Research Journal of Agricultural Science, 48 (4), 2016

IMPROVING THE TECHNICAL SYSTEM EFFICIENCY OF WATER USE THROUGH REFURBISHMENT AND MODERNIZATION OF THE IRRIGATION SYSTEM

Esmeralda Chiorescu[1], **Roxana Clinciu**[1] , **Laura Smuleac**[2]

[1]"Ion Ionescu de la Brad" University of Agricultural Sciences and Veterinary Medicine of Iasi ,
[2]Banat University of Agricultural Sciences and Veterinary Medicine "KingMichael I of Romania" from Timişoara
esmeralda_chiorescu@yahoo.com

Abstract. *The technical system efficiency of irrigation system is the type and playing volume, overall, the ratio between water consumption and water demand from the source. Ideas for fixing, was analyzed if a sprinkler irrigation system with pressure pipes fed by a centralized pressurizing station (SPP), but the methodology can easily be extended to all other types of irrigation systems. As the water, until it reaches the plant, goes down a route consisting of a set of a sprinkling irrigation system with water supply pipes powered by a pressure pumping station that contributes to transport and distribute them, each element is characterized by a yield partially owned, and the returning water use can be determined by the product of these partial yields. In the paper itis developed a mathematical model to assess with greater accuracy, the partial partial yields and water losses are related to all transport-technical elements of water distribution. This mathematical model was applied to the case study represented by the sprinkler irrigation system with pressure lines Berezeni of complex arrangement-FălciuAlbita, Vasluicounty - both existing version and the version proposed refurbishment and modernization. In the current version, Berezeni system may be characterized in the following technical components: 1 ° network of pipelines, distribution is made of asbestos cement pipes and tubes PREMO; 2 ° Watering phones are mainly the type of sprinkler wing; 3 ° station pressurization (SPP) is equipped with pumping aggregates composed of non-adjustable turbo pumps operated with electric motors powered directly from the mains; 4 ° SPP- operating the pipeline network is monitored only on the basis of indications from the gauges placed on individual pump discharge pipes and adjustment commands are manually SPP. The proposed solution for retrofitting and upgrading the irrigation system Berezeni consists of: 1 ° replacing the pipeline transportation-existing distribution network made of HDPE pipes; 2 ° the watering equipment is partially replaced by mobile watering installations with sprinkler installations wing sprinkler and hose drum; 3 ° fitting part of SPP with variable speed pump units through static frequency converter; Additional SPP 4 ° fitting with pressure gauge and meter discharge pipe joint, as well as automatic level indicator Basin water discharge; 5 ° introduction of SCADA automation and assembly operation monitoring SPP – pipeline network. In the case study analyzed resulted in an increase of water use efficiency of 28.76%, which resulted in water savings of 22.34%. In addition, this reduction in water demand implies a significant energy savings, even in the use of mobile watering installations requiring high working pressure.*

Key words: *mathematical model,sprinkler irrigation system, efficiency*

INTRODUCTION

National Rural Development Programme 2014 - 2020 (RDP) provides measures for revamping and upgrading agricultural infrastructure, infrastructure that includes, as a main component, and irrigation systems. Intervention works to these measures are mainly financed from the European Agricultural Fund for Rural Development (EAFRD) and partly by the Ministry of Agriculture and Rural Development through Rural Investment Financing Agency (AFIR).EAFRD and AFIR requirements specific to refurbishment and modernization of irrigation systems shall expressly and reduce water demand. Water requirement of an irrigation system (S.I), whilst ensuring the same water requirements of SI can be reduced only by increasing irrigation system efficiency (technical efficiency system).Irrigation efficiency is a system type and playing volume, overall, the ratio between the volume of water used by the plant useful (water requirements) and the volume of water abstracted from the source (water demand).

As the water until it reaches the plant, a route consisting of a set of technical elements that contribute to transport and distribute them, each element is characterized by a yield partially own efficiency irrigation system can be determined by the product of these yields partial. In the literature are given recommendations on irrigation system efficiency and yields some partial, depending on the type of facility, but only for November S.I designed and / or manufactured before 1989 - technologies, equipment and materials that period.

