Economic Feasibility of Investment in Agro-Based Industries-Using AIES

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ABSTRACT

The domain considered comprises proposed research work applied to investment in agro-based industrial sector using Expert System's techniques. The knowledge-based system, called AIES, enables users to determine the proper feasibility assessment for installation of agro-industries, which encompasses relationships among the many factors of the decision-making process across the domains of economic, financial, legal, technical, marketing and environmental feasibilities. The feasibility assessment of an agro-based industry is not a "one time event," but rather a series of evaluations at each stage of the financing process. Such a step-by-step process (the "stage-gate" method) will increase the probability of making the right decisions. In the present study only economic feasibility of agro-based industries is being considered in detail. In view of the existing opportunities and challenges faced by the economies of Asian and Pacific regions, installation of agro-based industries seems to be the best alternative for faster economic growth and rural poverty alleviation. AIES (Agro-based Industrial Expert System) as a precautionary measure have the ability to assess not only numerical data but also the qualitative facts. This system is not limited only to agro-based industries but may be extended to any type of industry and to any long-term investment problems. Human behaviors and natural phenomena are suggested to be included as qualitative facts in economic evaluation of investment in the problem domain as a further research.

Key Words: AIES; Expert System's Technology; Agro-based industries; ESTA; Economic Feasibility; Capital-budgeting Techniques; Modeling; Certainty Factors

INTRODUCTION

The present study depicts the application of Expert System's (ES) technology in long-term business environment. This expert system uses production-rules as a knowledge representation methodology and uses ESTA (Expert System Shell for Text Animation) as a development tool. The expert system's model enchains economic, financial, legal, technical, marketing, and environmental feasibilities into only three feasibilities, i.e. economical, technical, and general feasibility. But this paper limits the scope of the study only to economic feasibility of the ES model.

Agro products of one industry become raw materials for another industry and this process continues for many rounds. Application of innovated (i.e. expert system) technology can dramatically cut the cost of production.

Assignments of weights to the evaluation techniques, as well as interpreting and analyses the results by making the investment evaluation an intelligent, logical, impressive, with the ability of explaining the decision-making process at each and every moment thereby improving the user's confidence in the Expert System's consultation. Certainty Factors' combination formula was used in the expert system model to assess the project feasibility.

The program may be implemented in financial, educational institutions, and in about all industries, especially in agro-based industries.

Objectives. The basic objective of the paper is to explain the Economic Feasibility of agro-based industries using AIES and to see how this ES consolidate the knowledge of multiple human experts and gives a system more breadth that a single person is likely to achieve. The summarized objectives of the present research work are given as under:

1. To introduce the application of Expert System's technology in agro-based industrial sector.
2. To elicit, extract, and consolidate the knowledge of experts of a variety of disciplines heretofore unfamiliar with one another's fields, in an intellectual counseling system.
3. To simplify, expand and clarify the existing methods of the process of information retrieval along with the investment evaluation in the field of agro-based industries.
4. To present the Economic Feasibility of the problem at hand in different types of models.
5. To integrate and prioritize numerous economic evaluations' techniques into an ES model.
6. To stimulate investors providing ES reasoning capabilities of answering questions like, "why" and "explain", and getting their confidence.

Previous work. Expert systems replicate decision-making process and describe the way an expert would approach the

problem domain, e.g., medical consultant, geologist, financial advisor etc.

Expert choice is helpful in quantifying subjective judgments used in decision-making. It uses the analytic hierarchy process (AHP) developed by Saaty, which has been applied successfully in numerous situations, ranging from selecting an appropriate expert system shell to choosing the best house to buy.

According to Ross *et al.* (1994) six following criteria have been used to evaluate the proposed investments: 1) Net present value (NPV) 2) Payback period (PP) (3) Discounted payback period (DPP) 4) Accounting rate of return (ARR) 5) Internal rate of return (IRR) 6) Present value index (PVI).

