ACTA UNIVERSITATIS AGRICULTURAE ET SILVICULTURAE MENDELIANAE BRUNENSIS

Volume LIX 49 Number 7, 2011

COST INDICATORS OF COMMON FACILITIES OF LAND CONSOLIDATION

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Received: September 2, 2011

Abstract

TICHÁ, A., PODHRÁZSKÁ, J.: *Cost indicators of common facilities of land consolidation*. Acta univ. agric. et silvic. Mendel. Brun., 2011, LIX, No. 7, pp. 459–468

Land consolidation can be defined as the spatial and functional arrangement of lands. By the process of land consolidation the ownership rights to land are settled and conditions for the rational management of land owners are created. The plan of common facilities is an important part of the land consolidation project. It is a set of measures creating conditions for access to lands (traffic network) and conditions for improvement of the environment (land resources conservation and development, water management, enhancement of landscape ecological stability). The costs of land consolidation are covered mainly by public resources.

Considerable investment costs are necessary for the implementation of structures. The volume of investments is given by the estimation of construction costs. The cost indicator of a structure of common facility (CICF) can be used as a ratio.

Among other things, this paper presents the catalogue of construction works for representative structure of common facilities, including the prices and a card of the cost estimation. These data may be used for a better orientation in the price level of particular items by both employees of land authorities and construction companies competing for contracts during the awarding of contracts for public procurement.

land consolidation, common facilities, cost estimate, cost indicators

Land consolidation is an important tool for the settlement of property rights to land, allowing the owners the rational management of their land. At the same time, land consolidation creates opportunities and conditions for the conservation, planning and optimum use of landscape. Thus land consolidation may bring about economic, environmental and social benefits (Subedi *et al.*, 2007; Du Jing, Wang AiLing, Ma Tumbo, 2008).

Required measures are designed in the framework of the plan of common facilities in accordance with Act No. 139/2002 and implementing Decree 545/2002. The design of their parameters is based on methodology (Dumbrovský *et al*., 2004; Uhlířová, Mazín *et al*., 2005; Janeček *et al*., 2007; Agroprojekt, PSO, 2010; Kyselka, Hurníková, Rozmanová, Stejskalová, Podhrázská, 2010). The design of respective measures should be developed with respect to the type of landscape, its capacities and limits.

In the plan of common facilities the designed measures are explicitly defined in terms of their area and spatial arrangement under the preferential use of state-owned and municipal land. Preconditions for their successful implementation are ensured in this way (Filip, Podhrázská, 2010).

The costs of land consolidation are covered by public resources (Mazín, 2003). Other natural and artificial persons that are interested in the execution of land consolidation may participate in their funding.

Considerable investment costs are necessary for the implementation of structures. Their volume is determined on the basis of budgets for the respective structures. Among other things, this paper presents the catalogue of construction works for representative structure of common facilities, including the prices and a card of the cost estimation. These data may be used for a better orientation in the price level of particular items by both employees

of land authorities – as the investors of the common facilities constructions – and construction companies competing for contracts during the awarding of contracts for public procurement.

MATERIAL AND METHODS

The costs of land consolidation represent a huge volume of resources from the state budget. For their optimization it is advisable to define the standards of costs in the phase of the designing, implementation and maintenance of common facilities of land consolidation. The present paper describes the method of determining such standards and their application. Their updating and completing are also suggested.

The proposed methodology of determining the cost standards of common facilities develops the methods used to calculate the costs of conventional structures (Hanák, 2005; URS 2009). The procedures described in studies and monographs published by the Institute of Structural Economics and Management at the Faculty of Civil Engineering of Brno University of Technology are also used (Korytárová, Aigel, Hromádka, Marková, Puchýř, Šlezingr, Uhmannová, Tichá, 2007).

Cost standards are based on the technical solution, especially on the plan of common facilities of land consolidation. The present first phase of development of the database of cost standards for common facilities relies on field data processing. In the second phase of development of these standards a catalogue with type structures in technical terms will be elaborated (Tichá, Podhrázská, Coufalová, Švadlenková, 2010). Normative, cost and price standards of common facilities of land consolidation will be defined for these structures. The database is designed for the needs of land authorities. It will certainly be useful for contractors or other agents in the land consolidation market. It is assumed to be used to a maximum extent by project engineering companies engaged in designing and implementation of land consolidation.

