AgEcon SEARCH
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search
http://ageconsearch.umn.edu
aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

AGRICULTURAL PLANNING EXPERT: A MODEL OF FARM ENTERPRISE SELECTION

Richard A. Levins and Winston T. Rego

Abstract

Agricultural Planning Expert is a software model designed for advising small-scale farmers in southern Maryland. Choosing farm enterprises is modelled as consisting of four activities: suggesting enterprises for consideration, investigating the suitability of enterprises, allocating resources to suitable enterprises, and controlling the overall direction of an advising session.

Key words: enterprise selection, resource allocation, computer software, farm planning

INTRODUCTION

The enterprise selection problem faced by farmers is complex for several reasons. First, changing economic conditions often force consideration of enterprises with which a farmer is not familiar. Second, producers have multiple preferences, some of which are not clearly articulated. And, third, many enterprises may be technically possible for production on a given farm.

Agricultural Planning Expert (APEX) [1] is a computer model in which these difficulties are directly addressed. First described here is the setting in which the model was developed; description of the software itself follows. A more complete description of the software is provided in Levins *et al.*

A SOUTHERN MARYLAND CASE STUDY

The software approach described in this paper was motivated by the authors' experience with farmers in St. Mary's county. St. Mary's county, in southern Maryland, offers a wide cross section of small-scale farmers, most of whom are making planning decisions concerning crops to plant in place of tobacco. Tobacco, the economic mainstay of the region for over 300 years, has become less profitable, and many farmers must find alternatives if they are to survive.

A series of interviews with farmers within the region was first conducted to determine which persons were sought out for advice in choosing enterprises. All of the farmers interviewed expressed respect for and confidence in the advice provided by the two agents in the St. Mary's County Extension Office. These two agents had many years experience in teaching agriculture to farmers and high school students. They lived and worked in St. Mary's County and were frequent visitors to farms in the county.

In addition to their individual advising of farmers, the agents taught an annual six-night course on farm planning. This course was attended by 18 farmers in the fall of 1987. The course provided an ideal opportunity to observe the agents expressing their methods of advising farmers in a more formal way than that which could be observed in one-on-one situations. We therefore attended the course, made careful notes on the material presented, and posed follow-up questions to the agents to clarify decision strategies being taught. We also scheduled several individual sessions with the agents to discuss matters which did not come up during the classes.

The class observance and individual interviews together became the basis for designing the system described here. Four aspects of the planning environment in which the farmers operated were of particular importance in system design:

(1) Farmers were viewed by the agents as having multiple preferences which were at times only made explicit during an advising session. The agents' method was therefore one of gradually modifying plans in an interactive dialogue rather than one of gathering information, formulating a plan, and recommending that it be pursued.

(2) The agents were considering introducing new enterprises, some of which would not be feasible for

[1] The APEX program requires an IBM-PC, AT, or compatible running MS-DOS 3.0 or higher. One disk drive and 256K RAM are required. A demo program which gives a quick overview of the software is also available. The demo requires 512K.

Richard A. Levins is an Associate Professor and Extension Agricultural Economist and Winston T. Rego is a Research Assistant in the Agricultural and Applied Economics Department, University of Minnesota, St. Paul, Minnesota. The authors wish to thank the Agricultural Research Service, USDA, for funding support, and E. L. Swecker, D. J. Donnelly, and D. C. Caillavet for their contributions in developing in developing the APEX software..

Copyright 1990, Southern Agricultural Economics Association.

Table 1. Example of Enterprise Data from an APEX Data Base

Name:	Corn				
Group:	Grain Crops				
Production unit:	acre				
Production cost:	$105/acre				
Yield:	85 bu./acre				
Price:	$2.40/bu.				
Land use:	Each acre of corn produced requires one acre of land				
Labor requirements:	(hours/acre)				
January:	0	May:	0	September:	5
February:	0	June:	0	October:	0
March:	0	July:	0	November:	0
April:	3	August:	0	December:	0
Requirements:					
Level land?					
Corn planter?					
Combine?					
Corn head for combine?					

some farms. A method was therefore required for verifying that each new enterprise considered for a farm was not only suitable for the region but was suitable for the particular farm.

(3) The program had to run with minimal pre-session information gathering. The agents felt that the farmers they were advising would be discouraged from participating in any planning exercise having large pre-session information gathering requirements.

(4) Only PC class hardware was available in the field. Any software which required more sophisticated hardware could not have been applied.

