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## SMALLHOLDERS' PRIORITIES IN FINANCING: MATHEMATICAL APPLICATIONS IN THE CONTEXT OF A POST-TRANSITION ECONOMY

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### Abstract

*Smallholders in the North Macedonia face different constraints in accessing to finance. Various formal institutions, mechanisms and support programmes were established to increase the external capital consumption by farmers, but still smallholders remained underserved with appropriate finance. The aim of this study is to determine the priorities of the smallholders in choosing their best alternative of financial sources under different financing incentives. The Analytical Hierarchy Process, as a multi-criteria decision making technique, enabled prioritisation in the complex financial decision-making, considering multiple conflicting criteria at once. The results show that the smallholders mostly need finance to support investments in farm modernization, followed by the need of investment capital for adaption and mitigation of negative climate change effects and environment protection. In order to meet these needs, smallholders mostly prioritise the national institutions for providing financial support in agriculture. Especially important for the smallholders is the National Rural Development Programme and IPARD Programme that follow complex procedures, and thus, these funds have a relatively low utilisation rate. Another priority of smallholders is given to the direct credits by the National Development Bank that are currently unavailable to smallholders due to legal restrictions. Analyses of this kind, considering the bottom-up approach in valuing the smallholders' opinions and needs of financing, are scarce in the practise, but they are very important in tailoring the financing offer and financial support measures in agriculture to the real needs of the smallholders.*

**Key words:** Analytical Hierarchy Process, decision making, financing alternatives, small-scale agriculture, North Macedonia

### INTRODUCTION

Even after two decades from the transition to a market economy, smallholders in North Macedonia, still face different constraints in acquiring finance to support investments and operating activities. First, small farm sizes, measured in both land and economic units, contribute to lower level of productivity and profitability of farms [11], affecting their liquidity and limiting their free cash flows [15]. Next, the lack of collateral and unsuitable credit conditions are another credit constraint to smallholders [10]. And finally, financing alternatives tailored to the needs of smallholders are lacking [15], [14]. On the other hand, smallholders are also faced with different constraints in utilisation of financial support programmes, such as the large

number of measures with complex procedures for the smallholders, where the frequent changes, especially in annual programming, additionally burden less educated farmers to follow, understand and meet the set requirements [5].

The general financial infrastructure in the country that supports farm crediting is represented by nine out of thirteen private banks, three out of four savings houses and a national development bank [15], along with the established supporting mechanism of the Agricultural Credit Discount Fund (ACDF) to ease the access to loans of smallholders [17]. In addition, budgetary support to smallholders is available through the national programmes for agriculture and rural development (i.e. direct payments and investment support through the National Programme for Rural

Development) and the European Union's Instrument for Pre-Accession Assistance for Rural Development (IPARD) [8].

Although various formal institutions, mechanisms and support programmes were established to improve the flow of capital into the agricultural sector, still the access to finance in small-scale agriculture has remained one of the country's weakest segments [10]. For instance, the direct credit programmes of the national development bank are not available for smallholders that are not registered as legal entities [14]. Therefore, other formal institutions and financing instruments are missing in order to improve the access to finance of smallholders [16], which contribute to 89.4% in the total national agricultural output [18].

When developing the commercial financing offer in agriculture and when creating the national programmes and measures for farm financial support, it is important to undertake the bottom-up approach so to value the opinions and the needs of the farmers, especially those of the small sizes, which mainly face financing constraints but constitute the largest part of the Macedonian agriculture. Hence, the aim of this study is to determine the priorities of the smallholders in choosing their best alternative of financial sources under different financing incentives. This is in line with Saaty's [13] technique for a multi-criteria decision making (MCDM) based on mathematical and psychological elements, which enables analysis of complex decisions involving many stakeholders and multiple alternatives by using a hierarchical structure in the decision-making processes.

The methodological framework of MCDM is well suited to the complex nature of financial decision problems, emphasised by different researchers working in the field. Operational research has contributed to different financial decision-making problems and these contributions are not only limited to academic research, but they also extend to the daily practice of corporate decision-making processes [23], [21]. However, there is a little notice in applying MCDM in regard to farm financial decision-making for policy settings. On the other hand, MCDM has been widely

used technique in other fields of agricultural research, proving to be extraordinarily elegant for solving alternative problems with multiple conflicting criteria [22], [4], [19], [1].