The five methods of evaluating investment proposals as proposed by Block *et al.* (2000) are: AAR 2) PP 3) IRR

Table I. The result of one such survey

Method	% Respondents using*	% Ranking most important
Pay back (non-discounted)	51	10**
IRR	47	23
NPV	44	17
ARR (Average investment)	31	15^
ARR (initial investment)	30	
Payback (discounted)	18	
Other (e.g. PVI)	10	2
Business judgment		13
No response		20
Total		100

* Note that the aggregate % for this column totals more than 100% as most respondents use more than one technique.

** The ranking included payback and payback (discounted).

^ This ranking included ARR based on average and initial investment.

4) NPV 5) Profitability Index (PI).

There have been a number of surveys conducted asking large firms what types of investment criteria they actually use. The result of these surveys may be seen in Table I (Ross *et al.*, 1994).

Capital budget decision is the decision as to which real assets the firm should acquire in the future. Broadly speaking, a capital budget would help the management (Gopalakrishna, 1985).

(i) In the formulation of a separate plan

(ii) In coordinating the activities of the various departments of the firm

(iii) In taking into account variations and deviations between what is planned and what is achieved. In this way, it helps to achieve control and flexibility

(iv) In optimizing the resources of a firm. Capital budgeting is essentially and necessarily a process of planning, which enables a company to put its resources to the best or optimal use

(v) To identify anomalies and take corrective action. A capital budget should serve as an index of the performance of a company during a given time. In this sense, it is a tool, which measures the management's performance on a permanent basis, and brings to the surface the anomalies in its performance.

Approach. The primary contribution of this study is the development and application of a general methodology for modeling and representing an expert's problem-solving knowledge that supports ontology import and development, an intelligent problem-solving agent for agro-based industrial sector. The stages to solve the problem at hand may be seen in the following paragraphs.

Knowledge was acquired through the sources like: Meeting with AI experts, industrialists, top, middle, and lower level managers; Literature review, i.e. government census reports, pre-feasibility reports, books, research journals and technical articles etc.; Pilot survey of industries and product markets using the questionnaire through direct observations and interviews; Checking world wide webs.

1. System's modeling. System's designing approach is based upon *Top-down* designing, and composes the following models.

1.1. Symbolic Modeling. Some of the computational formulae have been shown symbolically as below:

1.1.1. Net present value (NPV). NPV calculates the net present value of an investment by using a discount rate and a series of future payments (negative values) and income (positive values).

Discount rate (r) can be found out from the relationship (Elsaesser, 1996),

$$FV_t = PV*(1+r)^t \qquad (1)$$

Where PV represents the present value of the investment, FV is the future value of the investment after the time period t.

Similarly Dominick Salvatore (1998) defined:

$$PV = \pi_1/(1+r)^1 + \pi_2/(1+r)^2 + \pi_3/(1+r)^3 + ... + \pi_n/(1+r)^n = \sum_{t=1}^{n} \frac{\pi_t}{(1+r)^t} \quad (2)$$

Where, PV represents all expected future profits, π_1, π_2, π_n represent the expected profits in each of the n years considered.

$$NPV = \sum_{t=1}^{n} \frac{R_t}{(1+k)^t} - C_0 \qquad (3)$$

Where, NPV represents net present value, R_t refers to the net cash flow or return from the investment project in each of the n time periods considered, k is the risk-adjusted discount rate, Σ refers to the sum of the present discounted value of all the future net cash flows from the investment, and C_0 is the initial cost of the investment.

1.1.2. Internal rate of return (IRR). The internal rate of return on a project is the discount rate that equates the present value of the net cash flow from the project to the initial cost of the project (Salvatore, 1998). The IRR may be obtained by solving the following equation, for k*.

$$C_0 = \sum_{t=1}^{n} \frac{R_t}{(1+k*)^t} \qquad (4)$$

While the IRR=k* on a project can be obtained by trial and error method.

1.1.3. Payback period (PP). It computes the amount of time required to recoup the initial investment and a cutoff period is established. Payback time (PB) = Amount invested/Amount of return per year (Dean, 1996).

