Priority Setting in Agricultural Research in Croatia

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SUMMARY

In this paper, the main objective, a set of sub-objectives of national agricultural research system (NARS) and criteria for setting research priorities have been analysed and established. The Analytical Hierarchy Process (AHP) is applied and a hierarchical model developed containing three levels of criteria. On the basis of "pairwise comparison," weights are ascribed to criteria and sub-criteria as well as intensities of bottom level criteria values. Within this model, a decision support system (DSS) – Expert Choice - is used to develop a spreadsheet model for establishing rating of research projects.

For each objective a list of economic, social and ecological criteria was developed in order to measure the contribution of each alternative (research theme) to the achievement of the respected objective. The alternatives in this model are seventeen different agricultural commodities.

Results show that the sub-objective "economic efficiency" achieved the highest value and thus greatly influenced on the final rank of alternatives. The next criterion according to its relative importance is "sustainability of natural resources" and the last one is "social equity".

The "production value" criterion, which measures the research contribution to economic efficiency, achieved the greatest importance among economic criteria. In the social criteria group, the "cash flow" criterion achieved the highest importance, and among ecological criteria the most important was "natural environment".

Finally, the six best-ranked priority research themes were extrapolated from the model and could be considered as priority products for implementing research.

KEY WORDS

agricultural scientific research, priority setting, resource allocation

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Postavljanje prioriteta poljoprivrednih istraživanja u Republici Hrvatskoj

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SAŽETAK

U ovom radu određen je opći, glavni cilj naconalnog sustava poljoprivrednog istraživanja, razmotreni su i obrazloženi posebni ciljevi, te su definirani kriteriji za postavljanje prioriteta istraživanja.

U toj analizi primjenjena je AHP metoda; razvijen je hijerarhijski model s tri razine kriterija, na temelju "pairwise comparation" određene su težine kriterija, i podkriterija te intenziteti kriterijalnih vrijednosti posljednje razine kriterija. Na temelju tog modela uz pomoć DSS (decision support system) Expert Choice kreiran je "spreadsheet model" za određivanje rejtinga pojedinih istraživačkih projekata.

Za svaki od navedenih posebnih ciljeva definiran je niz ekonomskih, socijalnih, te ekoloških kriterija za postavljanje prioriteta istraživanja. Kriteriji mjere koliko istraživanja na određenoj temi (proizvodu) doprinose ostvarenju odnosnog zadanog cilja.

Različite mogućnosti u ovom modelu, predstavljaju istraživanja na 17 različitih poljoprivrednih proizvoda, pšenica, kukuruz, šećerna repa, suncokret, uljana repica, soja, krumpir, ostalo povrće, voće, masline, vinova loza, mlijeko, svinjetina, govedina, perad, jaja i ovce.

Iz dobivenih rezultata vidljivo je da je cilj "ekonomska učinkovitost" postigao najviši koeficijent relativne važnosti, te je kao takav i najviše utjecao na konačni poredak mogućih istraživanja. Drugi cilj po važnosti je ekološki cilj "poboljšanje održivosti prirodnih resursa", a na zadnjem mjestu nalazi se socijalni cilj "socijalna ravnopravnost".

Od ekonomskih kriterija najveću težinu ostvario je kriterij "vrijednost proizvodnje", od socijalnih kriterija "tijek gotovine", a od ekoloških "utjecaj istraživanja na okoliš".

Na kraju su izračunati konačni prioriteti mogućih istraživanja. Prvih šest proizvoda (trećina uzorka mogućih istraživanja) - svinjetina, pšenica, vinova loza, mlijeko, kukuruz, govedina – moguće je smatrati prioritetnim proizvodima za provođenje istraživanja.

KLJUČNE RIJEČI

poljoprivredno znanstveno istraživanje, postavljanje prioriteta, alokacija resursa

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INTRODUCTION

National Agricultural Research System (NARS)

The research subject is to define the main and specific objectives of the NARS and to establish criteria for research priority setting. The pairwise comparison has been carried out in order to ascribe weights to specific objectives (sub-objectives) and criteria, which demonstrate the relative importance of one element in the hierarchy in respect to an other. (Table 1a, 1b, 1c) Furthermore, quantitative parameters were obtained and calculated, expert opinions were collected and these were standardised for each criterion. (Table 2a, 2b, 2c) The Analytical Hierarchy Diagram was developed to demonstrate the hierarchical structure of the priority setting problem.