Thus, this study reveals how operational research models are applied in prioritizing the available financial sources, including support programmes, to smallholders under different farm financing incentives. The study is not intended to be uncritically used for immediate policy decision-making, but rather to show the importance of such prioritisation approach in the participatory policy applications. In this context, this study illustrates how smallholders' financing needs prioritization analysis could contribute to the national research-based policy decision-making. Moreover, the results may have a wider applicability if the mathematical model is applied to other related cases.

The following section briefly describes the research methods and the mathematical model, followed by a description of the prioritisation determinants. The results are then presented, followed by a short discussion and conclusions.

## MATERIALS AND METHODS

To get an insight into the smallholders' priorities in their financial decision making processes with operational research techniques, primary data were collected during August 2020 from a small sample of smallholders, represented by family farmers, whose agricultural income does not exceed circa 20 thousand Euros. Additionally, a control group was introduced, consisting of farmers whose income from agriculture exceeds 20 thousand Euros. The sample selection was done in two phases. During the first phase, 50 farmers were initially selected from a national network of farmers in order to get the initial understanding of the determinants of the farm financing behaviour by using a structured questionnaire. During the second phase, 17 farmers were randomly selected out of the initial sample, which were included in the prioritization exercise to determine the smallholders' perceptions and needs in financing by using a tailor-made

questionnaire for mathematical modelling of financial decisions. Unlike the statistical methods that require an optimum sample size, mathematical modelling allows a limited number of sample population [6], as it is the case of this study.

In regard to the questionnaire used in the prioritization exercise, it was constructed exclusively for the purpose of this research. The first part of the questionnaire provides general information on the farm, while the second part contributes to the operational research, specifically the Analytical Hierarchy Process (AHP), pairwise comparison survey. All respondents used a verbal scale to make a qualitative comparisons, which were further converted into quantitative values using [13] fundamental integer scale from 1 to 9.

The obtained data were further processed by using the AHP template developed by Goepel [2], specifically designed in MS Excel for conducting the prioritization analysis. The AHP technique does not separate the intangible from the tangible decision-making factors, thus enabling both qualitative and quantitative attributes to be considered in the process [6]. The AHP hierarchy follows a descending structure starting from the overall goal to criteria, sub-criteria and alternatives in successive levels [13]. The relative importance of the criteria and the alternatives is estimated through pairwise comparisons of all elements by using the pairwise comparison scale as proposed by Saaty [12].

Depending on the complexity of the goal, the hierarchy can have multiple levels [6], however in the case of this study, a three-level decision hierarchy was developed. The top level indicates the goal, that is, increasing the availability of financing to smallholders in North Macedonia, while the second level refers to the decision-making criteria i.e. the incentives for or the benefits from the use of the financing and support funding. The decision-making criteria are determined based on the Macedonian agricultural policy strategic objectives as presented in the National Strategy for Agriculture and Rural Development 2014-2020 [7].

Consequently, the first criterion refers to the modernization of the agricultural household

through farm investments leading to an increased productivity of the production factors as well as improved structure of the agricultural production. The second group of benefits relates to the improved household living conditions by increasing the farm income or by starting a new business in agriculture. The third criterion captures the benefits from use of financing and support funding that will contribute to the mitigation of the negative climate change effects, but also to the environmental protection and application of sustainable ecological practices. The third level of the hierarchy represents the available finance provided by both public and private financial institutions that will enable an accomplishment of the set criteria. Figure 1 shows the illustrative presentation of the conceptual framework of the decision hierarchy used in this study.

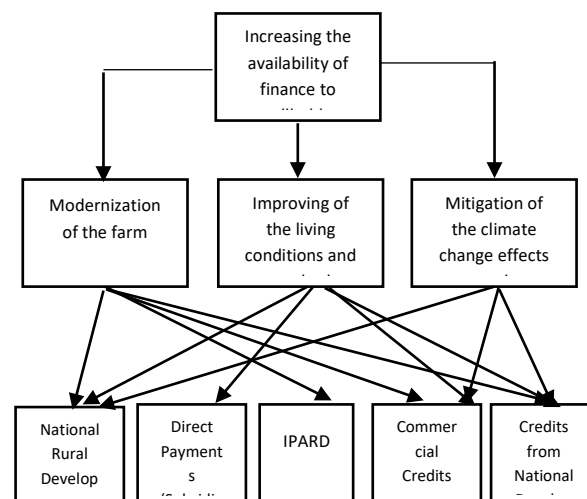


Fig. 1. AHP decision hierarchy for prioritization of the available finance to Macedonian smallholders

Source: Own determination.

