OPTIMAL IDENTIFICATION AND COMPOSITION OF INVESTMENT PROJECTS IN AGRICULTURE

Nikolai M. Svetlov

The objective of the paper is to discuss an agricultural application of a method that enhances identification and preparation of investment projects. This method allows to: a) achieve maximal synergism and reasonable resource sharing, b) easily prepare a set of projects for different funding opportunities, c) enhance investment opportunities in agriculture. It is especially important in the case of Russia where the problem of efficient agrarian projects urgently requires a solution.

The general project cycle concentrates on project selection. In the case of Russian agriculture most of the projects are usually rejected. Hence project identification and preparation processes need to be improved. The theoretical framework of this study is based on *Baum*, 1978 (the project cycle and the role of its stages), *Fonotov*, 1974 (approaches to objectives analysis), *Gataulin and Svetlov*, 1998 (synergism as a key to project composition), *Gavrilets*, 1974 (mathematical approaches to project identification).

There are commonly acknowledged approaches to the project identification and preparation (see *Gataulin and Svetlov* (1998) for details):

problems analysis (what are the problems? what are the key problems? could they be solved within the framework of a single project?);

objectives analysis (inside a project: what are the objectives? which of them deserve efforts?).

The approaches depend on expert knowledge and therefore may gain due to a special formalism. An approach based on the following problem statement is suggested:

Given

- the quantities of resources required for each goal;
- opportunities to share resources between goals and to upgrade inferior resource with superior one;
- effects of goals and costs of resources;
- available financing;
- incompatible goals;

Find

the set of goals that maximises the project worth.

The problem is an integer programming (IP) problem:

Objective function: $$\max \sum_{d\in D} c_d x_d - \sum_{d\in D}\sum_{r\in R_d}\left(c_r - \sum_{s\in R_r} c_s\right)x_r;$$

Budget constraint: $$\sum_{d\in D}\sum_{r\in R_d}\left(c_r - \sum_{s\in R_r} c_s\right)x_r \leqslant B;$$

Amount of resources: $$\alpha_{dr} x_d \leqslant x_r,\ d\in D, r\in R_d;$$

Incompatibles: $$\sum_{d\in D_i} x_d \leqslant 1, i\in I;$$

Inferiority: $$x_r \leqslant x_s, r\in R, s\in R_r;$$

Dummy variables: $$x_d \in \{0;1\},\ d\in D.$$

Sets:

D – goals;

R_d – resources required to attain the goal $d\in D$; $R = \bigcup_{d\in D} R_d$;

R_r – resources inferior to resource $r\in R$;

I –incompatible sets;

D_i – incompatible goals in the set $i\in I$ ($D_i \subset D$).

Variables:

x_d – goal $d\in D$ dummy;

x_r, x_s – amount of resource r, $s\in R_d$, $d\in D$.

Constants:

B – available funds;

c_d – benefit of goal d;

c_r, c_s – cost of resource r (s);

α_{dr} – quantity of resource r required to attain the goal d.

In both the objective function and the budget constraint, costs are calculated in a complicated manner to allow for the proper sharing of superior resources. Each superior resource is represented in a separable form using a set of variables. Introducing a superior resource automatically introduces all the opportunities related to inferior resources. For that, the set of constraints *inferiority* is provided. Each constraint *amount of resources* calculates the minimal quantity of a shareable resource required for a given goal. *Incompatibles* constraints guarantee that only one goal of each set of incompatibles can be introduced in the composed project. The Boolean constraints *dummy variables* ensure that the goal is either introduced to the project (1) or not (0).

With regard to the project identification, the goals are the problems to be solved within a single project. In the case of project preparation, the goals are the objectives to be attained in the framework of the given project. Solution of the IP problem provides an optimal set of the problems or of the objectives. Special constraints can be introduced into the IP problem to reflect a specificity of the project area (e.g., resources that can not be shared at all or above some limit).

A well-known ARIS project being implemented in Russia formed a prototype for the simplified example described in the following tables. The costs and benefits are completely illustrative and do not relate to the real prototype.