RESULTS AND DISCUSSION

Initial costs of common facilities of land consolidation

The common facilities of land consolidation are as follows:

- measures facilitating land access such as rural and forest roads, bridges, culverts, fords, railway crossings, etc.,
- soil-conservation measures for the protection of land resources such as erosion-control balks, infiltration belts, intercepting ditches, terraces, windbreaks, erosion-control grassing, afforestation, etc.,
- hydrological measures ensuring the harmless draining of surface waters and protection of the territory from floods such as dry polders, water reservoirs, ponds, drainage systems, levees, etc.,
- measures increasing ecological stability such as biological centres, habitat corridors, interactive elements,
- measures aimed at environment conservation and planning such as planting of greenery, landscaping, etc.,
- other measures not listed above.

The common facilities of technical nature involve new structures or reconstructions or rehabilitation of existing structures.

This paper is focused on the calculation of initial costs of common facilities from which eligible costs are derived according to certain rules. Their level is crucial in the application for a subsidy for the implementation of common facilities (Rules defining the conditions for granting subsidies for projects of the programme Rural Development of the CR for the years 2007–2013: Measures 1.1.4 Land consolidation). Common facilities are structures from the construction aspect. Their initial costs are subjected to cost estimating and their actual price is derived from them on the basis of conventional methods used in the Czech Republic. The structure is usually divided into parts of the structure in accordance with the Classification System of Engineering Structures and Construction Works (CSSW). In the framework of parts of the structure an itemized statement of particular constructions and works is elaborated. The line item cost estimate of a structure will be derived from estimations of the particular items in the itemized statement.

Line item cost estimate of a structure

For preliminary tentative determination of initial costs the designers use the catalogues of descriptions and prices of construction works that are put into market by specialized engineering organizations. Cost estimates are commonly drawn up using software and electronic databases of the prices of construction works and materials. Construction companies that participate in tenders, i.e. in tenders for the implementation of plans of common facilities, draw up the cost estimates partly using catalogue prices but they calculate significant items according to the specific conditions of their company (Tichá, Tichý, Šimáček, Vysloužil, 2004). Therefore the submitted cost estimates with which they apply for public procurement are different in the particular applicants.

According to the Classification System of Engineering Structures and Construction Works (CSSW) the line item cost estimate of a structure is traditionally called basic construction activity (BCA) and it is specified into the group of works of main construction activity (MCA) and associated construction activity (ACA). The particular groups of parts of the structure are assigned codes while the

basic classification according to the first digit of the code is as follows:

1. Earthworks
2. Foundations and foundation engineering
3. Vertical structures
4. Horizontal structures
5. Roads
6. Surfacing
7. Associated construction activity (ACA)
8. Piping
9. Finishing works.

Line item cost estimate

Structure:	**1 Cadastral area – Nová Ves u Leštiny**	Budget: 1
Road:	**SO 01 PC C5 "Ke kříži"**	