This paper is developed a mathematical model generally to determine the efficiency of the irrigation system - both old and executed before 1989, currently in operation with a high degree of wear as well as we designed with technology equipment and modern materials.

Ideas for fixing, was analyzed SI particular case of a sprinkler with pressure pipes fed by a centralized pressurizing station (SPP); And this is called plot irrigation (irrigation plot).

The mathematical model proposed allows the evaluation with greater accuracy, yield and partial loss of water transport for all the technical elements-water distribution. Such partial returns were considered the following: for watering the field; Watering mobile facility; Network-distribution pipelines and SPP. In addition, some of the above partial returns may present complex structure, highlighting the main forms of water loss: through percolation through evaporation due to our tight pumps and pipes connecting devices due to accidents etc.

This mathematical model to determine the efficiency of the irrigation system was applied for the case study represented the plot irrigation Berezeni of complex arrangement-FălciuAlbita, Vaslui county - both existing version and the version proposed refurbishment and modernization; since in both cases it was found necessary to water of the same S.I it has been found to increase the saving of water caused by the yield of the latter.

Determining the efficiency of water use, η_a(Cazacu E. et al, 1989), (Hîncu S. et al, 1971), (Smith Del., 1993), η_{SPP}reference η_{PPS} (PricopGh. Et al, 1989).

Irrigation system efficiency, expressed in absolute η_a, or the percent value η_a%, is defined by the following relationship (1).

$$\eta_a = \frac{V_u}{V_s},\ \eta_{a\%} = \frac{V_u}{V_s} \cdot 100\,(\%) \qquad (1)$$

Where: V_u is the water needs (water consumption) of S.I and V_s - water demand (water requirement of S.I.).

As the water until it reaches the plant, a route consisting of a set of technical elements that contribute to transport and distribute them ηa yield can be calculated as the product of partial returns, the following equation (2):

$$\eta_a = \eta_C \cdot \eta_{IU} \cdot \eta_R \cdot \eta_{SP} \qquad (2)$$

Where: η_C is watering the field ¬ yield (water application efficiency); η_{IU} - yield plant watering (I.U), η_R – returnon network, η_{SP} –return pressurizing station.

Next they were systematically examined each of partial returns highlighted above.

MATERIAL AND METHODS

2.1. Water application efficiency

Sprinkler watering, water losses in the field (through evaporation, and by percolation) is p_C% of the useful volume Vu. This means that the volume to be dispensed by the I.U. $\sum V_{IU}$,isexplained inequation (3)::

$$\sum V_{IU} = V_u + V_C^{ev} + V_C^{pc}, \sum V_{IU} = \left(1 + p_{C\%}/100\right)\cdot V_u = \left(1 + p_C\right)\cdot V_u \qquad (3)$$

and thus yield watering the field has the expression (4):

$$\eta_C = \eta_C^{ev}\cdot\eta_C^{pc}, \eta_C^{ev} = \frac{V_u}{V_u + V_C^{ev}}, \eta_C^{pc} = \frac{V_u + V_C^{ev}}{\sum V_{IU}}, \eta_C = \frac{V_u}{\sum V_{IU}} \qquad (4)$$

According to the literature (Hîncu S. et al, 1971) and (PricopGh. Et al, 1989), regulate the functional parameters of the pumping station of pressurization (SPP) by the classic (non adjustable pumps operated at non-adjustable speed), $p_c\% \approx 10\%$..

Plot irrigation analyzed is equipped with two types of I.U mobile: a) γ party wings watering sprinkler; b) (1-γ) parts Sprinkler drum and hose (I.A.T.F.).