DATA REQUIREMENTS

APEX has a data base that is maintained separately from the program. This separation allows for easier updating and transfer among producing regions. Much of the supporting data is organized by enterprise. Probable prices, yields, and costs for each enterprise are entered prior to using the system with farmers. The enterprise data also include certain technical information such as which units (bushels, pounds, etc.) are used for production and sale in the chosen enterprise, the amount of land required per unit of the enterprise, and the monthly labor requirements to produce the enterprise.

The data base also contains a hierarchical relationship among the enterprises called "similarity groups," or simply "groups." A group is defined as all enterprises that are considered by the person designing the data base to be similar to each other. For example, broccoli and cabbage might be grouped as "fall vegetables" while hogs and cattle might be grouped as "livestock." The motivation for these groups was that the agents were concerned that, if a new enterprise was to be recommended to a farmer, the new enterprise should be similar to other enterprises with which the farmer has had success. For example, if a plan that includes finishing hogs must be modified, the expert would be more comfortable introducing an enterprise from the livestock group than from the fall vegetables group. The group names and criteria for including enterprises in a group are left entirely up to the person designing the data base.

Another important component of the data base is a listing of requirements necessary for producing each enterprise. This knowledge is represented by production rules, each of which has the general format: IF a condition is not met THEN reject an enterprise from all plans. For example, these rules might be included:

IF there is no irrigation THEN reject tomatoes;

IF there is no roadside market THEN reject sweet corn; and,

IF there is no clay soil THEN reject pond-raised fish. There may be several of these rules for each enterprise in the data base.

A specific example of data for corn is shown in Table 1. While the data requirements for any one enterprise are relatively simple, they are linked into networks of more complexity that allow for efficient search. In the example shown in Figure 1, choosing

