parameters*). Third, we must be realistic with current allocation thresholds Sole is able to meet, these are explicitly defined in the *Decision Variables, Sets, and Parameters* section as: total pounds crushed and sliced pineapples at 50,000,000, total gallons of juice at 20,000,000, and total whole pineapples at 30,000,000 (See *Equations 6-8*). Finally, we want to model realistic demand and variables (See *Equation 10*). In order to do this, we take the total amount of gallons or pounds of product produced per acre and make sure it is at least the minimum amount for each product (See *Equation 9*).

*Equation 4-10* has a detailed list of each mathematical constraint the problem.

*Equation 4*:

Maximum Acreage Constraints.

*Equation 5*:

Minimum Product Quality Constraints.

*Equation 6*:

Maximum Canned and Sliced Pineapples Constraint.

*Equation 7*:

Maximum Juice Constraint.

*Equation 8*:

Maximum Whole Pineapples Constraint.

*Equation 9*:

Minimum Production Constraints.

*Equation 10*:

Non-negativity Constraints.

Model Output and Interpretation

With each equation properly discussed in previous sections, we can evaluate the model output and interpret its results. To refer back to our *Problem Statement* and *Decision Variables* listed in *Table 1*, we will expand this only slightly in *Table 4* with some basic row and column totals.

Table 4:

Aggregate Optimal Acreage per Product.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Amount of Acres for each Product** | **Juice (Gallons)** | **Whole (Pounds)** | **Crushed (Pounds)** | **Sliced (Pounds)** | **Total** **Acres** |
|
| **Field 1 (High-Quality)** | 11666.7 | 20000.0 | 4000.0 | 4333.3 | 40000.0 |
| **Field 2 (Mid-Quality)** | 13333.3 | 0.0 | 8000.0 | 8666.7 | 30000.0 |
| **Field 3 (Low-Quality)** | 35000.0 | 0.0 | 0.0 | 0.0 | 35000.0 |
| **Total Product** | 60000 | 20000 | 12000 | 13000 |  |

We can see from the model output that 105000 (I.e., sum of total acres) acres are allocated in the optimal solution. We also can see that the field that was desired the least was the low quality field (Only 70% max capacity leveraged), which correlates to the constraint expressing minimum juice quality per gallon must be at least 7.5 (See *Table 3*). This shows that the acres from high and mid quality suppliers are more ideal when used for gallons of juice production which requires the least amount of quality (7.5 v. 9, 8, or 8, See *Table 3*). In closing, to implicitly entertain the maximum benefit from current suppliers without explicitly reproducing the above analysis, utilizing higher quality fields for lower quality products scaled out to the majority of maximum profit. Though this could have been due to the revenues and costs of current products, this likely doesn’t hold chiefly due to gallons of juice not costing the most or yielding the least amount of dollars.

# Conclusion

## Recommendation

Sole Pineapple Co. has several suppliers and several products available at their disposal. Each of these offer unique characteristics and constraints offering rival costs and revenues in junction. BC Consulting recommendation to Sole Pineapple Co. is to produce the following amount of acres per supplier field as show in *Table 1* and *Table 3* in order to maximize profit. This produces over 5 times more profit this year than last.

## Further Research

Further research and analysis must be done to sufficiently inform any of the changes found in *Assumptions* as well as if any number of suppliers, changes in suppliers, change in number of products, or changes in products themselves arise; any changes could substantially impact profit margins without appropriate consultation. Additional work can be done with this analysis to integrate any and all of the following: *Statistics* to illustrate custom hypothesis tests and confidence intervals to give assurance on very specific domain based questions regarding current demands and data, *Stochastic Simulation* to forecast future market demands based on historical data, evaluate the risk via impact and likelihood to understand severity of economic and political change, as well as future company changes, and *Predictive Modeling* to build sustainable models that will show which markets Sole is impacting the most, least, and where the next step for the company would yield the greatest impact.

# Appendix A: References

*Linear Programming* <https://en.wikipedia.org/wiki/Linear_programming>

*Excel Solver* [*https://en.wikipedia.org/wiki/Solver*](https://en.wikipedia.org/wiki/Solver)

*Problem Statement* [*https://en.wikipedia.org/wiki/Problem\_statement*](https://en.wikipedia.org/wiki/Problem_statement)

*LINGO* [*https://www.lindo.com/index.php/products/lingo-and-optimization-modeling*](https://www.lindo.com/index.php/products/lingo-and-optimization-modeling)