No.	Item No.	Item name	Unit	Quantity	Price/unit	Total (Kč)
Part:	**1**	**Earthwork**				
1	122202203R00	Excavations for roads in the rock of hardness class 3 by 10 000 m3	m^3	1 174.55	66.90	78 577.40
2	131201101R00	Open-cut sinking in the rock of hardness class 3 by 100 m3	m^3	12.13	259.00	3 141.67
3	132201101R00	Sinking of trenches less than 60 cm in width in the rock of hardness class 3 by 100 m3	m^3	5.85	621.00	3 632.85
4	132201201R00	Sinking of trenches less than 200 cm in width in the rock of hardness class 3 by 100 m3	m^3	72.96	389.50	28 417.92
5	162301102R00	Horizontal displacement of excavated material from the rock of hardness class 1-4 by 1 000 m3	m^3	1 094.23	85.60	93 666.09
6	167101101R00	Loading of excavated material from the rock of hardness class 1-4 at the quantity smaller than 100 m3	m^3	47.79	163.50	7 813.67
7	171201101R00	Depositing of loose material into tipped fills	m^3	1 094.23	22.60	24 729.60
8	174101101R00	Closing of holes, trenches and shafts with compaction	m^3	43.15	68.00	2 934.20
9	180401213R00	Grassland creation by sowing on slope 1:1	m^2	2 405.89	15.50	37 291.30
10	181101102R00	Levelling of ground surface in cuts in the rock of hardness class 1-4, with compaction	m^2	5 771.85	10.80	62 335.98
11	182101101R00	Slope work in cuts in the rock of hardness class 1 - 4	m^2	2 217.06	42.50	94 225.05
12	182201101R00	Slope work in fills	m^2	188.85	36.90	6 968.57
13	00572465	PROFI standard grass mixture packing of 25 kg	kg	49.56	82.84	4 105.55
14	58344170	Crusher-run material of fraction 0-32 B	T	11.96	370.00	4 425.20
	Total of	***1 Earthworks***				**452 265.03**
Part:	**2**	**Foundations and foundation engineering**				
15	212571112R00	Filling of drainage trenches with ballast	m3	5.85	776.00	4 539.60
	Total of	***2 Foundations and foundation engineering***				**4 539.60**
Part:	**4**	**Horizontal structures**				
16	457971111R00	Placing a geotextile layer on a slope by 1:5, width less than 3 m	m^2	4.00	28.10	112.40
17	464531112R00	Gritting of crushed coarse aggregates 63-125 mm from the terrain	m^3	4.13	895.00	3 696.35
18	40444999.A	Stop road sign P6 700, retro reflexive foil class 1, EG 7 years	No.	1.00	943.92	943.92
19	67390880	Petex 400 non-woven extruded fabric, white, width 150cm	m^2	6.12	25.75	157.59
	Total of	***4 Horizontal structures***				**4 910.26**
Part:	**5**	**Roads**				
20	564261111R00	Bottom course of gravel sand after compaction 20 cm in thickness	m^2	5 000.34	133.50	667 545.39
21	564861111R00	Bottom course of crusher-run material after compaction 20 cm in thickness	m^2	5 132.44	185.50	952 067.62
22	569721112R00	Chip seal with crushed aggregate, 9 cm in thickness	m^2	1 013.00	97.00	98 261.00
23	573411114R00	Bitumen coat with gravel, road bitumen, 1.5 kg/m2	m^2	3 734.50	35.60	132 948.20
24	575181111R00	Penetration bitumen macadam, aggregates + asphalt 9 cm	m^2	3 825.67	198.00	757 482.66
	Total of	***5 Roads***				**2 608 304.87**
Part:	**8**	**Piping**				
25	871218113R00	Laying of drain pipes into a trench, flex. PVC, by 65 mm	m	34.00	16.60	564.40
26	895641111R00	Installation of drainage outlet from concrete elements, two-part	No.	1.00	559.00	559.00
27	28611223.A	Flexible PVC drain pipe, d 100 mm	m	34.34	27.76	953.28
28	592990004	Prefabricated drainage outlet	No.	1.02	600.00	612.00
	Total of	***8 Piping***				**2 688.68**

Part:	**91**	**Additional works on the road**				
29	912291111R00	Installation of a plastic safety post	No.	2.00	417.00	834.00
30	914001111R00	Mounting of vertical road signs onto posts, brackets	No.	1.00	428.00	428.00
31	916991115R00	Monolithic channels, gutters less than 0.30 m2 in area	m	4.75	1 217.00	5 780.75
32	919311112R00	Head wall of plain concrete B 10 (C8/10)	m^3	23.28	2 790.00	64 951.20
33	919511011R00	Construction of pipe culvert of concrete pipes DN 400	m	68.50	1 635.00	111 997.50
34	919511211R00	Construction of pipe culvert of concrete pipes DN 600	m	5.50	2 075.00	11 412.50
35	56288950	Coloured traffic delineator 1 200 mm with foil	No.	2.00	150.53	301.06
36	59222408.A	Bell-and-spigot pipe of reinforced concrete TZH-Q 400/2500 integro	No.	28.56	3 156.97	90 163.06
37	59222410	Bell-and-spigot pipe of reinforced concrete TZH-Q 600/2500 integro	No.	2.04	5 420.64	11 058.11
38	553990001	Steel post including coating	No.	1.00	550.00	550.00
	Total of	***91 Additional works on the road***				**297 476.18**
Part:	**93**	**Finishing works of engineering structures**				
39	936561111R00	Base and surface course of aggregates, culverts	m^3	5.10	1 077.00	5 492.70
	Total of	***93 Finishing works of engineering structures***				**5 492.70**
Part:	**96**	**Demolition of structures**				
40	966008111R00	Demolition of pipe culvert made of pipes DN smaller than 30 cm	m	6.00	1 009.00	6 054.00
	Total of	***96 Demolition of structures***				**6 054.00**
Part:	**97**	**Breaking of openings**				
41	979083112R00	Horizontal displacement of rubble to a dump site at a distance shorter than 1000 m	t	4.52	178.00	804.56
	Total of	***97 Breaking of openings***				**804.56**
Part:	**99**	**Displacement of materials at a construction site**				
42	998225111R00	Displacement of materials, road, bitumen course	t	5 571.33	53.70	299 180.42
	Total of	***99 Displacement of materials at a construction site***				**299 180.42**
Part:	**767**	**Metal construction works**				
43	767995108R00	Installation of atypical metal structures above 500 kg	kg	521.73	20.70	10 799.81
44	998767101R00	Displacement of materials for millwright constructions, heights up to do 6 m	t	0.55	844.00	464.20
45	553990004	Transverse drainage long 4,746 – weighty	No.	1.00	33 900.00	33 900.00
	Total of	***767 Metal construction works***				**45 164.01**

