DEVELOPMENT OF IRRIGATION FOR THE ENSURING OF FORAGE PRODUCTION IN THE SOUTH OF RUSSIA

DÉVELOPPEMENT DE L'IRRIGATION POUR LA PRODUCTION FOURRAGÈRE AU SUD DE LA RUSSIE

Irina F. Yurchenko[1], Aleksei K. Nosov[2]

Le résumé

Les mots-clefs: l'irrigation, la production fourragère, l'agriculture multiforme, les entreprises agricoles, les économies des fermiers.

On a élaboré les arguments scientifiques du développement de l'irrigation au District fédéral du Sud (DFS) de la Russie ainsi que des recommandations pratiques visànt a augmenter le niveau technique des systèmes d'amélioration de la production fourragère dans la cadre de l'agriculture stratifiée.

Les tâches suivantes sont accomplies:

- Analyse de l'état actuel de l'irrigation dans le monde, en Russie et estimation du role de l'irrigation en développement des cultures fourragères;
- Évaluation de l'état technique des systèmes d'amélioration existents; argumentaion des capacités de production des terres fourragères du DFS comprenant la création des paysages agricoles écologiquement durables et hautement productifs;
- Détermination des volumes de production végétale suffisant pour créer une base assurée de ravitaillement en fourrage au DFS;
- Calcul de la superficie des terres irriguées suffisant pour satisfaire les besoins en aliments; argumentation du choix des elements et de la structure des assolements; argumentation de l'ensemble de mesures de bonification et d'organisation économique afin d'augmenter des capacités de production des terres irriguées.

L'agriculture multiforme est typique pour la branche agricole en général. On propose de l'assurer dans le secteur de l'agriculture d'amélioration du DFS. Il est nécessaire de développer la production fourragère sur les terres irriguées pour la production de grand volume de la viande du gros bétail, de la volaille, des porcs. Pour la production du lait on peut utiliser les petits formes de la production fourragère sur les terres irriguées les économies des fermiers

Summaries and Conclusion

A strategy for development of irrigation in Southern Federal District (SFD) of Russia up to 2020, aimed at the increase of efficiency of irrigation and assurance of a guaranteed forage supply in the District, has been worked out. An area of irrigated lands, necessary for the ensuring of forage production and the required growth of cattle stock for the

[1] All-Russia Research Institute of Hydraulic Engineering and Reclamation, Head of Laboratory, 007 127550, ul. Bolshaya Akademicheskaya, d.44, Moscow, Russia. Tel/fax: 007 495 1541326, e-mail:irina@vniigim.ru

[2] North Caucasus Institute of Water Supply Design and Reclamation Construction, Deputy Engineering Director, pr. Kirova, 78, Pyatigorsk, Russia. Tel/fax: 007 8793 339064, e-mail:skgvh@skgvh.ru

purpose of meeting the needs of the population of the District for the livestock products, has been determined.

On the basis of a new energy approach a target crop yield of forage meadowlands, ensuring the ecological sustainability of the agricultural landscape, has been substantiated and the production potential of all types of soils has been calculated for the south of Russia for the first time.

The main principles of implementation of the irrigation development strategy in the SFD have been put forward:

- priority development of field, meadow and pasture forage production on irrigated lands, ensuring stable, ecologically safe productivity of agricultural lands;
- primary development of irrigated agriculture on the basis of large-scale irrigation systems on lands of large agricultural producers;
- ensuring of attractiveness of reclamation projects for investors through the possibility of purchase of lands.

The prime focus on the development of irrigation on farms of large agricultural producers is determined by the following factors: the reduction of overhead expenses when building large irrigation systems and efficiency increase of water use; monetary means that large producers have for participating in the investment process whereas small farming enterprises lack; the ability of large agricultural enterprises to ensure the whole "production of agricultural produce - processing - sales to consumers" process.

A mechanism of implementation of the irrigation development strategy, including state support for irrigated forage production by means of direct financing, soft lending, land and farm mortgage lending, insurance and leasing has been given.