Due to inability to distribute pressure evenly to all the heads-up, only parts of α wings sprinkler irrigation works with flow smaller (but respecting the criterion of uniformity proposed by Christiansen) or equal to the flow rate, while the restby (1- α) party works with overflow, exceeding the β times the nominal flow. In general, we can assess losses and broken down as follows equations (5), (6):

$$V_C^{ev} = p_{C\%}^{ev}/100\cdot V_u = p_C^{ev}\cdot V_u, \text{with } p_{C\%}^{ev} = 1\cdots2\% \qquad (5)$$

$$V_C^{pc} = \left(1-\alpha\right)\cdot\left(\beta-1\right)\cdot\left(1+p_C^{ev}\right)\cdot V_u \qquad (6)$$

and in equations (5) followsequation (7):

$$\sum V_{IU} = \left(\alpha+\beta-\alpha\cdot\beta\right)\cdot\left(1+p_C^{ev}\right)\cdot V_u \qquad (7)$$

Thus, from the equations (6) for the partial field yields the following expressions result:

$$\eta_C^{ev} = \frac{V_u}{V_u + p_{C\%}^{ev}/100\cdot V_u} = \frac{1}{1+p_C^{ev}} \qquad (8)$$

$$\eta_C^{pc} = \frac{V_u + V_C^{ev}}{\sum V_{IU}} = \frac{1}{\alpha+\beta-\alpha\cdot\beta} \qquad (9)$$

From equations (5) and (9) gives the following expression (10,11) for sizes p_C, p_C% and by and:

$$p_{C\%} = \left(\alpha+\beta-\alpha\cdot\beta\right)\cdot\left(100+p_{C\%}^{ev}\right)-100 \qquad (10)$$

$$p_C = \left(\alpha+\beta-\alpha\cdot\beta\right)\cdot\left(1+p_C^{ev}\right)-1 \qquad (11)$$

2.2. The yield watering plants:

The yield watering plants, η_{IU}, is given by the ratio of the volume distributed I.U, $\sum V_{IU}$, and volume taken up by I.U. from hydrants in equation (12):

$$\eta_{\mathrm{IU}} = \sum V_{IU} / \sum V_h \tag{12}$$

It is considered that water losses due to those who are not watertight I.U, V_{pierd}^{neet}, I.A.T.F sites are null, but for watering wings δ part of the actual flow rate is distributed by them – equation (13):

$$V_{IU}^{neet} = \gamma \cdot \delta \cdot \sum V_{IU} \tag{13}$$

Volume $\sum V_h$ is the sum- equation (14):

$$\sum V_h = \sum V_{IU} + V_{IU}^{neet} = (1 + \gamma \cdot \delta) \cdot \sum V_{IU} \tag{14}$$

and the expression for return: I.U, η_{IU}, is in equation (15):

$$\eta_{IU} = \sum V_{IU} / \sum V_h = \frac{1}{1 + \gamma \cdot \delta} \tag{15}$$

2.3. Network efficiency:

Network efficiency with pressurized pipes η_{R}, is given by the ratio of the volume distributed hydrants, $\sum V_h$, and volume taken up by the SPP network, VR- equation (16):

$$\eta_{\mathrm{R}} = \sum V_h / V_R \tag{16}$$

For networks with pressure pipes we tubes made of HDPE (high density polyetilen), extrapolating recommendations from the literature (Cazacu E. et al, 1989), η_R ÷ 95% = 98%.

The yield depends directly on the water losses in the network, which generally comprise two main components: 1 ° - water losses due our tight network including hydrants V_R^{neet}; 2°- water losses due to damage (pressure pipeline networks with old V_R^{av}. Considering the loss of mains water so broken, resulting network and yield two components – equation (17):

$$\eta_{\mathrm{R}} = \eta_R^{neet} \cdot \eta_R^{av} \tag{17}$$

Where: η_R^{neet} is the yield due to our tight network; η_R^{av} Yield due to network failure.