1: *The line item cost estimate of a common facility "Rural Road C5 Ke kříži"*

The groups of parts of the structure belong to the main construction activity (MCA) with the exception of group No. 7.

The complete line item cost estimate of a structure contains detailed bill of quantity, which is drawn up on the basis of project documents of the structure, and cost estimate sheets. These sheets contain estimated items in the bill of quantity. In the cost estimate the costs of parts of the structure are summarized in the cost recapitulation sheet. Aggregate data on the costs of the entire structure are indicated in the cost estimate cover sheet.

Fig. 1 shows an example of the cost estimate sheet from the line item cost estimate for the "Rural Road C5 called Ke kříži". The cost estimate was worked out for the 2010/2nd half-year price level.

The initial costs in the line item cost estimate are generally calculated from the following equation:

$$N_R = \sum_{i=1}^{m} n_i = \sum_{i=1}^{m} q_i \times jc_i, \quad (1)$$

where:

N_R . the initial costs of an implemented common facility (Kč),

n_i.... the costs of the i-th to m-th item in the line item cost estimate (Kč),

q_i.... the quantity of the i-th to m-th item in the line item cost estimate (units of measure),

jc_i ... the unit price of the i-th to m-th item in the line item cost estimate (Kč/unit of measure).

Cost indicators of structures

Line item cost estimates are documents for the elaboration of which it is necessary to know both construction and technological detailed information about the designed structure of common facilities. The cost engineer should have the actual price

database and suitable software for the budget elaboration.

However, the employees of land authorities do not have such detailed information at their disposal to make decisions on investment in the phase of preliminary estimation of costs for the application for subsidy or for resources from the state budget. For these cases it is advisable to build a database of cost indicators of common facilities of land consolidation. The available databases of cost indicators of structures compiled by private engineering organizations do not comprise the specific structures of common facilities of land consolidation that would reflect the actual price level and would be arranged in a suitable well applicable form.

The database of cost indicators of common facilities of land consolidation has been built stepwise in cooperation of the employees of Research Institute of Soil and Water Conservation, workplace in Brno, and the employees and students of the Institute of Structural Economics and Management at the Faculty of Civil Engineering of Brno University of Technology (Malečková, 2010; Švadlenková, 2011), under substantial support of project engineering offices, land authorities and employees of the Institute of Landscape Water Resources Management at the Faculty of Civil Engineering of Brno University of Technology.

Fig. 2 shows an example of a card of the cost indicator. It is a card of the cost indicator drawn up on the basis of the above line item cost estimate. The card is divided into several parts designated by letters.

Part A shows the name of the structure and its location in the cadastral area. Part B provides a brief construction and technical description of the structure of common facility. Part C contains cost estimated data in Czech crowns related to the unit of measure: e.g. square meter of built-up area (m^2 BA), metre of road length (m RL), etc. Just this data is the most important for an expeditious calculation of initial costs of the structure of common facility. The calculation of the cost indicator is based on cost estimate as shown by the equation below:

$$NU_R = N_R / Q_R, \quad (2)$$

where:

NU_R ....the cost indicator (Kč/u. of m.) of the implemented common facility,

N_R .....the initial costs (Kč) of the implemented common facility,

Q_R.....the quantity (u. of m.) of the implemented common facility, e.g. m^2 of built-up area (m^2 BA) or road length (m RL).