The efficiency of the state support to a great extent depends on the choice of the priority of agricultural producers for forage production development on irrigated lands. Development of the meliorated farming of large agricultural producers will also ensure a positive impact on small farming producers on the lands under irrigation due to the solution at a state level of issues of development of rural areas and infrastructure and the ensuring of well-being of people dwelling therein.

It is proposed to ensure a mixed nature of agriculture (typical for the branch) in the meliorated farming sector in SFD. Forage production on irrigated lands is planned for large-scale production of meat of cattle, poultry and pig. For the production of milk, vegetables and potato, small forms of forage production on meliorated lands will also be in demand.

Results of pilot calculations have shown the efficacy of these measures. Long-term soft loans to be given for a period up to 10 to 15 years without a down payment with the loan repayment up to 9 to 14 years ensure the reduction of the investment payoff period for agricultural producers by 2.8 times.

Important measures of support for agricultural producers are as follows: legislative determination of the reclamation sphere development as a priority direction of the state support for agriculture; the solution at a state level of the question of land ownership and the actual cost of agricultural lands; enhancement of legal safety of agricultural producers; integration of material flows and resources of the state and those of produc-

ers of agricultural produce on irrigated lands by means of creation of a private/state structure - a corporation, uniting authorities, agricultural business and the scientific and production potential.

The worked-out complex of reclamation measures for the increase of the engineering level of reclamation systems, which ensure the effectiveness of irrigated agriculture in forage production, has been implemented in the design of the 6th stage of the Pravo-Egorlynskaya irrigation system (PEIS) in Stavropol region.

As a result of the proposed design solutions the productivity of the irrigated hectare has increased from 30.6 to 100.07 centners of feed units/ha. The engineering level of the reconstructed PEIS and the standard of natural resources use have been raised. The land use ratio of the system has increased from 0.8 to 0.97; the water use ratio - from 0.6 to 0.82, the coefficient of efficiency of the system - from 0.62 to 0.8.

The assessment of eco-economical public and commercial effectiveness of irrigation development in SFD for forage production under the conditions of existing relations between purchasing prices on agricultural products and production costs has been made. With relative capital investments into construction and reconstruction of reclamation systems up to 71 thousand roubles/ha the payoff period for a reclamation investment project to break even amounts to 6.5 years.

Introduction

The solution of present socio-economic tasks of the agro-industrial complex (AIC) of Russia – import substitution and provision of domestically produced livestock products to the population of the country - requires creation of a stable forage supply in the country. Irrigated agriculture, whose development is a topical and timely task for forage production in Southern Federal District (SFD), is an effective way of achieving a stable high productivity of agricultural lands.

The objective of the research has been the scientific substantiation of irrigation development in Southern Federal District and formulation of practical recommendations for raising the engineering level of reclamation systems, which ensure the effectiveness of irrigated agriculture in forage production.

To achieve the set objective the following tasks have been solved:

- analysis of the current irrigation situation in the world and in Russia has been carried out; an assessment of the role of irrigation in developing the forage resources has been made;
- evaluation of the engineering state of operating reclamation systems has been performed; a production potential of forage lands in SFD with a view to creation of ecologically stable and high yielding agricultural landscapes has been substantiated;
- required volumes of crop production for creation of a guaranteed forage supply in SFD have been determined;
- areas of irrigated lands to cover the forage requirements have been calculated; the choice of composition and structure of crop rotation and the choice of a complex of necessary reclamation, organisational and management measures to increase the production potential of irrigated lands has been substantiated.