The research objectives are:

i) to develop a procedure for research priority setting that is of practical use for policy makers;
ii) to set the main and specific NARS objectives;
iii) to analyse all relevant criteria in respect to setting research priority;
iv) to assess the Analytical Hierarchy Process (AHP) method on the specific problem of setting research priority or allocation of research resources;
v) to set research priority subjects accordingly.

METHOD AND DATA SOURCES

The method applied in this work is Analytical Hierarchy Process (AHP), as developed by Thomas L. Saaty. AHP is a multi-criteria decision-making approach that uses multiple comparison of different elements in a hierarchical structure in order to establish priorities among a set of alternatives. Saaty, Vargas (1991)

AHP is a comprehensive logical and structural framework that divides a complex problem into the elements of hierarchical structure. By including all relevant criteria and pairwise comparison, the method enables decision-makers to determine tradeoffs of different objectives that a final decision has to meet. This method involves the knowledge and expert opinion of process participants when quantitative data are missing. Braunschweig, Janssen, Munoz, Rieder, (1998)

The three main principals of AHP:

1. A decision that has to be reached, AHP divides into its elements;
2. AHP compares different opinions about these elements;
3. Synthesise priorities. Braunschweig, Janssen, Munoz, Rieder, (1998)

The highest hierarchy level contains just one element that reflects the main objective of the problem. Lower levels usually contain a broader number of elements. Elements on the same level are mutually independent, but are connected with the elements on the successive lower level. AHP shows where additional information is necessary, what the main points of disagreement are, etc. Šegotić (1997)

PRIORITY SETTING PROCESS

The main objective that makes the first hierarchy level in problem structure is "optimal allocation of research resources in priority research subjects". Bosch, Preuss (1995) The second hierarchical level consists of three NARS objectives that represent its development objectives or more broadly, the objectives of the whole national economy, and are as follows:

i) economic efficiency; Norton, Pardey, Alston (1992)
ii) social equity; Norton, Pardey, Alston (1992)
iii) sustainability of natural resource base. Collion, Kissi (1995)

For each of these aforementioned objectives, a list of economic, social and ecological criteria, respectively, was developed. The criteria measure the contribution level of each alternative (research subject) to the achievement of its respective objective.

The alternatives in this model are seventeen different agricultural commodities: wheat, maize, sugar beet, sunflower, rape, soy bean, potato, other vegetables, fruit, olives, grape vine, milk, pork meat, beef meat, poultry meat, eggs and sheep.

Economic Criteria

Economic criteria measure the research effect on general welfare of society. Since that agricultural research resource is scarce, it should be allocated so as to achieve optimal benefits for agricultural producers and consumers. Norton, Pardey, Alston (1995) Economic efficiency presumes equal financial benefits from research to all groups of producers and consumers. In this paper, regarding the focus to the product, economic criteria measure the importance of different products in relation to the increase in the living standard of all agricultural product producers and consumers. One possible outcome of such priority research is an increase in production income to agricultural producers and a decrease in prices to consumers.

Relevant economic criteria for the situation currently facing Croatia:

> The Production value of a certain product is calculated by multiplying product price by total amount of production in the country in year 1997. The product price in HRK is converted as an average annual price to DM by the exchange rate of Privredna banka. One of the miner shortcomings of the system is that the author did not take into account the present inflation in Germany.

Table 1a. Pairwise comparison, first assessment

2. Level – specific objectives	Economic efficiency	Social Equity	Sustainability of natural resources	
Economic efficiency	1	5	3	
Social equity	0,20	1	0,33	
Sustainability of natur. resources	0,33	3	1	
3. Level – criteria				
a) Economic criteria	Value of production	Consumption	WTO	Self-sufficiency
Value of production	1	3	3	7
Consumption	0,33	1	0,33	3
WTO	0,33	3	1	7
Self-sufficiency	0,14	0,33	0,14	1
b) Social criteria	Cash flow	Employment	Marginal areas	
Cash flow	1	3	5	
Employment	0,33	1	5	
Marginal areas	0,20	0,20	1	
c) Ecological criteria	Soil Preservation	Water Preservation	Quality of natural environment	Biodiversity
Soil Preservation	1	1	1	3
Water Preservation	1	1	1	3
Quality of natural environment	1	1	1	3
Bio-diversity	0,33	0,33	0,33	1