Water losses V_R^{neet} can be expressed as equation (18):

$$V_R^{neet} = \frac{p_{R\%}^{neet}}{100} \cdot V_R = p_R^{neet} \cdot V_R \tag{18}$$

where :

For networks with pressure pipes – equation (19):

$$p_{R\%}^{neet} = 100 - \eta_{R\%},\ p_R^{neet} = 1 - \eta_R \tag{19}$$

- For networks with pressurized piping old, following relationship (20):

$$p_{R\%}^{neet} = 5 \ldots 12\% \tag{20}$$

The volume to be conveyed and distributed network, V_{R1}, isexplained in equation (21):

$$V_{R1}=\sum V_h + p_{R\%}^{neet}/100\cdot V_R \text{ sau } V_{R1}=\sum V_h + p_{R}^{neet}\cdot V_R \quad (21)$$

and thus yield due to leaks on the network has value -equation (22)::

$$\eta_R^{neet}=\sum V_h / V_{R1} \quad (22)$$

Water losses V_R^{av} they can be evaluated by the relationship (23):

$$V_R^{av}=K_R\cdot N_{av}\cdot T_{av}\cdot Q_{av} \quad (23)$$

Where: K_R is a coefficient dependent on the type of network: (K_R=1.0 for single line network and network branched K_R=1.3); N_{av} = number of failures recorded in a growing season (N_{av} = 0 if pressurized piping networks with new or HDPE);T_{av}=duration of removing water loss through damage, [h]: (T_{av}= 1.0 h for single line network and T_{av} = 2.0 h for ramified network);Q_{AV}=water flow lost from damage [m^3/h]

(Q_{AV} = 100 m^3/h for single line network and Q_{AV} = 200 m^3/h for ramified network). The total water volume over the network from SPP, V_R, is given by equation (24):

$$V_R=V_{R1}+V_{av} \quad (24)$$

The yield due to network failures is given by equations (25):

$$\eta_R^{av}=\frac{V_{R1}}{V_R}=1-\frac{V_R^{av}}{V_R}; \quad (25)$$

Volumes (24), (21) and (19) were deducted following expressions (26,27,28):

$$V_R=\frac{100}{100-p_{R\%}^{neet}}\left(\sum V_h+V_R^{av}\right)=\frac{\sum V_h+V_R^{av}}{1-p_R^{neet}} \quad (26)$$

$$V_{R1}=\frac{\sum V_h+p_{R\%}^{neet}/100\cdot V_R^{av}}{1-p_{R\%}^{neet}/100}=\frac{\sum V_h+p_R^{neet}\cdot V_R^{av}}{1-p_R^{neet}} \quad (27)$$

$$V_R^{neet}=\frac{p_{R\%}^{neet}}{100}\cdot\frac{\sum V_h+p_{R\%}^{neet}/100\cdot V_R^{av}}{1-p_{R\%}^{neet}/100}=p_R^{neet}\cdot\frac{\sum V_h+p_R^{neet}\cdot V_R^{av}}{1-p_R^{neet}} \quad (28)$$

2.4. The yield of the pumping station

The yield of the pumping station, η_{SP}, consider losses due the glands and internal communications of the station (suction pipes and / or individual discharge), V_{SP}^{neet} ; loss, are generally very small and in the literature cited weights thereof are not; therefore these losses shoul be assessed only through field observations. The total volume of water pumped over the source V_s is given by equation (29):

$$V_s=V_R+V_{SP}^{neet} \quad (29)$$

The yield of the pumping station, η_{SP} is given by equation (30):

$$\eta_{SP}=\frac{V_R}{V_s} \quad (30)$$

Volume losses V_{SP}^{neet}, typically, less than 1% of Vs (Smith Del., 1993); more accurate determinations can be obtained through direct measurements and observations $q_{ne.P.}$They are proportional to the flow rate of the pump.