The scientific novelty of the research consists in:

- the designing of a strategy of irrigation development in SFD, specifying the composition and structure of crop rotation; areas of irrigated lands, required for forage production development; the engineering level of irrigation systems and the economic effectiveness of chosen melioration measures;

- the substantiation of a target yield of irrigated agricultural crops, in accordance with the ecologically permissible productivity of agricultural lands in SFD to ensure the stability of agricultural landscapes and restoration of productive soil capabilities. This has made it possible for the first time to calculate the production potential of all types of soils in southern Russia with a view to the new energy approach to the assessment of the state of agricultural lands;

- the formulation of a package of melioration measures to ensure the transition of the melioration sector to the innovative high-end technology-oriented development, making it possible to substantially save water and material resources through the increase of the efficiency factor of a system, water use and land use ratios and other performance indices of irrigation systems.

1. The assessment of the current state of the AIC (Agro-Industrial Complex) and the role of irrigation in SFD

The area of agricultural lands in SFD amounts to 43.89 mln. ha, including 22.83 he of plough land. The bulk of reclamation lands is represented by irrigated lands. Out of 2153 mln. ha of irrigated lands on the list, currently to the tune of 652 thousand ha are under irrigation (Figure 1).

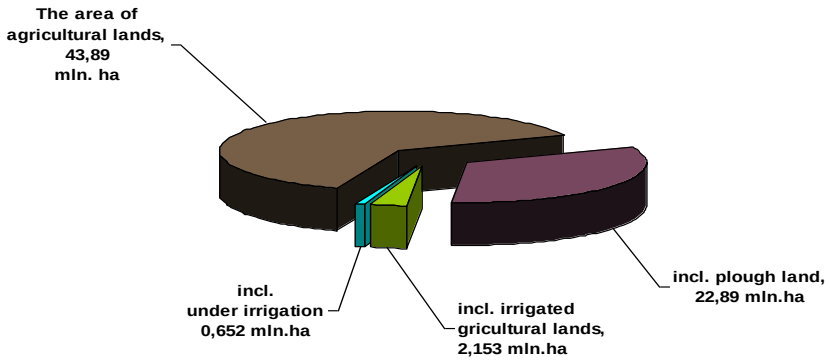

Figure 1. - The structure of agricultural lands in SFD

Up to 30% of the gross volume of grain in Russian Federation, up to 25% of sugar beet, 20% of vegetables, more than 55% of sunflower seeds are produced in the District. The output of cattle and poultry for slaughter has amounted to 26.1% of the total in Russian Federation, of milk – 32.97%, eggs – 25.8%. However only in two SFD territories – republics of Dagestan and Kabardino-Balkaria – the volume of gross agricultural produce attained in 1990 has been surpassed. In the period of 2004-2009 conservation of rough and succulent fodder in the District dropped by 45.4%, conservation of forage per cattle unit decreased from 20.2 metric centners of feed units to 13.4 metric centners.

Irrigation is the most important factor for yield growth of agricultural lands in the District. The yield of agricultural crops on irrigated lands is 2-3 times larger than on boghara. SFD not only has land resources but also water resources, necessary for irriga-

tion development, which renders the region favourable for the creation of the forage base here. The riverflow in Povolzhsky and North-Caucasian economic regions of SFD is presented in Table 1. Water withdrawal for irrigating up to 3 411 thousand ha is possible in prospect.

Table 1. - The area of SFD agricultural lands, provided with surface runoff water resources, thousand ha [1]

Time period under consideration	Area of agricultural lands	including along river basins of							
		Volga	Don	Terek	Kuban	Sulak	Samur	Kuma	Other
SFD									
2008	2153	411	232	532	352	139	120	87	281
In prospect up to 2020 (w/out diversion)	3411	637	351	1064	381	438	154	87	300
North-Caucasian Economic Region									
2008 г.	1510			532	352	139	119	87	280
In prospect up to 2020 (w/out diversion)	2423			1064	381	438	154	87	300
Povolshsky Economic Region									
2008 г.	643	411	232						
In prospect up to 2020 (w/out diversion)	988	637	351						

However, starting from 1990 up to date irrigated agricultural lands in SFD have been steadily decreasing, the crop yield on irrigated lands has been declining. This is linked to the fact that no necessary measures of servicing irrigation systems were taken under the conditions of the reorganisation of the economic arrangement of the country.