Product consumption. Products that are in greater demand (consumption) on the national and international market are more suitable for research. Aggregate consumption of agricultural products on the domestic market mostly comprises the need for the primary agricultural products, semi-manufactured products and fully manufactured products. It comprises human consumption, the needs of the processing industry, inputs in livestock production, reproduction inputs and losses. Kovačić and associates (1996) In this paper, product consumption is presented as an annual average of consumption per capita weighted through the cereal units in order to become comparable to different products.

The importance of the product in country's transitional period. Products that previously did not hold any significant importance for the country could now become very important for its international trade and new market approach by becoming a member of the World Trade Organisation (WTO). The scores for these criteria are ascribed according to the list of priority products during the negotiation process for entry to WTO.

Food self-sufficiency is expressed as a relative measure that reflects in what percentage agricultural production covers agricultural consumption. Kovačić and associates (1996) Realisation of this objective could encourage a higher level of production that does not have comparative advantages to other countries. Since that liberalisation of international trade influences the changes in domestic production, the self-sufficiency policy often puts trade barriers in place, and could result in increased variability of food availability in a country. One of the basic objectives of agricultural policy in the majority of countries is to achieve highly covered domestic consumption with domestic production. Namely, a country that is fairly dependent on import of agricultural strategic products becomes politically and economically vulnerable. Therefore, countries tend to keep high levels of food self-sufficiency despite high costs incurred by the state. One of the better ways to achieve a high level of self-sufficiency in production that does not have comparative advantages is to achieve high technological development instead of the application of an extensive package of government subsidies.

Social Criteria

Social criteria measure the distribution of research benefits among different target groups. Norton, Pardey, Alston (1992) This group of criteria measures the effect that different commodity research has on employment and income, which is the most direct and the most important measurable social effect. So, it is important to include in the priority setting process some social criteria, particularly when the target beneficiary group are small or pure farmers or farmers in less favourable areas.

Relevant social criteria for the situation that Croatia faces at the moment:

Total employment in a certain production. The number of working days is calculated by multiplying production area (ha) or number of animals with the approximation of work unit estimates of the labour requirements per hectare or animal. From the social aspect, productions that require higher employment are more suitable for research. Out of the total labour amount in the agricultural sector, Croatia has an annual labour potential of

Table 1b. Pairwise comparison, second assessment

2. Level – specific objectives	Economic efficiency	Social Equity	Sustainability of natural resources	
Economic efficiency	1	3	5	
Social equity	0,33	1	2	
Sustainability of natur. resources	0,20	0,5	1	
3. Level – criteria				
a) Economic criteria	Value of production	Consumption	WTO	Self-sufficiency
Value of production	1	5	3	3
Consumption	0,20	1	5	0,33
WTO	0,11	0,33	1	3
Self-sufficiency	0,33	3	3	1
b) Social criteria	Cash flow	Employment	Marginal areas	
Cash flow	1	0,33	0,20	
Employment	3	1	0,33	
Marginal areas	5	3	1	
c) Ecological criteria	Soil Preservation	Water Preservation	Quality of natural environment	Biodiversity
Soil Preservation	1	0,33	3	5
Water Preservation	3	1	3	5
Quality of natural environment	0,33	0,33	1	3
Bio-diversity	0,20	0,14	0,33	1

Table 1c. Pairwise comparison, third assessment

2. Level – specific objectives	Economic efficiency	Social Equity	Sustainability of natural resources	
Economic efficiency	1	3	3	
Social equity	0,33	1	1	
Sustainability of natur. resources	0,33	1	1	
3. Level – criteria				
a) Economic criteria	Value of production	Consumption	WTO	Self-sufficiency
Value of production	1	3	0,33	7
Consumption	0,33	1	0,33	5
WTO	3	3	1	7
Self-sufficiency	0,14	0,20	0,14	1
b) Social criteria	Cash flow	Employment	Marginal areas	
Cash flow	1	0,33	0,20	
Employment	3	1	0,33	
Marginal areas	5	3	1	
c) Ecological criteria	Soil Preservation	Water Preservation	Quality of natural environment	Biodiversity
Soil Preservation	1	0,20	0,20	0,14
Water Preservation	5	1	0,33	0,33
Quality of natural environment	5	3	1	0,33
Bio-diversity	7	3	3	1

Since that AHP method requires pairwise comparison of problem objectives and criteria the procedure was followed as it is showed further.