Assuming that water flows are not lost due to tight for each pump (the glands and internal communications thereof).They are proportional to the flow rate of the pump, Q_p^{nom} -equation (31):

$$q_P^{neet} = p_P^{neet} \cdot Q_p^{nom}, p_{SP}^{neet} = p_P^{neet} \tag{31}$$

volume losses: V_{SP}^{neet} they can be evaluated by the relation (32):

$$V_{SP}^{neet} = p_{SP}^{neet} \cdot V_s \tag{32}$$

From the relations (29) and (32) follows equation (33)::

$$V_s = \frac{V_R}{1 - p_{SP}^{neet}} \tag{33}$$

RESULTS AND DISCUSSION

The mathematical model described by equations (1) ÷ (33) was applied for the case study represented the plot irrigation Berezeni of Arrangement complex Albita-FălciuVaslui - both in the version existing as well as proposed refurbishment and modernization assumption considering, in both embodiments, the same water requirements of SI.

3.1. Assess the efficiency of water use in the existing situation

In the current version, Berezeni system may be characterized in the following technical components: 1 ° network of pipelines, distribution is made of asbestos cement pipes and tubes PREMO; 2 ° Watering phones are mainly the type of sprinkler wing; 3 ° station pressurization (SPP) is equipped with pumping aggregates composed of non-adjustable turbo pumps operated with electric motors powered directly from the mains; 4 ° SPP- operating the pipeline network is monitored only on the basis of indications from the gauges placed on individual pump discharge pipes, and adjustment commands are manually SPP. Plot 16 Berezeni powered by pressurizing station 16 SPP, the operating records and consultations held with representatives O.U.A.I 16 Berezeni have the following data:

1. water annual requirement of Vs for a period of 5 years representative (Table 1);

Table. 1.

Plot annual requirement of water for 16 Berezeni

Year	2077	2008	2009	2010	2015	Minimal
V_s, [m^3]	304000	104000	529000	45000	758000	348000

2. SPP 16 is equipped with 3 new units Grundfos type VDP 1434/5, each with nominal flow = 504 m^3./h; 2 VDF units 300, each = 510 m^3 / h and 253 MV aggregate 1 with = 500 m^3/h. Since the approx. SPP16 with half of the new pump is carried out. We consider that the nominal flow = 500 m^3 / h, water losses are 3 m^3 / h.

3. percentage losses through network = 11 %

4. frequency of damage: damage to the tray n_{av} = 2-7 days;

5. γ% = 60% of the I.U

Sprinkler watering wings are, where δ% = 10% of the flow distributed by a sprinkler wing is lost through (connections between tubes).

The data available were determined:

Average number of failures during the growing season

$N_{av} = n_{av} \cdot T_{veg}/t_{av} = 2 \cdot 214/7 = 61{,}1$-proportionality factor isequation (33).

Waterlosses duet o networkfailures, relationship (23), (24).

Further calculations were summarized in (Table 2), where they said equations used to determine each size. It started from the annual water requirement (during the growing season), average years between 2010 and 2007 -2015; V_s = 348.000 $m^{3,}$ taken from(Table. 1), col. 7th and then stated in (Table 2), col. I-a.

Finally they were obtained:

Annual water demand (during the growing season) irrigation system, the average years between 2007÷2010 and 2015, taken from (Table 3), col. 20-a,V_u = 245.548 m^3

Efficiency irrigation systems :η_a = 0.7085 0r 70.85% taken from (Table 2), col. 22nd.

Table 2

Centralization calculations to assess the efficiency of the irrigation system in the existing situation