Within the research the evaluation of the current level of the engineering condition of state-owned irrigation works in SFD has been made. Deviation of gross withdrawn water volume, water use ratio and efficiency factor of the system from the conventional guideline values are taken as baseline reliability and safety indices of irrigation systems operation.

The baseline reliability and safety indices of irrigation systems operation have been determined according to the following relations (1-3):

- Deviation of the actual gross water withdrawal (water diversion) value (P_o) from the conventional guideline value ($P_{но}$) - ΔP_o, %;

$$\Delta P_o = \frac{P_o - P_{но}}{P_{но}} * 100\%$$

(1)

- Deviation of the actual irrigated water use ratio ($ή_{iwur}$) from the conventional guideline value ($ήн_{iwur}$) -Δ $ή_{iwur}$, %;

$$\Delta\eta_{киов} = \frac{\eta_{киов} - \eta^{н}_{киов}}{\eta^{н}_{киов}} * 100\% \quad (2)$$

- Deviation of the actual efficiency factor of the canal (canal network) operation $ή_{o}$ ($ή_{оск}$) from the conventional guideline $Δή_{но}$, ($Δή_{носк}$)- Δ $ή_{o}$

$$\Delta\eta_{o} = 100\frac{\eta_{o} - \eta_{но}}{\eta_{но}} * 100\% \quad (3)$$

The results of the performed evaluation indicate considerable (up to 72.5%) wear and obsolescence of irrigation systems in SFD (Table 2), due to the lack of necessary service measures on irrigation systems. Permissible deviations of all actual indicators from guideline values are only in place in two SFD federal territories – Volgogradskaya oblast and Kabardino-Balkar republic.

2. Productive potential of crop lands

The evaluation of the productive potential and ecologically allowable productivity of main SFD soils with integrated reclamation has been carried out in accordance with recommendations [2]. Consideration of energy efficiency in irrigated agriculture through the increase of use of thermal solar energy is a distinctive aspect of the accepted approach. Ecologically safe productivity of main soils in SFD with a view to the assurance of ecological sustainability of the agricultural landscape has been determined. Irrigation increases the maximum productivity (productive potential) of chernozem (black earth), chestnut and brown semi-arid soils in SFD up to 12, 10.7 and 9.7-9.9 thousand forage units, respectively.

3. The strategy of irrigation development in SFD

The analysis of environmental and economic conditions of the District has rendered it possible to design a strategy (a package of first-priority and further tasks and measures) of irrigation development in SFD (Figure 2). The objective of the strategy is priority rate development of forage production on irrigated agricultural lands to provide the population with home produced livestock products in the required quantity and of proper quality.

Tasks of the strategy: increase in productivity of irrigated lands and in sustainability of agricultural landscape; renovation, reconstruction and development of the reclamation facilities; growth in the engineering level of the reclamation works.

Table 2. - The results of the evaluation of the engineering condition of state-owned irrigation works in SFD

	Water withdrawal evaluation			IWUR evaluation			EF (efficiency factor) evaluation	
	Conventional guideline volume of gross water withdrawal, Pon m^3/ha	Actual volume of gross water withdrawal, Po m^3/ha	Deviations of ΔPo actual water withdrawal from conventional guideline value, %	Actual values ήф of IWUR	Conventional guideline, ήнIWUR	Deviations Δ ήф of actual IWUR. from conventional guideline value, %	Actual EF , ήо	Deviations Δήо of actual CE from conventional guideline value, %
TOTAL in RF	2744.46	686.626	143.64	0.35	0.85	-59.21	0.85	4.2
SFD	5175	8640	66,96	0,51	0,87	-41,44	0,87	6.74
R. of Adygeya	5175	27170	425,02	0,17	0,87	-80,95		
R. of Ingushetia	5175	6703	29,52	0,67	0,87	-22,79		
Kabardino-Balkar r,	5175	4691	-9,36	0,96	0,87	10,33	0.80	1.8
R. of Kalmykia	5175	16966	227,84	0,27	0,87	-69,50		
Karachayevo-Cherkesskaya r.	5175	1049	-79,72	4,29	0,87	393,19		
R. of North Ossetia	5175	4346	-16,02	1,04	0,87	19,08	0.77	5.58
Krasnodar krai	5175	10454	102,01	0,43	0,87	-50,50		
Stavropol krai	5175	8383	61,99	0,54	0,87	-38,27	0.65	20.2
Astrakhanskaya obl.	5175	18027	248,34	0,25	0,87	-71,29		
Volgogradskaya obl.	5175	5660	9,37	0,80	0,87	-8,57	0.80	1.8
Chechen r.	5175	10814	108,96	0,42	0,87	-52,14	0.76	6.7