## RESULTS AND DISCUSSIONS

### Characteristics of the sample farms

The initial sample that describes the farm determinants in regard to their financial position in obtaining different financing, includes 50 farms with an average size of the household of  $4.38 \pm 2.06$  family members. Most of the farms generate income from agricultural activities and 54% of the sample farms generate less than 20 thousand Euros annual agricultural income (Figure 2). This

indicate that the majority of the sample represents the smallholders.

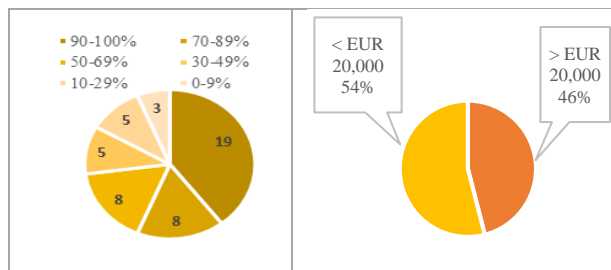


Fig. 2. Number of farms according to the share of agricultural income in total household income (left) and structure of the sample based on the annual agricultural income (right)

Source: Survey data, 2020.

Table 1 provides an insight into the farm determinants relevant for specifying the farm financial opportunities. Legal status of the farms is often a limiting factor for smallholders in accessing finance because most of the favourable commercial and uncommercial credits are aimed for legal entities. In this regard, a negative determinant is observed, that is, only 8% of sample farms are legal entities i.e. agricultural companies. Most of the sample farms or 38% are only evidenced in the farm register at the Ministry of Agriculture, Forestry and Water Economy, 28% are not registered at all, and 26% are registered farms as individual agricultural households. This determinant shows that the majority of the sample farms are limited to use the direct credit offer by the national development bank.

There is special commercial and support financing for agricultural cooperatives, but this financing is available only to 14% of the sample farms. The membership in agricultural cooperatives in general is very low. This determinant also shows that the majority of the sample farms face limited access to tailored financial products in agriculture.

An optimistic indicator in regard to tailoring the financial offer to the needs of the farmers, is the observation that most of the sample farms or 88% keep a regular farm accountancy. Farm accountancy data are the main source of information to the financial institutions in assessing the farms' creditworthiness. In addition, these data are

necessary for cash flow projections of the investment. Another positive determinant was observed, which emphasises the serious intentions of the farmers in their financing decision-making process. In fact, 68% of sample farms plan further farm investments to modernize the agricultural production by introducing new technologies and innovations.

Table 1. Farm determinants in regard to their financing opportunities (n=50)

	Share of all respondents
<b>Legal status of the farms</b>	
Unregistered farms	28%
Evidenced farms	38%
Registered individual family farms	26%
Agricultural companies	8%
<b>Membership in cooperatives</b>	
Members in cooperatives	14%
Not members in cooperatives	86%
<b>Farm Accountancy</b>	
Farms that keep regular farm accountancy	88%
Farms that do not keep farm accountancy	12%
<b>Future investment plans</b>	
Farms that plan investments on farm	68%
Farms that do not plan investment on farm	32%

Source: Survey data, 2020.

### Smallholders' priorities in financial decision-making

In order to better understand the smallholders' priorities in financial decision-making, 17 farms out of the initial sample were further selected for the prioritization study based on their personal preference to determine the priority of one element over another one in the hierarchy decision-making tree.

Regarding the structuring of the decision problem in a hierarchy, the application of this model is an appropriate tool if each category has at least four but not more than seven to ten sub-categories since more than that these target numbers, it will require over 45 pairwise comparisons leading to a complex and a confusing decision-making [2]. In the case of this study, only three criteria with five alternatives were considered, thus the application of this model provided plausible results.

Considering the farmers' financing incentives, Table 2 presents the consolidated priorities

and the consistency ratio (CR) for each criterion the farmer will benefit from, using the eigenvector method (EVM). The eigenvalue ( $\lambda$ ) of 3.001 equal to the matrix size indicates on sample consistency and enables further prioritization. Regarding the consistency ratio (in the case of this analysis  $CR=0.1\%$ ), the acceptable threshold of less than 0.1 or 10% was checked, and the results confirm that the judgments made by the participants are perfectly consistent (CR of 10% or less indicates on perfect consistency of the sample, while value of the CR less than 20% is tolerable for the sample consistency [20]). The consensus indicator ranges from 0% (no consensus between participants) to 100% (full consensus between participants); in the case of the prioritization of financing incentives for the smallholders, the indicator is 68.4%, illustrating a moderate consensus among the participants [2].