550 mil. working hours. If the working time of full-time farm employees is added to this amount then this working potential is approximately 749 mil. Different types of production and different labour intensity of respected production have different requirements on labour resources.

The importance of product in areas devastated by war. The estimation of this indicator is expressed by approximate damage of agricultural production in twelve war devastated zones in Croatia in 1991. This criterion is taken as a substitute for criterion "product importance in less favourable areas" since these areas have not yet been identified.

Constant cash flow resulted from a certain agricultural production. Productions that ensure constant cash flow for a farm are suitable for cash-constrained farmers. This is an important criterion that classifies different types of production, but since quantitative data relating to this criterion are missing, expert opinion was collected instead.

Ecological Criteria

The group of ecological criteria assesses the research contribution to the objectives of the resource base conservation and protection. Since that agricultural production influences the resource base and

possible future production, the sustainability of natural resources issue often raises the question of balancing present benefits and possible future benefits for society.

Relevant ecological criteria for the situation currently facing Croatia:

The extent to which a certain production helps in conservation of soil quality. Priority is given to commodities that positively influence soil quality.

The extent to which a certain production requires water and the production impact on water quality. Priority is given to commodities that positively influence water quality.

The commodity role in preserving the quality of natural environment. In order to improve rural tourism and the quality of agricultural products it is necessary to maintain the quality of natural environment. Priority is given to commodities that contribute to this aim.

The importance of the product regarding its bio-diversity. Priority is given to products with broader biological diversity (with regard to species, varieties, breeds, climate, feeding, storage etc.). The term agricultural bio-diversity refers to the variability and quantity of varieties and breeds of those plants and animals, respectively, that are important for food production. Agricultural bio-diversity is the result of interaction among natural environment, genetic resources and farming system. It is not just diversity of genes, species, agro-ecosystems and farming practice, but also cultural diversity that influences the interaction within human population on each level. Bio-diversity has its spatial, time and quantitative dimension. It comprises diversity of genetic resources (breeds, varieties etc.), and species that are directly or indirectly used in agriculture or production of food, forage, fuel and pharmaceutical products, then diversity of species that help production (pollinators, predators etc.) and those that help agro-ecosystems (agricultural, pastoral, forestall, water, etc.) (FAO).

DISCUSSION

In order to obtain an empirical estimation of the optimal relationship among resources invested in different research programmes, the appropriate model has been established. A set of alternatives that mutually compete for disposable funds and criteria that assess the contribution of each alternative, either to sub-objective or main objective, make variables in the model.

With assistance of AHP method, the model has been formatted in the hierarchical structure with four levels. The main objective "optimal allocation of research resources in priority topics" is placed at the top of the pyramid. The next hierarchical level contains three specific objectives "economical efficiency", "social equity" and "sustainability of natural resources". The third level is made up of criteria that measure the potential impact of each alternative to the two higher levels and the lowest level consists of 17 competing alternatives.

In addition, triple pair-wise comparison of specific objectives and criteria have been implemented in order to obtain their relative weights. These "relative importance" coefficients ensued from expert assessments that are also preliminary entering data for AHP software support "Expert Choice". This means that the relative importance of variables on the second and third level is defined as "relative importance" of specific objectives to the main objective and relative importance of criteria to specific objectives.

The results obtained show that the objective "economic efficiency" achieves the highest relative importance (0,665) and had the greatest influence on the final score of alternatives. The second objective according to its relative importance is "sustainability of natural resources" and the third one "social equity".

Of the economic criteria, the "value of production" holds the greatest importance, out of social criteria "cash flow" and of ecological the most important is "quality of natural environment".

Subsequently, the contribution of each alternative or potential research to the main objective was assessed. The model shows that alternative values for some criteria are expressed quantitatively and for others expert judges are demonstrated. For quantitative data, values are categorised and priorities are set among alternatives according to quantitative category within the specific criteria. For qualitatively expressed values, a value scale is developed for setting priorities for qualitative criteria.