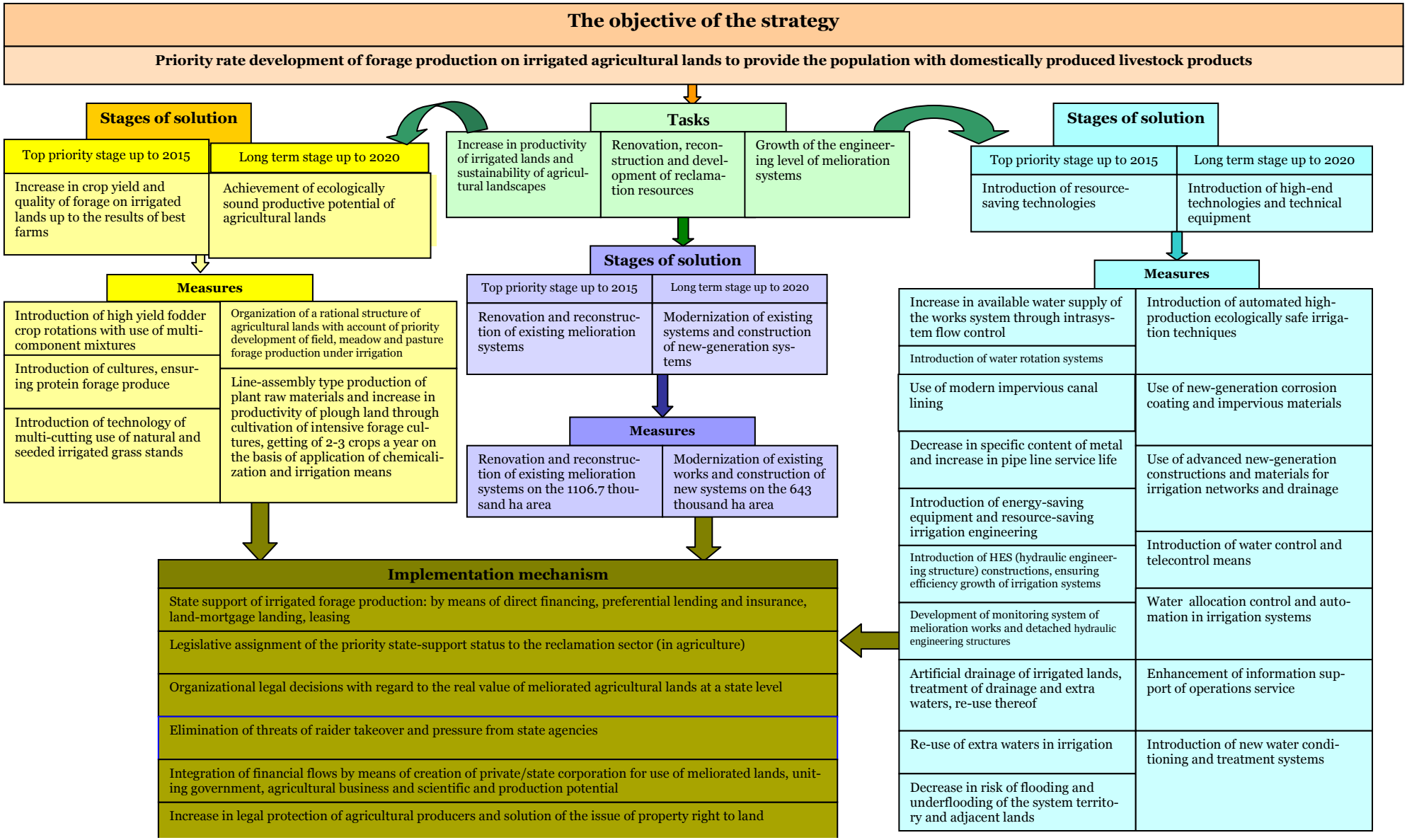

Figure 2. - The strategy of irrigation development in SFD

The main principles of the strategy implementation are:

- priority development of field, meadow, and pasture forage production on irrigated lands to insure stable, ecologically safe productivity of agricultural lands;
- prior development of irrigated agriculture on the basis of powerful irrigation systems on lands of large agricultural producers;
- ensuring of investment attractiveness of reclamation projects through the possibility of taking lands into possession [3].

Orientation for primary development of irrigation on farms of *large* agricultural producers is supported by: reduction of overhead costs when building large-scale irrigation systems and efficiency enhancement of water use management; the fact that large producers - unlike little farming enterprises - have monetary resources for participation in this investment project; ability of large agricultural producers to ensure all links of the "agricultural production – processing – sales to consumers" chain.

Restoration and further development of the reclamation complex with large hydraulic engineering structures (HES) will not only contribute to the increasing of the gross produce output, but also ensure the reliability and safety of HES operation, precluding the possibility of occurrence of emergencies in the area of influence of large hydraulic engineering facilities. Besides, this will ensure a positive impact on small agricultural produce farms on irrigated lands through the reduction of natural and technogenic risks, caused by acts of nature, by availability and accessibility of natural resources and by high degree of obsolescence and physical wear of the reclamation facilities.

The positive impact of development of reclamation resources of large agricultural producers on small agricultural produce farms on irrigated lands is also expected due to the solution at a state level of the issue of development of rural areas, infrastructure therein and assurance of the well-being of people dwelling there.