Symbol	V_s	p_{SP}^{neet}	V_{SP}^{neet}	V_R	η_{SP}	p_R^{neet}	V_R^{av}	V_{R1}
U.M.	[m^3]	[%]	[m^3]	[m^3]	[-]	[%]	[m^3]	[m^3]
Column	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***
Equations		(31)	(32)	(29)	(30)		(23)	(24)
Value	348000.0	0.006	2088.0	345912.0	0.9940	10.0	23845.7	322066.3
Symbol	η_R^{av}	V_R^{neet}	$\sum V_h$	η_R^{neet}	η_R	$\gamma_{\%}$	$\delta_{\%}$	η_{IU}
U.M.	[-]	[m^3]	[m^3]	[-]	[-]	[%]	[%]	[-]
Column	***9***	***10***	***11***	***12***	***13***	***14***	***15***	***16***
Equations	(25)	(19)	(21)	(22)	(17), (18)			(16)
Value	0.9311	34591.2	287475.1	0.8926	0.8311	60.0	10.0	0.9434
Symbol	$\sum V_{IU}$	V_{IU}^{neet}	$p_{C\%}$	V_u	η_C	η_a		
U.M.	[m^3]	[m^3]	[%]	[m^3]	[-]	[-]		
Column	***17***	***18***	***19***	***20***	***21***	***22***	***23***	***24***
Equations	(15-2)	(15-1),(14)		(5)	(6)	(1-1), (4)		
Value	271202.9	16272.2	10.0	246548.1	0.9091	0.7085		

3.2. Assess the efficiency of the irrigation system when upgraded

The proposed solution for retrofitting and upgrading the irrigation system Berezeni consists of: 1 ° replacing the pipeline transportation-existing distribution network made of HDPE tubes; 2 ° partial replacement of mobile type installations watering with sprinkler installations wing sprinkler and hose drum; 3 ° fitting part of SPP with variable speed pump units through static frequency converter; Additional SPP 4 ° fitting with pressure gauge and meter discharge pipe joint, as well as automatic level indicator Basin water discharge; 5 ° introduction of SCADA automation and assembly operation monitoring SPP- pipeline network. Thus, the design data for Plot 16 Berezeni powered by pressurizing station 16 SPP, we have the following data:

1. Given that the VDF 300 2 units, each with = 510 m3 / h will be replaced by other 2 units Grundfos new type VDP 1434/5, each with nominal flow = 504 m.c./h approx. 5/6 ofSPP16 pump capacity is achieved we consider that the nominal flow = 500 m3 / h, water losses are = 2.5 m^3/h.

2. percentage losses through our tight network = 2%;

3. frequency / number of faults: $N_{av} = 0$

4. γ% = 15% of the I.U. Sprinkler watering wings are, where δ% = 10% of the flow distributed by a sprinkler wing is lost through the watertight us. Further calculations are summarized in (Table 3). It started from the average anuual water demand is valued at point 3.1, V_u= 245.548 m^3, taken from (Table 2), col. 20 th, and then enrolled in (Table 3), col I-a. Finally, there were obtained:

- Annual water demand (during the growing season), average years between 2007 ÷ 2010 and 2015, when upgraded, V_{SM} =270254,4m^3, taken from (Table 3), col 25 th;
- Efficiency irrigation system, when upgraded, η_{aM} = 0.9123 = 91.23% or η_{aM} % taken from (Table 3), col 27 th.

-Economy water carried through modernization, E_c%, using the relationships (34,35):

$$Ec_{\%} = \frac{V_s - V_{sM}}{V_s} \cdot 100 = \frac{348000{,}0 - 270254{,}4}{348000{,}0} \cdot 100 = 22{,}341\ \% \tag{34}$$

$$Ec_{\%} = \frac{1/\eta_a - 1/\eta_{aM}}{1/\eta_a} \cdot 100 = \frac{1/0{,}7085 - 1/0{,}9123}{1/0{,}7085} \cdot 100 = 22{,}341\ \% \tag{35}$$

Value for saving water E_q% =22.341%. It was entered in (Table 3), col. 28th.