Lastly, the following final priorities of potential research programmes are extrapolated from the model: pork meat, wheat, grapevine, milk, maize, and beef meat. These first six products (one third of all alternatives) could be possibly considered as of high priority for undertaking research.

Pork meat has relative importance of 0.539, and is first on the priority list since it has the highest production value and the same criterion has the highest weight. Furthermore, pork meat has a very high consumption value (it is placed on the second level according to its consumption value), and also has mid-importance due to its significance in terms of foreign trade and self-sufficiency, high level of cash flow and the highest employment in production. This production is not very favourable for natural environment and bio-diversity, but since these criteria have only a 20.9%

Table 2a. Calculation of quantitive parameters and expressing expert judgements
Measuring products according to quantitive criteria

No	Criterion	Wheat	Maize	Sugar Beet	Sunflower	Rape	Soy bean	Potatoe	Other vegetables	Fruit	Olive	Grape wine	Milk	Pork meat	Beef meat	Poultry	Eggs	Sheep
	Economic																	
1	Value of production (mil DM)	257,6	414,6	64,3	20,1	5,7	20,5	234,9	23,5	14,7	3,5	381,7	235,1	492,2	191,1	231,8	136,6	31,3
2	Consumption (kg/st./god.)	140,0	10,0	313,0	9,1	9,1	13,5	75,0	93,1	56,2	7,6	90,3	193,0	25,0	14,7	12,4	10,2	1,3
3	Importance of product in transitional period of the country (order of importance)	2	0	1	0	0	0	0	6 tomato	5	0	4	3	7	7	0	0	0
4	Food selfsufficiency (%)	133,8	101,0	61,3	70,6			97,9	88,0	91,6*	99,3	110,0	70,3	83,0	73,6	103,1	96,5	39,4
	Social																	
5	Cash flow																	
6	Labour force in production (mil hours/year)	30,0	30,0	30,0	30,0	30,0	30,0	11,0	11,0	11.0 kont.	2,1	12,3	225,0	225,0	225,0	225,0	225,0	225,0
7	Importance of product in war-devastated areas (mil DM)	113,0	237,8	61,3	24,2	1,9	12,3	70,8	57,9	77,7	7,6	147,8	111,9	126,4	280,4	20,7	27,6	127,2
	Ecological																	
8	Soil conservation																	
9	Water conservation																	
10	Perservation of natural environment																	
11	Biodiversity																	

*79.3 continental fruits 12.3 citrus fruits

Table 2b. Calculation of quantitive parameters and expressing expert judgements
Pondering of quantitive values

No	Criterion	Wheat	Maize	Sugar Beet	Sunflower	Rape	Soy bean	Potatoe	Other vegetables	Fruit	Olive	Grape wine	Milk	Pork meat	Beef meat	Poultry	Eggs	Sheep
	Economic																	
1	Value of production (mil DM)	257,6	414,6	64,3	20,1	5,7	20,5	234,9	23,5	14,7	3,5	381,7	235,1	492,2	191,1	231,8	136,6	31,3
2	Consumption (kg/st./god.)	p 1 140	p 1 10	p 0.25 78.3	p 2 18.2	p 2 18.3	p 1.5 20.25	p 0.3 18.8	p 0.15 14.0	p 0.5 38.1	p 1.3 9.9	p 0.3 27.1	p 0.7 135.1	p 5 125.0	p 6 88.2	p 6 74.4	p 0.25 2.55	p 6 7.8
3	Importance of product in transitional period of the country (order of importance)	2	0	1	0	0	0	0	6 tomato	5	0	4	3	7	7	0	0	0
4	Food selfsufficiency (%)	133,8	101,0	61,3	70,6			97,9	88,0	91,6*	99,3	110,0	70,3	83,0	73,6	103,1	96,5	39,4
	Social																	
5	Cash flow																	
6	Labour force in production (mil hours/year)	30,0	30,0	30,0	30,0	30,0	30,0	11,0	11,0	11.0 cont.	2,1	12,3	225,0	225,0	225,0	225,0	225,0	225,0
7	Importance of product in war-devastated areas (mil DM)	113,0	237,8	61,3	24,2	1,9	12,3	70,8	57,9	77,7	7,6	147,8	111,9	126,4	280,4	20,7	27,6	127,2
	Ecological																	
8	Soil conservation																	
9	Water conservation																	
10	Perservation of natural environment																	
11	Biodiversity																	