Moreover the social situation in rural areas will improve through preservation of existing jobs and creation of new jobs and the growth of the taxable base there; issues of water supply and agricultural water supply of rural settlements, preclusion of desertification of lands will be solved. All this will lead to the improvement of the quality of life of the rural population.

The currently achieved level of production of livestock products in SFD is 2.6 times lower than the need of the population in meat and 2.2 times lower of that in milk.

The total area of irrigated lands in SFD to cover the requirements of the region in agricultural products will make up 2797 thousand ha, out of which 2182 thousand ha will be for forage production. The area of newly constructed irrigation will be 643 thousand ha, the area of reconstructed irrigation will be 1107 thousand ha.

For successful implementation of the irrigation development strategy in SFD the following conditions are necessary:

- measures of legislative, legal and financial state support for forage producers on irrigated lands;
- concentration of material flows and resources of the state and agricultural producers on irrigated lands.

It is proposed to materialise the financial state support for forage production under irrigation by means of direct financing, preferential and land-mortgage lending, insurance and leasing.

Results of pilot calculations have shown the effectualness of these measures. Long term zero-downpayment preferential credits for a period of 10 to 15 years with loan repayment for 9 to 14 years ensure the reduction of the period of return of investment made by producers by 2.8 times. The use of leasing sufficiently – up to 2-3 years – reduces the period of return of investments, formed by agricultural producers with own means.

The effectiveness of financial support by the state depends on the choice of priority ranking of agricultural producers for the development of forage production on irrigated lands. It is proposed that the 'mixedness' of agriculture, typical for the branch as a whole, be achieved in the meliorated agriculture in SFD, as well. It is planned that large forms of forage production on irrigated lands will be for cattle, pig and poultry meat production. For milk production and vegetable and potato growing small forms of forage production on irrigated lands will be in demand.