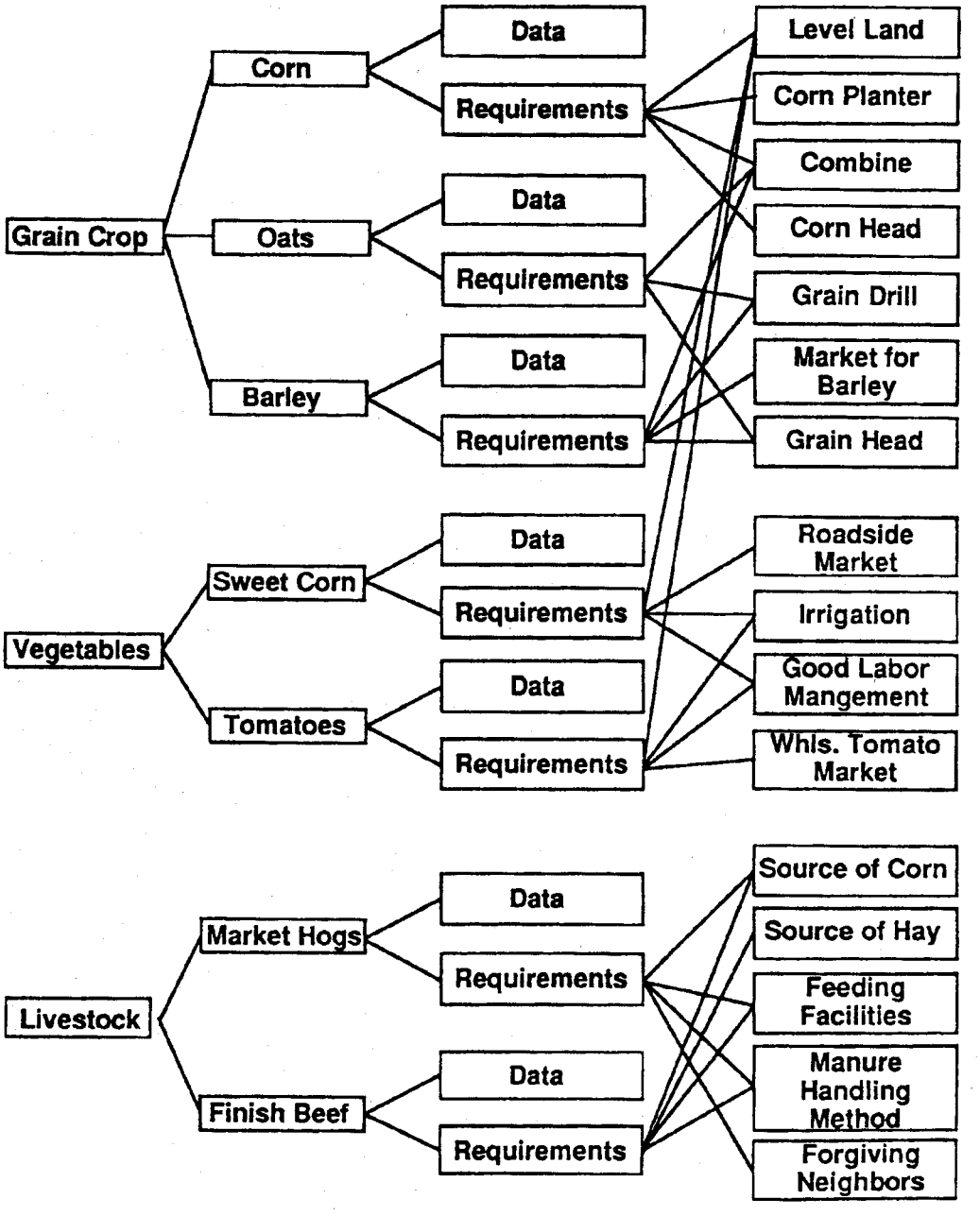

Figure 1. Example Data Structure for the APEX Program

not to consider the "Grain Crop" group would clearly eliminate corn (as well as oats and barley) from further consideration. But corn might also be eliminated by an action in the "vegetables" group--saying "no" to "level land" would eliminate corn, sweet corn, and tomatoes in this example.

An APEX data base can have as many as eight groups with up to eight enterprises in each group. There can be up to 80 enterprise requirements with as many as 15 assigned to any particular enterprise. These assignments need not be unique.

OVERVIEW

We now give an overview of how the data base is applied in a typical advising session. A session begins with entering an initial plan developed by the farmer, labor available to the farm, and land available to the farm. By an "initial plan," we simply mean the enterprises and production levels that, at