PP=Investment/Cash benefits per year (5)

In case of replacement of new equipments, i.e., including salvage value, the formula becomes as:

PP = Net Investment / Saving (6)

1.1.4. Discounted payback period (DPP). Formula for Discounted Payback Period (Elsaesser, 1996):

YR [I] = YR [I] - DCF [I] (7-a)
REM =YR [I]/DCF [I] (7-b)
Tyrs = K + REM (7-c)

Where YR [I] represents Yearly money remaining. First time it is equated to the Initial Investment. DCF [I] shows the Discounted Cash flow for different years. The REM is the time portion covered in the current and previous years. While, Tyrs is the total number of years, i.e. the period in which the whole investment will be recovered. K represents the period previously covered.

1.1.5. Average accounting return (AAR). The ARR may be computed as Dean (1996):

ARR = ANI /AI (8)

The average rate of return may also be defined as: Some measure of accounting profit/some measure of accounting value. ANI represents average net income after taxes, and AI represents average investment over the life of the project.

1.1.6. Present value index (PVI). Present Value Index may be found by the formula (Elsaesser, 1996):

PVI = PV/II (9)

Where, PVI is the present value index, PV represents present value of the future cash flows, and II represents initial investment for the period.

1.2. Tree diagrams. The whole structure of the ES model was represented as tree structures. All decision-making parameters were represented in tree diagrams that depict the relationship among these parameters. The top element is divided into its sub-elements as shown in Fig. 1. Project feasibility was divided into its sub elements as economic, technical, and general feasibilities.

1.3. Dependency diagrams

Dependency diagrams (Fig. 2) adopted in "An Expert System for Feasibility Assessment of Product Development represent the overall structure of the Knowledge Base" (Akoka *et al.*, 1994).

These diagrams show how the parameters of the *Expert System's Model* are interrelated among each other. *Rectangles* depict variable names, *triangles* represent dialog with the ES and *ellipse* are used for connections and rules numbers. In the picture rules show all the computations and conditions used in the knowledge base (KB); rules appearing below the rectangle are rules that are used to evaluate the variable i.e., the variable appears in the conclusion of these rules (Khan, 2004).

2. Knowledge representation. AIES uses production rules to represent the knowledge base through: sections, parameters, and title. AIES uses ESTA that facilitates both the forward chaining strategy and backward reasoning approach. Sections are used for forward chaining (data-driven) strategy. While, parameters use backward chaining (objective-driven) process to arrive at a result (Fig. 3).

3. Economic feasibility evaluation. The Expert System's model is based upon 57 *decision-making parameters* with assignment of priorities based upon judgments and their importance. Economic Feasibility is composed of 37 parameters, which may be evaluated through ES model as below:

$$F_E = \sum_{n=1}^{m} P_n * W_n \qquad (10)$$

Where, F_E represents Economic Feasibility (m=37), P_n= value of parameters, and W_n = Weight of the relative parameter. The Value of parameters, either 1 or 0 will be the result of associated parameter. The outcomes of the leaf nodes are summed up using the above equation to find outcomes of the three mentioned feasibilities. At last, we have to adopt either Equation (11) or (12).

$F_P = (F_E) + (F_T) + (F_G)$ (11)

F_P represents project feasibility

The expert system usually reaches goal state based on several rules in chain. If each rule or conclusion has a Certainty Factor (CF), the outcome will have a composite CF. Several methods have been devised for combining certainty factors. One of these is indicated here (Townsend, 1988).
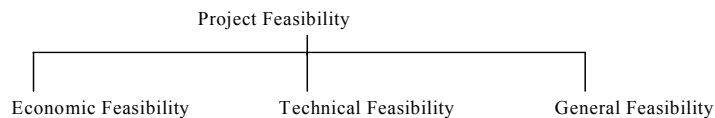
$CF(C) = CF(A)+CF(B) - CF(A)*CF(B)$ (12)