Part D presents crucial data on costs and decisive units of measure. Part E is designed for a schematic diagram either taken over from the project or simplified one with the indication of the most important data. It should enable the user to rapidly estimate whether the common facility depicted on the card is similar to the facility that is to be budgeted. Part F contains the costs from the cost estimate recapitulation sheet in accordance with CSSW for the particular parts of the structure. Part G shows additional data.

The cards of cost indicators are compiled on the basis of information and data acquired in the field. The sources are project documents and line item cost estimates of planned or already implemented structures of common facilities of land consolidation. Line item cost estimates used for the compilation of cards of cost indicators are usually drawn up by cost engineers of the project engineering office in the pre-investment phase or by cost engineers of the contractor in the bidding and implementation phase. From them data are entered into cards of cost indicators in a transparent way.

Based on the cost indicators of already implemented structures the user will draw up the estimation of initial costs of a newly planned common facility applying this equation:

$$N_P = NU_R \times Q_P \ , \quad (3)$$

where:

N_P.....the initial costs (Kč) of the planned common facility,

NU_R ....the cost indicator (Kč/u. of m.) of a similar implemented common facility,

Q_P.....the quantity (u. of m.) of the planned common facility, e.g. m^2 of the built-up area (m^2 BA) or road length (m RL).

Obviously, the accuracy of the estimation of initial costs mainly depends on how recent the price level of the cost indicator is used. It is also necessary

I: *Average cost indicators of common facilities*

Common facility name	Cost indicator (Kč/u. of m.)	Unit of measure (u. of m.)
Rural road - new construction	1 329	m^2 of built-up area (m^2 BA)
Rural road - reconstruction	1 220	m^2 of built-up area (m^2 BA)
Development of existing rural roads	1 142	m^2 of built-up area (m^2 BA)
Planting of greenery along rural roads	699	Number of trees (No. TR)
Subsequent maintenance of greenery along rural roads	205	Number of trees (No. TR)
Pond	70	m^3 of the capacity of pond reservoir (m^3 CP)

Card of the cost indicator of a structure of common facility - CICF

Card No. **1**

A Name and location of the structure

Name of the structure:	**Rural road C5 called "Ke kříži"**
Location of the structure:	Cadastral area Nová Ves u Leštiny

B Construction and technical description

It is a reconstruction of the existing rural road. The road is designed in the category of rural roads P4.5/30. The road length is 1 012.58 m and the pavement width is 3.5 m with gravel shoulders 0.5 m in width. In the section of km 0.000-0.135 the gravel sand course was not constructed within this road, total thickness in this section is 290 cm. The road drainage is ensured by the one-side cross fall of 3%. One passing place and one pipe culvert made of concrete have been constructed on this road.

The road structure:

coating N 2V A	~ mm
macadam VM 90	90 mm
crusher-run material ŠD 200	200 mm
gravel sand ŠKP 200	200 mm
total thickness of the road	**490 mm**

C Cost indicators

u. of m.	Kč/u.of.m.
m^2 of BA	**818**
m of RL	**3 679**

D Crucial data

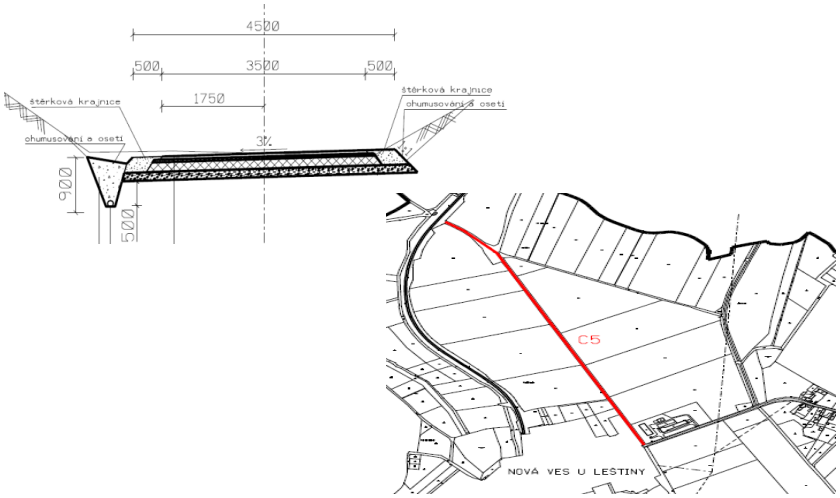
Cost estimate:

