A Heuristic Optimization Model for Vegetable Production and Marketing Decisions

Carl R. Dillon and Michael Vassalos

Department of Agricultural Economics

403 C.E. Barnhart Building

University of Kentucky

Lexington, KY 40546-0276

cdillon@uky.edu and vassalosmichael@uky.edu

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INTRODUCTION

- People often use heuristics, or experience-based methods, to make decisions

- Farm managers face the paradox of needing simple decision-making tools while facing inherently complex problems

- The purpose of this study is to provide an innovative research method combining the power of optimization with the practicality of heuristics

- One form of heuristics is a "rule-of-thumb" approach wherein a manager takes different course of actions depending on some criteria or trigger information

- Rather than solve for a strategy to be followed every year, this study will solve for two optimal strategies: one for years above and one below an optimal trigger

OBJECTIVES

- Formulate and briefly describe a mathematical programming model which determines an optimal "rule-of-thumb"

- Demonstrate the use of this model with an empirical example of Kentucky vegetable production and marketing

- Determine the best trigger criteria (e.g., rainfall), optimal trigger level and optimal decisions above and below the trigger level

E-mail: cdillon@uky.edu or vassalosmichael@uky.edu

METHODS

- A mixed integer programming model is formulated with an endogenous trigger variable as well as logical binary variables

- Production and marketing decision variables above and below the trigger are included

- Standard technical constraints as well as Boolean conditional constraints are reflected

- A five acre Kentucky tomato, bell pepper and sweet corn producer with 38 years simulated yield data serves as the empirical example

- A random half of the years are used in optimization (referred to as sample) and the remaining half is for out-of-sample evaluation

- A "perfect" heuristics model is optimized for comparison- no specific trigger criteria is considered thereby allowing any "above" and "below" years

BELL PEPPER MODEL RESULTS

	No Heuristics	Temp	Rain	Perfect Heuristics
Sample Mean Net Returns ($)	82,398 0.0 %	82,766 +0.42%	85,126 +2.58%	85,389 +3.60%
Out-of-Sample Net Returns ($)	82,431 0.0%	83,710 +2.73%	84,130 +3.24%	89,277 +9.56%
Trigger Level	NA	50.6° F	14.5"	NA
Transplant Date	June 26	June 26 & July 10	June 19 & July 10	June 5 & June 26

RESULTS AND DISCUSSION

- Heuristics on the tomatoes selected under the full model made little difference

- Bell pepper results presented herein illustrate potential more than sweet corn

- Using the annual precipitation through April 24th enabled a 2.58% increase in optimal mean net returns or a 3.24% increase for the out-of-sample years

- Greater rain than the 14.5 inch optimal trigger level called for earlier transplanting with less rainfall leading to later transplanting

- As a check, a "perfect" two category heuristics criteria would lead to a 3.60% net returns increase (9.56% out-of-sample)

- The rainfall results achieved 91% of the "perfect" heuristics potential gain (25% for out-of-sample)

CONCLUSIONS

- Sometimes heuristics will provide a substantive improvement but not always

- Knowing the upper bound of potential improvement ("perfect" heuristics) is helpful

- There is seemingly endless potential applications and opportunities for this model but mixed integer programming models are notoriously difficult to solve in practice