Table 1. The benefits of objectives, CU (conventional units)

Objectives	Regions				
	Central (1)	North West (2)	Black Earth (3)	South Urals (4)	Siberia (5)
Consulting centre (CC)	900	980	990	380	740
Training centre (TC)	1220/1120*	770	1110	480	1530
Wholesale market (WSM)	4400	3310	2950	1120	2200
Seed processing plant (SPP)	2200	1680	4830	3330	1010
Regional agrarian computer network (RN)	980	430	380	210	900
Federal agrarian computer network (FN)	3200				

* The former figure relates to the base subproject, and the latter – to the alternative.
FN substitutes any RN.

Table 2. Resources, requirements and costs, CU

Resources (aggregated)	Requirement					Cost per unit				
	Central	North west	Black Earth	South Urals	Siberia	Central	North west	Black Earth	South Urals	Siberia
Seed processing plant	SPP:1*					1765			1920	1605
WSM buildings and equipment	WSM:1*					975			1030	975
SPP informational infrastructure	SPP:1*					60			65	60
WSM informational infrastructure	WSM:1*					55			59	55
Central management	CC:1, CCa:1, TC:1, TCa:1, WSM:1, SPP:1*					60				
Manager	CC:1, CCa:1, TC:1, TCa:1*					48				
Trainer	TC:9, TCa:3	TC:5, TCa:3*				36				
Mobile trainer	TCa:4**					72				
Expert	CC:12, CCa:8, WSM:2, SPP:1*					24				
Mobile expert	CCa:6**					60				
Office	CC:1, CCa:1, TC:1, TCa:1*					50				
Classroom	CC:1, CCa:1, TC:5, TCa:5	CC:1, CCa:1, TC:3, TCa:5*				65				

Table 2 (continued)

Resources (aggregated)	Requirement					Cost per unit				
	Central	North west	Black Earth	South Urals	Siberia	Central	North west	Black Earth	South Urals	Siberia
Library	TC:1, TCa:1*					166				
Regional network equipment	CC:1, CCa:1, TC:1, TCa:1, RN:1*					400		550	650	320
Federal network equipment	FN:1**					2740				

* The same requirements for each region
** The requirement for all the regions

Requirements are shown as <Objective>:<Quantity>. Objectives are represented with abbreviations according to Table 1, followed, in case of alternative subproject, with letter **a**.
In Siberia, the alternative subproject of consulting centre (with mobile experts) is not allowed due to enormous transportation expenses.
In any case, existing (mobile) trainer may ever substitute (mobile) expert. Federal or corresponding regional network equipment makes special informational infrastructure for SPP and WSM unneeded.

The description of the project was processed with the PC considering different funding opportunities. The results are presented in the Table 3.

Table 3. Optimal project composition under different funding opportunities

Objectives	Complete funding	75% funding	50% funding
CC	1,2,3,5	1,3,5	1,5
TC	1,2,3,5	1,3,5	5
WSM	everywhere	1,2,3,5	1,2,3,5
SPP	1,3,4	3,4	3
RN	1,2,3,5	1,3,5	1,5
FN	–	–	–
Net worth (CU)	*19582*	*18064*	*14771*

The numbers indicate regions (according to Table 1) where the given objective should be implemented.
Complete funding is 16000 CU.
Alternative subprojects of training and consulting centres are always rejected.

The project which consists of all the possible objectives worth 18687 CU and requires 20443 CU of financing (or 18311 and 20819 CU respectively when all the possible alternative subprojects allowed). If one introduces FN then the corresponding figures are 18567/20763 and 18191/21139 CU. So the presented approach increases the project worth due to the optimal composition and thus contributes to the project opportunities in agriculture.

References

Baum, W.C. (1978). The project cycle, *Finance and development*, **15**, no. 4, 10-17.

Fonotov, A.G. (1974). Analiz tselei v programmno-tselevom planirovanii: metodicheskie voprosy (Objectives analysis for the objective programming approach to planning: the methodological items). Moscow, Central Economics and Mathematics Institute (unpublished dissertation).

Gataulin, A. and Svetlov, N. (1998). Revealing and selecting of investment projects in the AIC, *APK: ekonomika, upravlenie*, **3**, 36-43.

Gavrilets, Iu.N. (1974). Sotsial'no-ekonomicheskoe planirovanie: sistemy i modeli (Social and economic planning: systems and models). Moscow, Ekonomika.