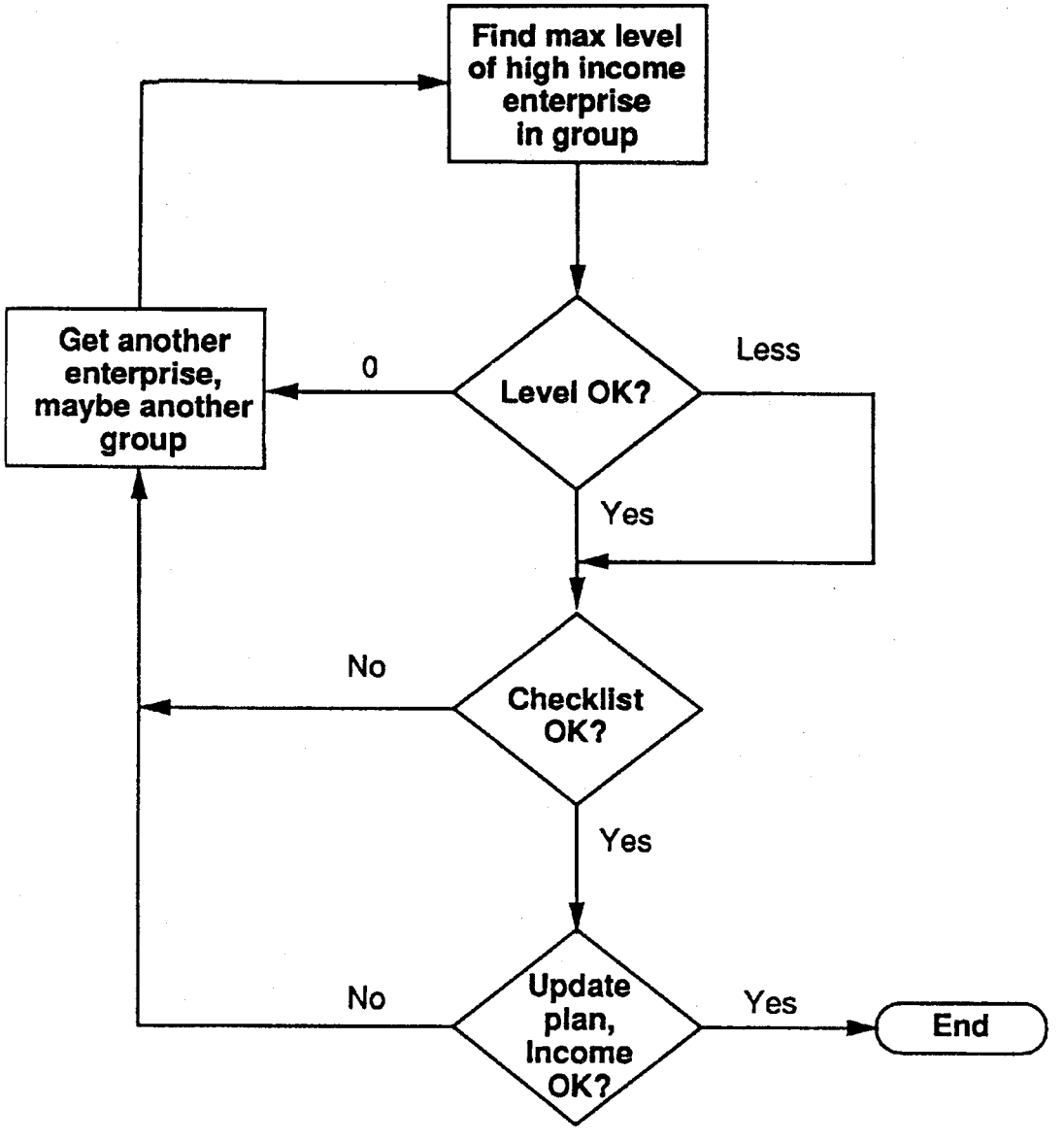

Figure 2. Simplified Flow Diagram for APEX Enterprise Selection Process.

the beginning of the session, the farmer thinks would be appropriate for the farm. These enterprises are typically those currently produced. We found that beginning this way kept future enterprise suggestions in line with the farmer's preferences.

The program logic from this point on is sketched in Figure 2. The enterprise requirements in the data base are applied to each enterprise in the farmer's initial plan. A "checklist" of enterprise requirements is displayed as questions to elicit additional facts concerning the specific farmer, e.g., "Do you have irrigation?". The farmer can respond with "yes," "no," or "maybe." "No" means the enterprise will be rejected on this criterion; "Yes" means that it will not be rejected. "Maybe" is not interpreted as "I don't know." Rather, it is provided to allow a farmer to reason hypothetically in this manner: "I don't have an irrigation system, but let's see what plan I might have if I invested in one."

At times, farmers, especially new farmers, propose plans that will simply not work. If any enterprises in the plan are rejected, the farmer is asked to formulate a new plan that does not include those enterprises. A farm plan that is not rejected by testing its requirements is assessed in terms of its labor and land requirements and income potential. This information is presented to the user and the question of whether the plan is acceptable is asked. If the farmer says that the plan is acceptable, the session is ended. It more often happens that the farmer will reject the

initial plan based on new knowledge of its labor and land requirements or its income. In this case, the initial group of enterprises under consideration includes only those in the farmer's proposed plan. As will be shown, this group can later be expanded in a way specified by the expert and farmer.

The basic logic of the method to modify a plan is similar to that described by Boehlje and Eidman. In general, the enterprise with the highest per-unit return over costs in the group being considered is determined. The farmer is first given a chance to review and/or edit price, yield, and cost information for the enterprise. The program then determines how much of the enterprise can be grown with available resources. The farmer is asked if this level of production is acceptable. The farmer may say the suggested level is acceptable, that a lower level is acceptable, or that the enterprise is not acceptable. The reasons the farmer is asked whether the suggested level of a new enterprise is acceptable are two-fold. First, an enterprise may be unacceptable for reasons not reflected in the production rules. A farmer may simply not like an enterprise or there may be other technical reasons to reject the enterprise. Second, it is possible that a commodity can be produced at high levels but can only be marketed at lower levels.

If the enterprise is not acceptable to the farmer, that enterprise is rejected from further consideration during the session and the next highest income enterprise in the group is considered. If some positive level of the enterprise is accepted (either the suggested level or some lower level), the production rules for that enterprise are checked with the suitability module. If the production rules do not eliminate the enterprise from consideration, it is added to the current plan at the accepted level. The farmer is then asked if the new plan is acceptable. If so, the procedure ends. If not, the resource levels available are updated to reflect what has been used by other enterprises in the plan and the procedure moves on with a trial of the next highest income enterprise in the group for addition to the plan.

It is always possible that the farmer will reject a plan and there will be no further improvements that can be made with crops in the current group. In such cases, the farmer is asked which of the remaining groups ("vegetables," "livestock," etc.) to add to the current group. All enterprises within that group name are added to the current group being considered, the last plan considered is reinitialized to no enterprises, and the process of introducing maximum amounts of most profitable enterprises continues.

Grouping enterprises and letting the farmer control the introduction of new crops is one way to minimize the amount of change which must be done to a plan to keep it acceptable. Therefore, potentially higher income will likely be the reason new plans are sought. But finding plans with higher income levels requires moving into less familiar groups, so the user is always asked if the income of each suggested plan is acceptable. In this way, the relationship between income requirements and other preferences is maintained. What may be an acceptable income level for one plan may not be acceptable for another because of other preferences and circumstances.