The following are important measures of legislative and legal support for agricultural producers:

- legislative definition of the reclamation sector development as a priority direction of the state support for the agriculture;
- solution at a state level of the issue of land property and the real value of agricultural lands;
- increase in the legal safety of agricultural producers.

For the integration of material flows and resources of the state agricultural producers on irrigated lands creation of a private/state structure – a corporation, uniting government authorities, agricultural business and scientific and industrial potential – will be required.

The evaluation of ecological and economic efficiency of the project of development of irrigation in SFD has been carried out according to recommendations of RD-APK 3.00.01.003-03 [guideline documents]. As calculations have shown, expenses do not surpass the profit from the project implementation under conditions of the parity of purchasing prices on agricultural and industrial products, either for public or commercial effectiveness, which testifies to the expediency of forage production on irrigated lands of the region both for the state and participants of the investment projects.

4. Approbation of the irrigation development strategy in SFD

The effectiveness of the proposed strategy of irrigation development in SFD has been supported by the example of the project of expansion and reconstruction of the 6th stage facilities of the Pravo-Egorlykskaya water supply and irrigation system (PEIS) in Stavropol kray.

The purpose of the system is to supply water to the territory of 1.5 mln. ha, and irrigate an area of 153.0 thousand ha for development of production of commodity grain and forage. The wettest southern, south-western and western parts of the system territory are represented by common and southern chernozems (blackearth), which - as the climate dryness increases – grade into chestnut soils. The operational Pravo-Egorlykskaya sys-

tem was put into service in 1960 with a water supply area of 1.5 mln. ha and an irrigation area of 96.960 thousand ha.

Based on the results of the analysis of natural and economic conditions of the territory, a conclusion on the necessity of reconstruction of the system to raise its engineering level has been reached. The following major engineering designs and solutions have been considered: system feed management scheme; anti-seepage measures; intrasystem storage reservoirs; re-use of extra and collector-drainage waters; replacement of irrigation engineering; drainage construction, anti-erosion measures.

For a more effective use of water resources it is proposed to raise the efficiency of main canals by means of compaction of canal beds with the help of the calmative explosion method, which will help save up to 139 mln. m3 of water resources. The efficiency factor of main canals will thus rise up to 0.88. The saving of water resources will make it possible to provide water for extra 69.85 thousand ha of irrigated lands.

For reduction of the salinity of waters in water receivers it is planned to treat drainage waters and use them for purposes of fish farms, for which construction of ponds with biological pre-treatment of water is envisaged in gullies (Figure 3).

Collector-drainage salinized water resources management plan

Collector-drainage waters – volume 76,67 mln. m3 (average salinity 0,9 g/l)

Biological pond with Higher Water Plants

HWP ensure removal of 99% of all forms of inorganic nitrogen, 60% $Na^{++}K+$ 71%, SO^{2-}_4 and 83% Cl^-

Reed, reed mace, water hyacinth, etc.

Water receiver

Name of collector-drainage water receviers	Annual volume of collector-drainage water.
r. Tashla	11,50
r. M. Kutulta	9.66
r. B. Kutulta	7,04
r B. Tok	3.62
r. M. Tok	28.61
b. Solenaya	4,01
b. Gashun	6,92
b. M. Bashanta	0,26
b. B. Bashanta	1,31
r. B. Jalga	2,03
b. Dunda	1.69

Figure 3. - Drainage waters bioremediation ponds

For preclusion of unscheduled water discharges, presently the system has 25 balance storage reservoirs with a total tank age of 11.2 mln. m^3. Construction of 20 additional reservoirs with a total volume of 1925 thousand m3 is planned, to primarily play the role of retarding reservoirs, which will throughout 24 hours regulate the runoff of water distributors and will also be used as settling basins for the operation of watering machines.