The CF of the conclusion or outcome (C) depends upon the CFs of rules A and B. We adopted Equation (12) as the ES shell has a built-in function of this formula.
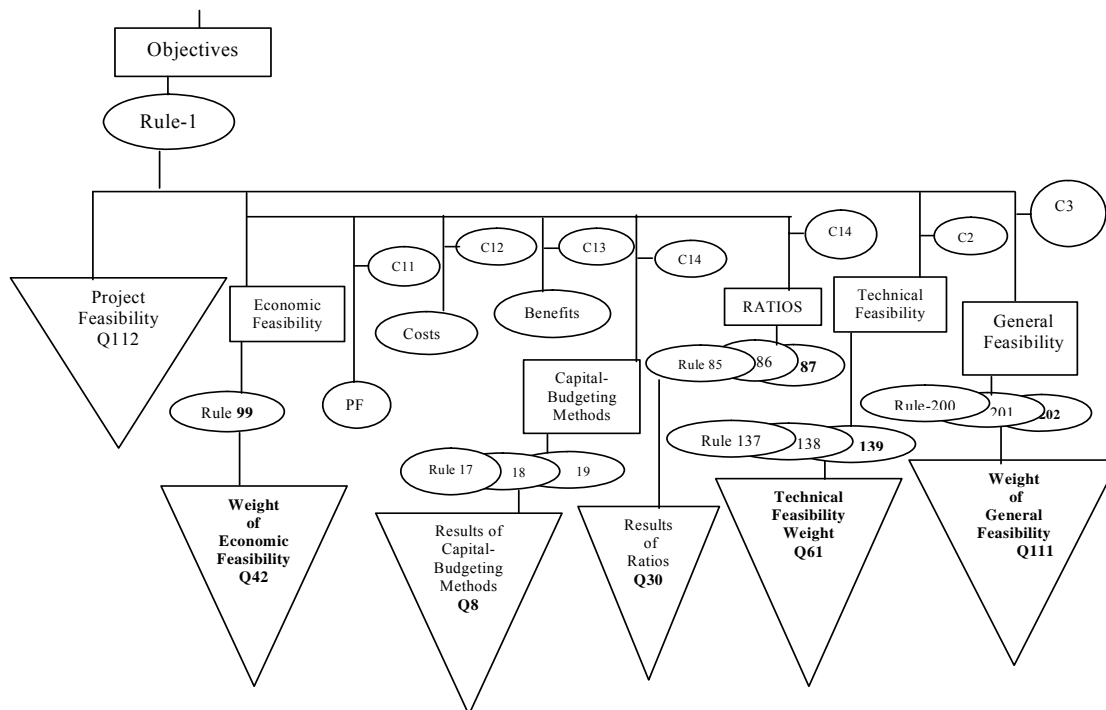
Maximum allocated weights to parameters of Economic Feasibility in the ES model may be seen in the Fig. 4. These priorities are assigned according to validity of conditions of each parameter. See conditions and rule-base structure for detail in my PhD dissertation.