Table 2. Smallholders' priorities of the financial incentives (criteria)

Criterion/Financial incentive	Comment	Weights
Modernization of the farm	Investments in new technology, machinery, equipment	44.3%
Improving the living conditions and standards	Increased income, starting a business in agriculture	19.3%
Climate change and environment protection	Mitigation of the climate change effects and environment protection	36.4%
Eigenvalue ( $\lambda$ ):		3.001
Consistency Ratio (CR)		0.1%
Group Consensus Indicator		68.4%

Source: Own calculation based on pairwise comparison survey, 2020.

The estimated average weighting of the financing incentives for the smallholders based on the applied AHP method is presented in Figure 3. The results reflect the smallholders' needs for financing resources, i.e. the relative importance (weights) for each benefit of using the external capital offered by both private and public financial institutions. The estimated weighted average of the decision matrix elements based on the individual decision maker's weight indicates that the smallholders mostly need finance to

support investments in farm modernization (44.3%), i.e. investments in new technology, machinery or other equipment that would contribute to increasing the productivity and efficiency of the production factors. Considering the negative economic effects of the climate change in the agricultural production reflected through the decrease in production yields and increase in production costs [9], smallholders additionally need financing capital for adaption and mitigation of these effects. Consequently, smallholders choose this financing incentive as a second priority with a relative importance of 36.4%.

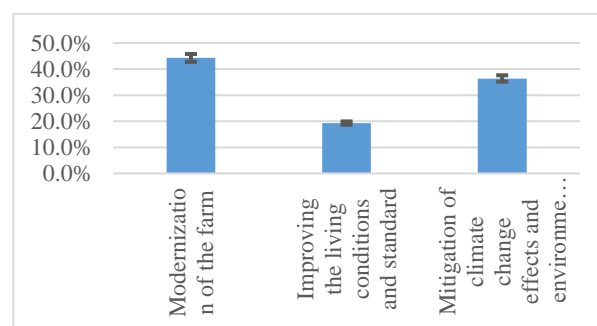


Fig. 3. Relative importance of the smallholders' financial incentives

Source: Own determination based on pairwise comparison survey, 2020.

Both financial benefits, ranked as a first and a second priority by the smallholders, could be financed through the national programme for agriculture and rural development, within the structural and rural development measures, as well as with the EU's IPARD funds.

However, the analysis of the budget transfers in the agriculture [5] reveals that most of the farmers in the country absorb finances through the direct support measures and not by the prioritised measures in this analysis (Figure 4). In fact, direct support measures in general contribute towards the second criterion i.e. improving the living conditions and the farmers' welfare, which was considered as the least important financing incentive for the smallholders in this research. Namely, the realisation of the programmed policy measures depends on many factors, among which the complex and time demanding procedures that are a big challenge for the smallholders due to their low experience, education and skills to manage

this process [5]. In this context, the participatory approach involving the smallholders' opinions and needs of finance should be applied in practice when developing and creating the national policy measures.

Smallholders are constantly coping with serious challenges arising from their limited access to finance necessary for their farm operations. Without enough finance, it is impossible for farmers to produce a surplus, to modernise the household or to change the production structure to become more competitive [3].

Therefore, the analysis further focuses on the pairwise comparison between the smallholders' prioritization of the financing alternatives available in agriculture and the prioritised financing incentive (Table 3, Figure 4). Herewith, five financing alternatives were included in the analysis, each referring to the external financial sources for meeting the farmers' financing needs, such as: financial support available through the National Rural Development Programme, direct support to farmers (Direct Payments), IPARD's support funds, loans available through the National Development Bank, as well as commercial loans issued by banks and savings houses. For the pairwise comparison of the financial alternatives, the three financial incentives were considered in the analysis, such as modernization of the farm, improving the living conditions and standards and mitigation of climate change effects and environment protection. The pairwise comparison between the available financing alternatives for each financing incentives resulted in equality of the eigenvalue with the matrix size, indicating on sample consistency (Table 3). The consistency ratio for each financing incentive also shows a perfect consistency. The group consensus indicator indicates to a high consensus reached in the prioritization of the financial sources i.e. alternatives available for mitigation of the climate change effects and the environment protection, and a moderate consensus for the prioritisation of the financial sources within the first and the second criterion, i.e. the modernization of the farm and improving of

the living conditions and standards at the farm.

Table 3. Pairwise comparison results on smallholders' priorities of a financing sources under different financing incentives

Indicators	Modernization of farm	Improving the living conditions and standards	Mitigation of climate change effects and environment protection
Eigenvalue (Lambda)	4.035	4.041	3.003
Consistency Ratio (CR)	1.30%	1.50%	0.30%
Group Consensus Indicator	71.30%	70.50%	79.30%

Source: Own calculation based on pairwise comparison survey, 2020.