DISCUSSION

The APEX program that uses the data base in an advising session was programmed as having four distinct components: (1) enterprise suggestion, (2) enterprise suitability, (3) resource allocation, and (4) overall program control. These components are at least implicit in every enterprise selection problem. Each has been condidered explicitly and separately as useful in addressing the southern Maryland problem. In this section these components are discussed for the benefit of readers interested in designing enterprise selection decision aids.

Enterprise suggestion assumes a list of enterprises that are suited for at least some farms in a particular region. The purpose of the suggestion module is to propose enterprises from the main list that might be well suited to a particular farming operation. A key word here is "might." At the time an enterprise is suggested, there is probably not enough information available to determine fully its suitability because of the farmer's reluctance to make a thorough test of the suitablilty of all enterprises for his or her particular situation at the beginning of a session. Thus, enterprise suitabitity is tested only after an enterprise is suggested for consideration.

Many schemes might be proposed for suggesting enterprises. Suggesting enterprises solely on their profit potential is an obvious scheme. In southern Maryland, the agents assumed that even though farmers had multiple preferences that were at times poorly articulated, these preferences were implicitly reflected in how the farm was currently being operated. The grouping concept helped steer suggestions toward familiar enterprises whenever possible.

Once an enterprise is suggested, it must be tested to make sure it is suitable for a particular farming operation. The suitability module solicits additional information about a particular farm to make sure that the suggestion module, which always relies on more limited information, has not proposed an unworkable enterprise. For example, knowing that a farmer feeds hogs may cause the suggestor to propose consideration of feeding beef cattle. Use of the

suitability module may reveal that the farmer has no suitable hay supply and would therefore be ill-advised to consider cattle. Determining enterprise suitability is well-adapted to modelling with rule-based methods. Statements such as "If you do not have irrigation, then tomatoes cannot be grown successfully" naturally suggest rule-based methods.

Resource allocation is most often done with mathematical programming methods. While mathematical optimizing schemes are not inconsistent with the framework proposed here, the southern Maryland system uses a simpler method of resource allocation that was developed through the agents' experience. One reason for the choice was, as Romero *et al.* observed, that "multiple objectives are the rule rather than the exception in agricultural planning" (p. 85). The compromise programming approach they suggest, however, requires that conflicting preferences be identified prior to, rather than during, an optimization run. A second method, nearly optimal linear programming, avoids this difficulty by determining several strategies from which a farmer might choose. The computational requirements of this method were, however, found by Burton *et al*, to be excessive for all but the smallest problems.

The program control module provides an overall procedure for using the suggestion, suitability, and allocation modules. The control feature of APEX must contain conditions for calling up each of the other three modules and conditions for terminating an advising session, *i.e.*, recognizing a satisfactory farm plan. Every farm planning session has at least an implicit control mechanism; making this mehanism explicit can have some important advantages.

Consider, for example, how a typical linear programming exercise might begin by simultaneously suggesting all enterprises on the list of possible enterprises based on the premise that the farmer will accept any plan that maximizes profits. Program users would then check the suitability of all enterprises and allocate resources to the enterprises not rejected. Alternatively, one might begin in the same way but allocate resources to all enterprises on the complete list. The suitability of only non-zero enterprises could be checked. If any of these enterprises failed the test, they would be eliminated and the allocaiton would be repeated.

What if the farmer is not indifferent among all enterprises on the list? This is clearly the case when multiple preferences are present and profit maximization cannot be the only guide. Or, more pragmatically, what if a farmer is not willing or able to determine the feasibility of every enterprise on a list before being shown any plan? In cases such as these, which were found to be the rule rather than the exception in southern Maryland, it becomes critical to have an efficient control procedure to search the list of enterprises for suitable plans.

CLOSING COMMENT

Experience in southern Maryland indicates that software designed within the framework suggested here is technically possible, can be delivered on PC-class hardware, and has a high level of user acceptance. Those interested in exploring the use of APEX in other settings are encouraged to contact the authors for a copy of the software, manual, and demo program. There is no charge for the software.

REFERENCES

Boehlje, M.D. and V.R. Eidman. *Farm Management*. New York: John Wiley, 1984.

Burton, R.O., Jr., J.S. Gidley, B.S. Baker and K.J. Reda-Wilson. "Nearly Optimal Linear Programming Solutions: Some Conceptual Issues and a Farm Management Application." *Am. J. Agr. Econ.*, 69(4)(1987):813-818.

Levins, R.A., W. Rego, D. Donnelly, and Y.C. Lu. *Agricultural Planning Expert User's Manual*. Dept. Agr. Econ., University of Maryland, College Park, 1989.

Romero, C., F. Amador, and A. Barco. "Multiple Objectives in Agricultural Planning: A Compromise Programming Application." *Am. J. Agr. Econ.*, 69(1)(1987):78-86.