4. How Does Expert System Work? Agro-based Industrial Expert System (AIES) was developed using ESTA as a development platform. The knowledge-based system is based upon both the analysis by inductive reasoning (i.e. prediction) as well as synthesis by deductive reasoning with planning (investment counseling) by type. Sections represent the static knowledge, parameters represent dynamic knowledge and titles represent picture database. Any changes are possible at any moment and the program may be continued from the point where stopped, by selecting "Continue Consultation" in the Consult menu.
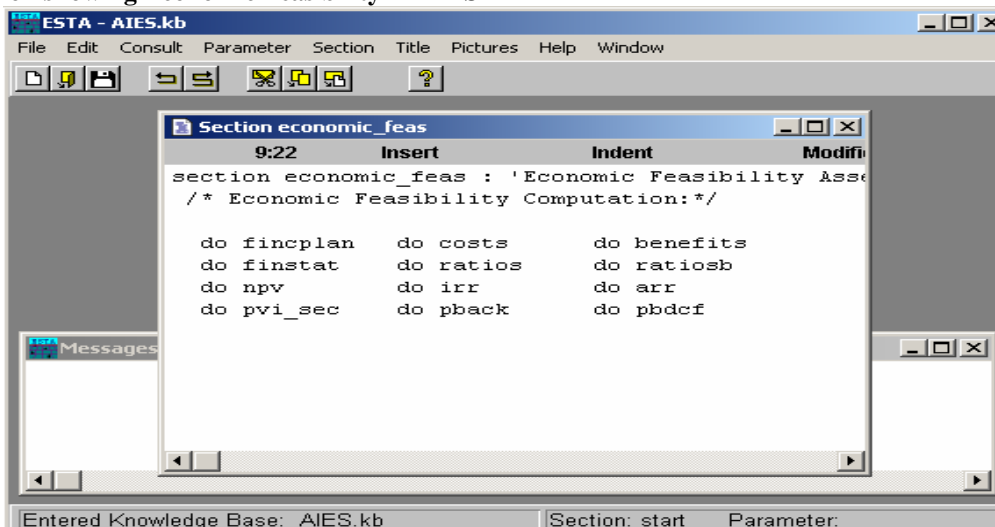
Fig. 1. Tree diagram of Project feasibility in ES model

Project Feasibility

Economic Feasibility   Technical Feasibility   General Feasibility

Fig 2. Dependency Diagram of the ES Model

Objectives

Rule-1

C3

C14   C2

C12   C13   C14

C11

Project
Feasibility
Q112

Economic
Feasibility

Costs

Benefits

RATIOS

Technical
Feasibility

General
Feasibility

Rule 85   86   **87**

Rule **99**   PF

Capital-
Budgeting
Methods

Rule 137   138   **139**

Rule-200   201   202

Rule 17   18   19

**Weight
of
Economic
Feasibility
Q42**

Results of
Capital-
Budgeting
Methods
Q8

Results
of
Ratios
Q30

**Technical
Feasibility
Weight
Q61**

**Weight
of
General
Feasibility
Q111**

Fig. 3. Section showing Economic Feasibility in AIES

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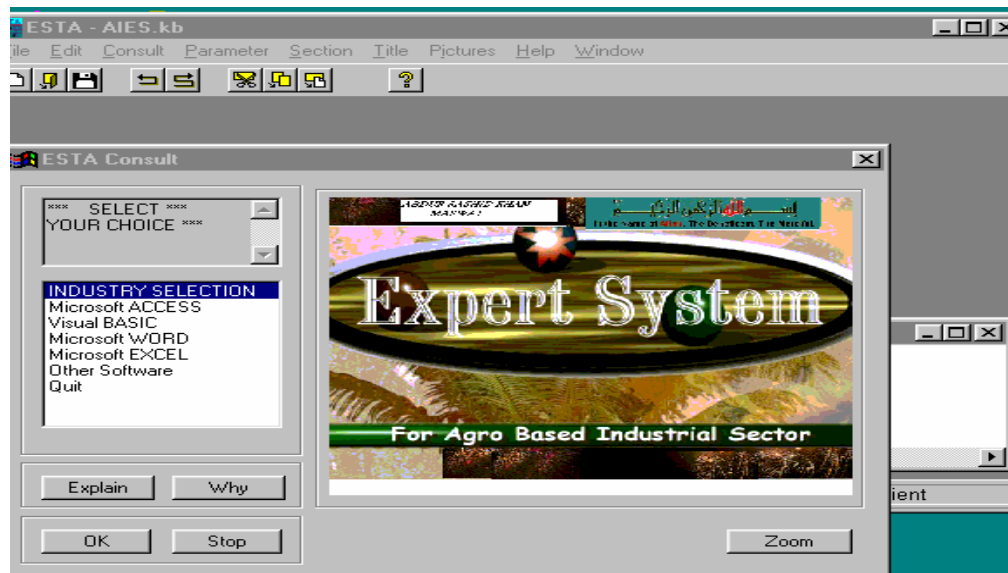
A framework exists in the ES to integrate MS-Office, Pascal, and other application software with it. Mostly the formulae were tested for the values taken from the quoted books, as referenced in reports. Fig. 5 shows the starting session of the AIES.