Item	u.of m.	Costs of the structure	Costs per u. of m.		%
			m^2 BA	m RL	
BCA	Kč	**3 726 880**	**818**	**3 679**	**100,0**
MCA		3 681 716	808	3 634	98,8
ACA		45 164	10	45	1,2
Assembly		0	0	0	0,0

Decisive units of measure:

Item	u.of m.	Total quantity
Built-up area	m^2 BA	4 557
Road length	m RL	1 013

E Schematic diagram



F Costs of the particular groups of construction and works

	Item	Costs (Kč)	%
	MCA	**3 681 716,00**	**98,8**
1	Earthwork	452 265,00	12,1
2	Foundations and foundation engineering	4 540,00	0,1
4	Horizontal structures	4 910,00	0,1
5	Roads	2 608 305,00	70,0
8	Piping	2 689,00	0,1
9	Other construction and works	609 007,00	16,3

	Item	Costs (Kč)	%
	ACA	**45 164,00**	**1,2**
767	Metal structural constructions	45 164,00	1,2
	Assembly	**0,00**	**0,0**
	Total BCA	**3 726 880,00**	**100,0**

G Additional information

Project engineer:	Agroproject	Classification JKSO:	822 25 76	Price level	2010 / II		
Investor:	Land Office	Classification CZ-CC:	211 21	Date	21.4.2011	Author	Bc. Monika Malečková

2: *An example of the card of the cost indicator for "Rural Road C5 Ke Kříži"*

to have a card of the cost indicator of an already implemented common facility that is very similar to the planned one. The updating of the cost database is feasible by means of statistical indexes of price increases.

The cards of cost indicators are drawn up not only for the construction of common facilities but also for the planting of greenery and its subsequent maintenance.

For fast orientation in estimations the resultant cost indicators will be shown in the form of an overview that should be updated on the basis of price indexes every year. As a matter of interest, some average data from the developed database are presented on the 2010/2nd half-year price level.

The database will be gradually systemized using already available and developed projects that are aimed at the categorization and classification of common facilities of land consolidation.

SUMMARY

Land consolidation can change the features of agricultural landscape to a great extent. The principles of soil and water conservation and development of rural space are implemented particularly through common facilities. The costs of technical measures are obvious and calculable. It is more difficult to calculate economic benefits of these measures; nevertheless, it is possible to estimate e.g. costs of the liquidation of damage caused by erosion (Clarc, 1985; Winpenny, 1991; Barbier, 1995) or economic losses incurred by a reduction in soil productivity (Barbier, 1995) and/or losses of direct payments due to a default in observing the good agricultural and environmental condition (GAEC).

The estimation of initial costs of structures of common facilities is crucial for further economic calculations. In the phase of land consolidation contracting or planning it is not often possible to draw up a detailed line item cost estimate, which is a labour- and time-consuming procedure, but it is advantageous to use the cost indicators of structures of common facilities. The estimation of initial costs is fast, and the employees of land authorities are able to define the assumed bidding price of the structure. The initial costs and the price defined on the basis of estimation enter further calculations, for example assessment of property damage or determination of return on investments.

Different methods are used to assess the level of direct property damage. Besides methods used by insurance companies it is also a newly developed method based on regional property indicators (Aigel, 2005), (Tichá, Korytárová, Hanák, 2003) which is undergoing further development (Korytárová, Hromádka, 2010). For development and application of this method for the rapid estimation of landscape damage the information included in cards of cost indicators of common facilities is indispensable.

The scope of problems connected with the evaluation of economic effectiveness of common facilities of land consolidation is extensive and the lady-authors of this study will solve them in research projects and post-graduate research papers. Input data for such research papers will be cost indicators of common facilities presented in this paper.

Acknowledgement

This paper has been written with the support of the specific research of Brno University of Technology, Faculty of Civil Engineering, grant project FAST-S-11-61 Economic Aspects of Preparation, Realization and Running of Structural Projects and by Project No. 0002704902 Integrated systems of protection and improvement of the soil, water and landscape in the agriculture and development of countryside (Ministry of Agriculture of the CR).

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