*79.3 continental fruits 12.3 citrus fruits

Table 2c. Calculation of quantitive parameters and expressing expert judgements
Standardisation of results

No	Criterion	Wheat	Maize	Sugar Beet	Sunflower	Rape	Soy bean	Potatoe	Other vegetables	Fruit	Olive	Grape wine	Milk	Pork meat	Beef meat	Poultry	Eggs	Sheep
	Economic																	
1	Value of production (mil DM)	3	5	1	1	1	1	3	1	1	1	4	4	5	2	3	2	1
2	Consumption (kg/st./god.)	4	1	3	1	1	1	1	1	2	1	2	4	4	3	3	1	1
3	Importance of product in transitional period of the country (order of importance)	5	1	5	1	1	1	1	2 tomato	3 apple, mandarin	1	3	4	2	2	1	1	1
4	Food selfsufficiency (%)	1	2	3	3	3	3	2	3	4	2	1	3	3	3	2	2	5
	Social																	
5	Cash flow	1	1	1	1	1	1	4	3	1	2	2	5	3	3	4	4	4
6	Labour force in production (mil hours/year)	2	2	2	2	2	2	1	1	1	1	2	3	3	3	3	3	3
7	Importance of product in war-devastated areas (mil DM)	3	5	2	1	1	1	2	2	2	1	3	2	3	5	1	1	3
	Ecological																	
8	Soil conservation	4	1	3	3	3	5	3	1	1	5	1	3	1	4	2	2	1
9	Water conservation	3	1	2	3	2	1	2	1	1	3	1	1	1	2	1	1	3
10	Perservation of natural environment	4	1	2	3	2	1	2	1	1	5	3	1	1	3	1	1	2
11	Biodiversity	4	1	2	2	2	1	2	1	4	5	2	3	2	4	1	1	5

share of the total value of the "ecological objective" they do not strongly influence the rating of pork meat.

Wheat as second product on the priority list has a weight of 0,533 and the highest consumption value as well as importance for foreign trade. It also has the highest self-sufficiency level, great importance for areas devastated by war and a moderate influence on ecology and bio-diversity.

Grapevine as a third priority is in the first level by production value and self-sufficiency; it is very important for war-devastated areas, and for other criteria it has moderate values. Its weight amount is 0,530.

Milk as a fourth product on the priority list is in the first level by consumption value; it has strategic importance for international trade, extremely high cash flow, huge production employment and moderately favourable influence on ecological component. Its relative weight amount is 0,512.

Maize is the fifth product on the priority list and has a weight 0,468. Its production value, self-sufficiency and influence on war devastated areas are in the first level, while consumption value is in the lowest. This product has a very slight influence on the ecological component.

Beef meat, as a sixth product on the list with a weight of 0,320, significantly falls behind the previous five products whose weights vary between 0,51 and 0,54. Beef meet is on the first level by employment in production and by its importance for war-devastated areas, and for all other criteria it achieved moderate values.

In this work, AHP has been used for agricultural research priority setting, which in fact means decision-making procedure for allocation of research resources. Priority setting is a fairly complex procedure that involves a number of steps.

Since that investment decision in this case can not be given by just one person or one stakeholder group (e.g. scientists, policy-makers etc.), it is very important to gather a team of relevant participants for this decision-making process.

As a second phase of the procedure, research objectives were set, alternatives chosen and relevant criteria for assessing alternatives' contribution to objectives were defined. It was decided that different alternatives would present different agricultural commodities. Criteria analysis was implemented as those are key parameters on which the rank of final alternatives depends. For quantitatively non-measurable criteria, expert judges are collected on the workshop, and for others data are collected from different the primary and secondary sources.

AHP is a mathematical multi-criterial method easily understandable and broadly applicable for decision-making problems. The specific problem of investing scarce resources in agricultural research was divided in a hierarchical structure. Furthermore, triple pairwise comparison of objectives and criteria was implemented according to the original Saaty scale. With exact data, expert judges and AHP software support "Expert Choice", assessment of alternatives was implemented in order to obtain a synthesis of priorities, which is actually problem solution recommendable for implementation.