Fig. 4. Max allocated weights of Economic Feasibility in the ES model
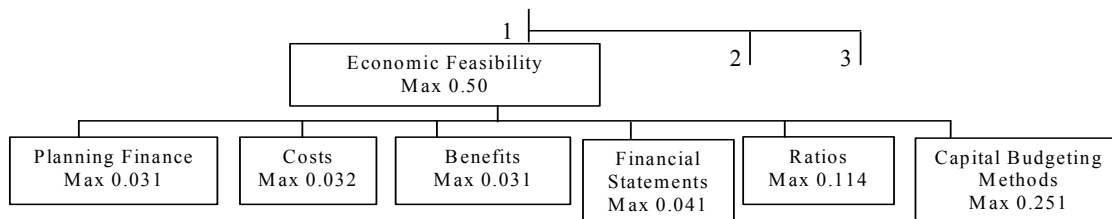
Fig. 5. Starting session of the AIES

RESULTS AND DISCUSSION

Economic feasibility is the most important part of the ES model; a max weight of 0.50 was allocated in the ES model and is based upon 18 reports. The results of these reports justify the project economically, and financially feasible or infeasible. The outputs of the capital-budgeting methods, and ratios are the most important reports among them. After selection of the specific industry in the AIES, the process of evaluation starts by selecting any one of the options (Fig. 6). Only results of capital-budgeting techniques is shown here, remaining results may be seen in my PhD dissertation or executing the AIES. These reports show the clear picture of the problem domain, whether, to invest the capital in a project, reject the project or rationing projects.

Report-1 (Anonymous, 2000):

CASHFLOWS

Years	1st	2nd	3rd	4th	5th
EBDIT	432501	582732	734484	837686	843784
EBIT	376119	526350	678102	781304	787402
EBT	376119	526350	678102	781304	787402
EAT	203162	293316	384382	446313	449973
Cash flows	259544	349698	440764	502695	506355

EBDIT: Earning Before Depreciation, Interest, & Taxes; EBIT: Earning Before Interest, & Taxes; EBT: Earning Before Taxes; EAT: Earning After Taxes

Report-2 (Anonymous, 2000):

NPV

Years	1st	2nd	3rd	4th	5th
Cash flows	259544	349698	440764	502695	506355
Pr. Values	238113.7615	294333.8103	340350.6794	356121.8115	329096.0071

Initial Investment = 635202; Total Present Value = 1558016.07; Net Present Value = 922814.0697; NPV Rounded = 922814

Report-3 (Anonymous, 2000):

Present Value Index

Currency	Rupees
P. value of the future cash flows	= 1558016.07
Initial investment for the period	= 635202
Present value index	= 2.452788357

Report-4 (Gallagher & Andrew, 1997):

Trial and Error Method

Cash flow(1): 2000.00   Discounted Return For Year [1] = 1904.76
Cash flow(2): 3000.00   Discounted Return For Year [2] = 2721.09
Cash flow(3): 500.00   Discounted Return For Year [3] = 431.92
Cash flow (4):   0.00   Discounted Return For Year [4] =   0.00
Discounted Return For 4 years   = 5057.7691
Initial Investment   = 5000.00
Net Present Value (NPV)   =57.769
Internal Rate of Return (IRR)   = 5.000 %
Cash flow(1): 2000.00   Discounted Return For Year [1] = 1886.79
Cash flow(2): 3000.00   Discounted Return For Year [2] = 2669.99
Cash flow(3): 500.00   Discounted Return For Year [3] = 419.81
Cash flow(4):   0.00   Discounted Return For Year [4] =   0.00
Discounted Return for four years   = 4976.5914
Initial Investment   = 5000.00