Considering the relative importance of the available financial alternative for each farmers' need (Figure 4), the results show that smallholders prefer the use of financial resources available through the IPARD programme for investments in new technology and modernization of the farm (35.16%), followed by available direct credit offer of the National Development Bank (27.47%), and finally, the investment support available through the National Rural Development Programme (26.08%). Additionally, the farmers recognize the National Rural Development Programme and its measures as a main source of finance also for improving the living conditions and standards at the farm (31.61%), as well as for mitigation of the climate change effects and environment protection (48.74%). In both cases, the second priority is given to the offer of the National Development Bank (relative importance of 30.93% and 37.11% respectively). This is an important result for policy applications since it reflects the smallholders' opinion and needs of a financing capital. In fact, as mentioned above, the majority of smallholders are not legal entities, and therefore, they are not eligible to use the favourable direct credit offer of the National Development Bank (since only legal entities are beneficiaries). In all prioritisation analyses, the loans supplied by the private

sector have the lowest ranking, even though more affordable interest rates to the commercial loans are now available through the Agricultural Credit Discount Fund. Even though the country had established different supporting mechanisms to improve the capital inflow to the agricultural sector, this result stresses that smallholders are still faced with different credit constraints.

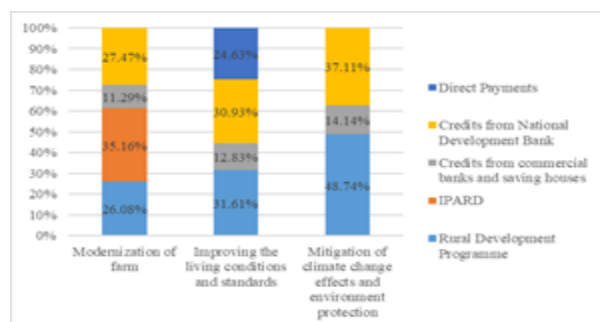


Fig. 4. Relative importance of financial alternatives under different financing incentives (in %)

Source: Own determination based on pairwise comparison survey, 2020.

## CONCLUSIONS

With a multi-criteria decision making based on the analytical hierarchy process, this study determines the priorities of the smallholders in choosing their best alternative of financial sources under different financing incentives. In fact, this is a first operational research in the country attempting to consider the opinions and needs of smallholders in regard to financing issues. As such, this study contributes to the literature indicating on the importance of the bottom-up approach in considering the priorities of the smallholders, especially important when developing the commercial financing offer and when creating the national support programmes and measures in agriculture. The findings from this operational research suggest that the smallholders mostly need finances for modernization of their farms. Investments in new technology, equipment or even change of the production structure should improve the production factors productivity and consequently the farm profitability. In addition to this, the smallholders' performances are affected by the negative climate change effects, and therefore farmers

need additional financial resources to also cope with this challenge. There are different financial alternatives for meeting these farmers' needs. However, the results from this prioritization exercise reveal that the smallholders mostly recognize the support programmes as a means of finance to the agricultural sector. This result confirms the presence of soft budget constraints in the national agriculture, which affect the preferred investment sources by smallholders. An optimistic observation is that the direct credit offer of the National Development Bank is given a second priority by smallholders, especially for improving the living conditions and standards at the farm and for mitigation of the climate change effects and environment protection. But, the direct credit offer of this bank supplies only legal farms with affordable loans that are not available to smallholders without a legal status. This is an important indicator for change in the financing policy settings aimed to enabling smallholders to use the direct credits by the development bank. In all prioritisation analyses, the loans supplied by the private sector have the lowest ranking, even though the country had established different supporting mechanisms to improve the commercial access to finance of the smallholders. This is also an important indicator for change in the financing policy settings. This result stresses that smallholders are still faced with different credit constraints. Although applied on a small sample, the exercised method may be implemented on larger cases since the developed methodological framework in this study showed a well suitability in solving complex financial decision problems. The mathematical modelling proves to be effective in the multi-criteria decision making process and such methodology can be widely applied in a number of similar research analyses. The method is relatively simple, the consistency tests confirm the consistency in the individual judgments, thus leading to plausible results. Last but not least, the mathematical modelling may serve as a good tool to implement the participatory approach for providing groundwork for agricultural and financing policy settings to tailor the financing offer and



support programmes to the needs of the smallholders.

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