Table 3

Centralization calculations to assess the efficiency of water use when upgraded

Symbol	V_u	p_C^{ev}	V_C^{ev}	α	β	V_C^{pc}	$\sum V_{IU}$
U.M.	[m^3]	[%]	[m^3]	[-]	[-]	[m^3]	[m^3]
Column	***1***	***2***	***3***	***4***	***5***	***6***	***7***
Equations			(7)			(8)	(5-1),(5-2),(9)
Value	246548.1	1.5	3698.2	0.5	1.075	9384.2	259630.6
Symbol	η_C^{ev}	η_C^{pc}	η_C	p_C	γ	δ	V_{IU}^{neet}
U.M.	[-]	[-]	[-]	[-]	[%]	[%]	[m^3]
Column	***8***	***9***	***10***	***11***	***12***	***13***	***14***
Equatios	(6-2), (10)	(6-3),(11)	(6-1), (6-4)	(12)			(14)
Value	0.9852	0.9639	0.9496	0.0531	15.0	10.0	3894.5
U.M.	[m^3]	[-]	[%]	[m^3]	[m^3]	[l/s]	[m^3/h]
Column	***15***	***16***	***17***	***18***	***19***	***20***	***21***
Equations	(15)	(13)		(17)			
Symbol	V_u	p_C^{ev}	V_C^{ev}	α	β	V_C^{pc}	$\sum V_{IU}$
Value	263525.0	0.9852	98.00	268903.1	5378.1	138.9	500
Symbol	q_{SP}	p_{SP}^{neet}	V_{SP}^{neet}	V_{sM}	η_{SP}	η_{aM}	$E_{C\%}$
U.M.	[m^3/h]	[-]	[m^3]	[m^3]	[-]	[-]	[%]
Column	***22***	***23***	***24***	***25***	***26***	***27***	***28***
Equations		(31)	(32)	(33)	(30)	(1-1), (4)	(34), (35)
Value	2.5	0.005	1351.3	270254.4	0.9950	0.9123	22.341

3.3 Evaluation of the water economy

Based on the results presented in sections 3.1 and 3.2 referring to the yearly water demands, the water economy was evaluated trough modernization, indicated trough percentage units reported to the existing situation, E_c% utilizing the following equation:

For the direct highlighting of the increase of the technical yield, due to the modernization of SI, on the water economy E_c%, the following equation was determined, with which was obtained the same value for E_c% same as equation (33):

So the value for the water economy is E_c%=22.341 %, a value put in (Table 3), col. 28th.

CONCLUSIONS

1.For highlighting the main technical elements which determine the technical yield of SI, it was evaluated as a product of four partial yields, and the yields for watering the field and for the pipeline network they were considered broken, for each two components.

2. An equation was determined and it highlights the direct influence of the increase of the technical yield of the system on the water economy.

3.A case study was treated afferent to a representative SI for which, by refurbishment and adequate modernization, it was observed an increase of the technical yield by 28.76%, which resulted to an water economy of 22.34%.

4. In the case study analyzed resulted in an increase of water use efficiency of 28.76%, which resulted in water savings of 22.34%. In addition, this reduction in water demand implies a significant energy savings, even in the use of mobile watering installations requiring high working pressure.

BIBLIOGRAPHY

CAZACU E. *et al*, 1989,Irigații, Ed. Ceres, București.

HÎNCU S. *et al*, 1971 - Hidrologie agricolă, Editura Ceres

POPESCU ŞT. , 1993 - Curs de maşini hidraulice. U.T. “Ghe. Asachi“, Iaşi.

PRICOP GH. *et al*, 1989 - Dicționar de îmbunătățiri Funciare, Editura Ceres, ISBN 973-40-0020-9

S.C. LOGITECH PROJECT S.R.L. IAȘI, 2016, D.A.L.I. „Modernizarea şi retehnologizarea sistemului de irigații la O.U.A.I. AGRO IRIG PRUT BEREZENI”, județul Vaslui

ȘMULEAC LAURA, ONCIA SILVICA, Resurse de apă și protecția lor, Ed. Agroprint, Timișoara, 2012

ŞMULEAC LAURA, SIMONA NIȚĂ, ANIȘOARA IENCIU, ADRIAN ŞMULEAC, DICU DANIEL - Topographic survey for the monitoring of the impact of the Brua/Rohuat pipe on water flow in the irrigation system at Fântânele, Arad County, Romania, SGEM2016 Conference Proceedings, ISBN 978-619-7105-81-0 / ISSN 1314-2704, 2 - 5 November, 2016, Book 3 Vol. 3, 333-340, 2016