Net Present Value (NPV)   = -23.409
Internal Rate of Return (IRR)   = 6.000 %
Cash flow(1): 2000.00   Discounted Return For Year [1] = 1892.15
Cash flow(2): 3000.00   Discounted Return For Year [2] = 2685.17
Cash flow(3): 500.00   Discounted Return For Year [3] = 423.39
Cash flow(4): 0.00   Discounted Return For Year [4] = 0.00
Discounted Return for four years = 5000.7088
Initial Investment   = 5000.00
Net Present Value (NPV)   = 0.709
Internal Rate of Return (IRR)   = 5.700 %

Report-5 (Anonymous, 2000):

Accounting Rate of Return
Currency   Rupees
Total Net Income (EAT)   = 355429.2
Average Book Value   = 317601
Initial Investment   = 635202
Average Rate of Return (ARR) = 111.9106048%

Report-6 (Dean, 1996):

Payback Period Computation
Currency   Rupees
Amount invested in the project = 50000
Annual returns   = 10000
Payback time   = 5 years

Report-7 (Anonymous, 2000):

Discounted Payback Period
Initial Investment   = 635202.00

Discounted Cash flow	Remaining Amount
237395.04	397806.96
292569.66	105237.30
337284.97	-232047.67

Fraction = -0.69
Total Years = 2.31

After complete evaluation AIES gives the following

result, if the project is economically, technically and generally feasible. At any moment the ES may give answers to the questions like, "why" and "explain".

## CONCLUSIONS, LIMITATIONS AND FURTHER RESEARCH

The AIES elicits, extracts, and consolidates the knowledge of experts of a variety of disciplines, like, Managerial and Agricultural Economics, Industrial Management, Statistics, and Information Technology, heretofore unfamiliar with one another's fields. The Economic Feasibility was modeled in various forms, e.g. symbolic modeling, tree diagrams, dependency diagrams, and ruled based system's representation.

The AIES integrates 57 decision-making factors into economical, technical, and general feasibilities in the proposed Expert System's Model, along with priority assignments to these parameters. Certainty Factors' addition formula was adopted to evaluate the ES model and to know the uncertainty involved in the project.