Out of 18 selected alternative research programs, the six best ranked in the final list of priorities are considered the best choice for implementing research.

This article shows a systematic approach to the decision-making process in respect to allocation of research resources and planning research policy.

The final solution resulting from this procedure is relatively reliable and constitutes an objective basis for making decisions about resource allocation and negotiation with potential investitures or donors. It may also be used where the appropriacy of a decision is being reviewed by different stakeholder groups.

CONCLUSION

The priority setting procedure is fairly complex since it consists of several phases that should be implemented in exact chronological order. The steps in priority setting procedure are as follows: 1.) Defining research objectives, 2.) Defining research alternatives, 3.) Development of measuring standards, 4.) Qualitative and quantitative assessment of research alternatives, 5.) Comparison of research alternatives, 6.) Confirmation and implementation. The procedure should involve policy makers, agricultural economists, researchers, and final beneficiaries.

The principal objective was set - Optimal allocation of research resources as well as specific objectives on national agricultural research system - Economic efficiency, Social equity and Sustainability of natural resources. It is expected from final priorities to realise these objectives or to greatly contribute to their achievement.

Possible criteria for priority setting were analysed and the most relevant ones were included in the model.

For certain criteria that could be expressed in physical value where data were missing, qualitative values or expert judges were used instead. Therefore, this work pointed to the lack of data for accurate priority setting process and research policy planning. Data was missing in the domain of foreign trade or Croatian export strategy, percentage of product home-consumption, cash flow in particular production and product importance for less favourable areas.

The applicability of the AHP method is assessed on the concrete problem of setting research priorities and allocation of funds to research projects. The method has been confirmed as very practical and straightforward in terms of application and very useful for making decisions when many criteria must be considered. One of the advantages of the model is that changing the inputs or data in the model means that the result of output is different. That means that the final outcome of the model depends on the objectives of the decision and relevant criteria for obtaining these objectives, which normally differ in different circumstances and at different times.

Priority products for scientific research are identified and could be recommended to decision-makers in charge of creating research policy. Priorities are the following agricultural products: pork meat, wheat, grapevine, milk, maize and beef meat.

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APPENDIX

For the comparability of results among different criteria, quantitative measures has been transformed into the points ranging from 1 to 5. For qualitative criteria, expert judges were collected and also transformed to the following scale of values:

5 = extremly important;
4 = very important;
3 = important;
2 = moderatly important;
1 = slightly important.

The standardisation of values for all quantifiable criteria was done in a way that the highest value for each criterion was divided in five grades (levels) of the score. According to the achieved result, values from one to five were attributed to these grades.

Criterion 1: Value of production for all products was divided in five grades. The highes value of production (pork meat) was divided with five. Thus, different commodities achieved values according to the following scale:

5 = 492 – 394 mil. DM
4 = 394 – 296 mil. DM
3 = 296 – 198 mil. DM
2 = 198 – 100 mil. DM
1 = 100 – 0 mil. DM

Criterion 2: Consumption values was weighted and scored as follows:

4 = 140 – 125
3 = 125 – 74
2 = 74 – 27
1 = 27 – 0

Criterion 3: The order of priority products for association to WTO was assessed as follows:

1 = priority no 1 and 2
2 = priority no 3
3 = priority no 4 and 5
4 = priority no 6 and 7
5 = not priority

Criterion 4: Self-sufficiency of production was expressed in percentage and scored as follows:

5 = 134 – 109 %
4 = 109 – 84 %
3 = 84 – 59 %
2 = 59 – 34 %
1 = 34 – 9 %

Criterion 5: Cash flow was expressed and scored as follows:

5 = extremely high;
4 =very high;
3 = high;
2 = moderate;
1 = low.

Criterion 6: Employment in certain production was expressed as follows:

3 = 225 mil. hours/year
2 = 30 mil. hours/year
1 = > 2 mil. hours/year

Criterion 7: Importance of the product in war-devastated areas:

5 = 280.4 – 224 mil. DM
4 = 224 – 168 mil. DM
3 = 168 – 112 mil. DM
2 = 112 – 56 mil. DM
1 = 56 – 0 mil. DM

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