Irrigated plots are planned for 6-8-course high-yield fodder crop rotations. The designed productivity of agricultural crops has been determined with account of the natural resources potential, evaluation of ecological sustainability of agricultural landscapes with mature chernozem and chestnut soils.

Change in composition shares of forage cultures by means of reduction of grain crops has demanded the revision of irrigation regimes and areas. Irrigation water requirements have been calculated based on the yearly water balance deficit of soils with a 75% probability.

Depending on the chosen irrigation technique, terrain conditions, organisational and economic conditions of the system, both open and closed irrigation networks are envisaged. An open irrigation network is envisaged on irrigated plots with EDMF Kuban [electrical frontal sprinkling machine] and DDA-100V with slopes up to 0,005. Replacement of a previously planned DDA 100MA watering machine with DDA-100V will ensure mobility, high productiveness and effectiveness of the irrigation process, rational use of the irrigated area and irrigation water through the possibility of regulating the irrigation rate and sprinkling distribution evenness; it will make it possible to lower the need for stoop labour. The saving of water resources will reach 8-10% from the irrigation requirement.

In the system zone organisational and economic anti-erosion measures are planned (table 3); agricultural methods (applying of plaster and slitting) are planned for the prevention of salivation and alkalinisation of lands.

Table 3. - Organizational and economic measures of soil saving

Regions	Soil-protecting crop rotations on fallow lands, thousand ha	Soil-protecting crop rotations on slope lands, thousand ha	Grassing of plough land, thousand ha	Forest belt, thousand ha	Pasture hay rotations, normal cattle grazing, thousand head of cattle
Apanasenkovsky	80	-	2,4	323,5	78,3
Ipatovsky	100	-	8,3	393,0	82,3
Krasnogvardeysky	48	4	3,6	224,6	26,2
Izobilnensky	-	20	8,1	176,9	25,7
Trunovsky	6	3	10,8	170,1	22,5
TOTAL	234	27	33,2	1288,1	235,0

With the purpose of intensification of forage production on cultivated pastures, situated in ravines and lows, irrigation on the basis of local flow on an area of 3,3 thousand ha with hose sprinklers DSh-110 "Agros" is planned, which will render it possible to increase their efficiency by 5-6 t feed units/ha.

The total area of new construction and reconstruction of irrigation systems of the 6th stage of PEIS will make up 12.0 thousand 643 ha.

The efficiency of the project has been appraised on the basis of the discounted net balance from the incremental flow of the investing and operating activities, implemented in the project. As an additional factor, the period of return of investments with regard to the net present value has been considered. The results of the appraisal have shown the effectiveness of the project, as the discounted net balance is positive for all kinds of calculation– public efficiency, commercial and budget effectiveness of investment in the irrigation development of the PEIS. The payback period for the public efficiency does not exceed 9 years.

Conclusion

Thus, it is established that the measures developed for the South of Russia for the increase in the engineering level of operational irrigation systems, and reconstruction and construction of new irrigation systems are promising for the growth of forage production and increase in livestock numbers in the region in the quantity sufficient for providing the population with home-produced livestock products, which is necessary for solving the problem of food security in the country [4].

References

1. Plan of multipurpose usage and conservation of water resources of the Kuban river. 2005 / YuzhNIIGIM Report. – Rostov-on-Don.

2. Kireycheva L.V., Belova I.V., Hohlova O.B. 2006. Methodology of productive potential forecast and formation of a stable meliorative agricultural landscape. / L.V. Kireycheva, I.V. Belova, O.B. Hohlova // Methods and techniques of integrated melioration ecosystem water use. M.

3. Kireycheva L.V., Nosov K. N., Yurchenko I. F. 2007. Development of irrigation in Russian Federation in 2009-2018 for conservation and recovery of natural resources potential of agricultural landscapes, ensuring of national food security and improvement of the quality of life of rural population (analitical report)/ L.V. Kireycheva, K. N. Nosov, I.F. Yurchenko. M..

4. Food security doctrine. 2010. M.