AIES clarifies and expands existing methods of investment evaluation and introduces additional topics, such as risk analyses, and symbolic evaluation of qualitative and uncertain facts, to gives users a chance to assess and understand the system's reasoning ability and complexities involved in assessment of feasibility for capital investment, thereby improving the user's confidence in the Expert
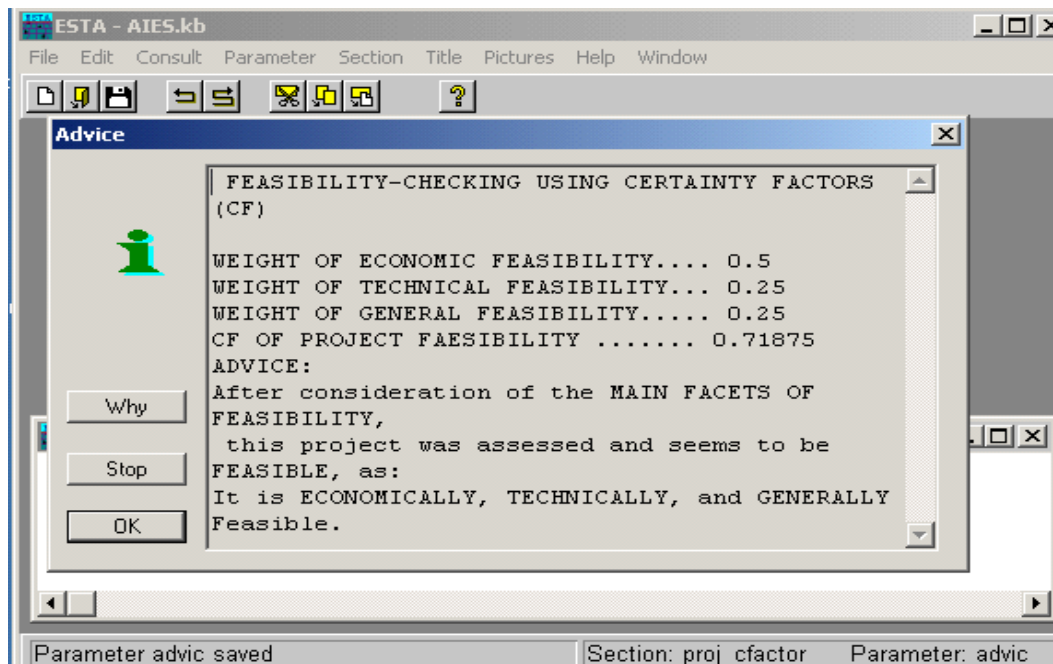
Fig. 6. Option to select feasibility
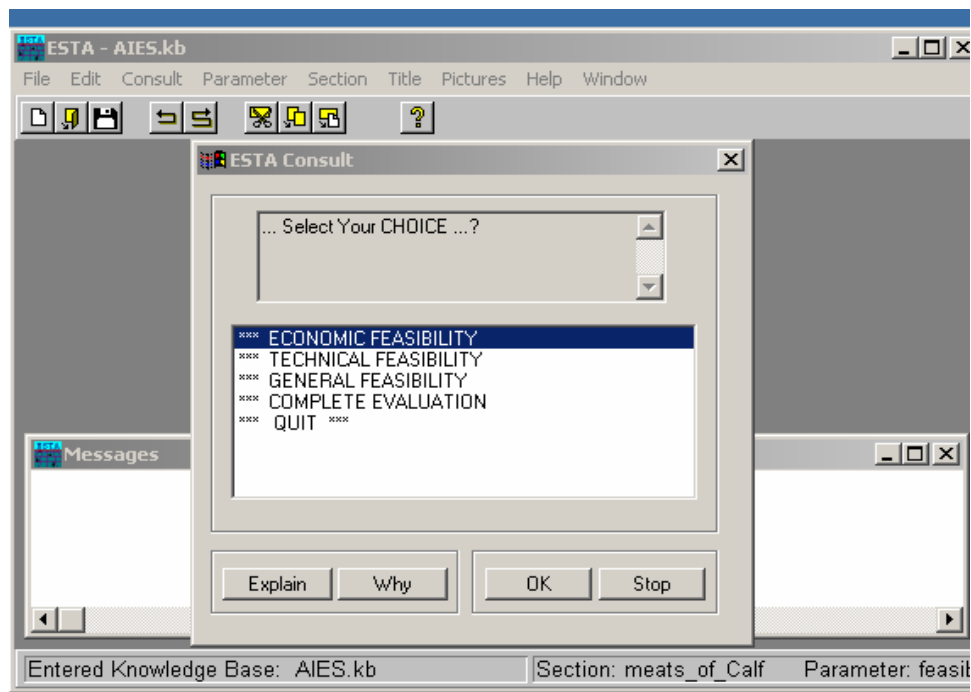
Fig. 7. Final advice of the ES consultation

System's consultation (Fig. 7).

Development of Agro-based industries will stimulate industrial development and assisting the promotion of business. Which in turn will decrease corruption, poverty, inflation, unemployment, and trade deficits of the country. Will assist the development of small, medium, and large-scale industries; will bring about socio-economic improvements for the population of the area; will change the rural structure and bring prosperity in the area.

Due to a shortage of time many logico-Mathematical models could not be included in the proposed expert system's model, e.g. Transportation model for location selection of industries, Linear programming model for allocation of scarce resources, CPM and PERT for scheduling and project evaluation.

Investment evaluation criteria should give due attention to human behaviors as well as to natural phenomena as qualitative evaluations criteria.

The proposed expert system has vast capabilities of dynamic changes and must be advanced incrementally in the span of its life. The above-mentioned logico-Mathematical models may be included in the ES model to enhance its capabilities.

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