REGISTER OF RESEARCH ON IRRIGATION AND DRAINAGE

QUESTIONNAIRE

A	**Project title:**
Study of an Irrigation Technique for Secondary Crops of the Rice Crop Rotation	

B	**Topic n^{o} : 1**	Sub-topic n^{o}: 4
1)	1	Technical field n^{o}: 4
2)	Category n^{o}: 01	

C	**Project location**	
	Country: Republic of Kazakhstan	Area: 7072 ha (net)
Chimkent province; Chardarinsky district, «50 Let Octyabrya» state farm		

D	**Duration of the project:**		
	Year in which the project was started: 1969	Project completed:	1973
		Dates of Expertise:	1974, 1976

E	**Organizations and technical staff involved**	
1	Supervisor/project coordinator: Grigory Nikolaevich Zhdanov	%
	Organization: Kazakh Research Institute of Water Management (KazNIIVKH) Address: Taraz, K.Koygeldy 12 telephone: fax: E-mail:	Staff resources 100
Other counterparts:	Organizations Surname First name	
1		%
2		%
3		%
4		%
Other collaborators:	man-years	

F	**Funding agencies**	
	Full name or acronym	Percentage of project finance provided
1	All-Union State Design-Research Institute on Design of Rice Irrigation Systems (Soyuzgiproris)	100 %
2		%
3		%

G	Summary of research project

1 *Objective and technical fields*:

Rectangular checks of the Krasnodar type do not meet the requirements of secondary crop growing. A check for rice irrigation, as a rule, does not coincide with a treatment check; at the same time it is not coordinated with the area of irrigation and treatment of secondary crops. These facts caused the necessity of finding a rational irrigation method.

The objective is finding rational lucerne irrigation methods in the rice crop rotation and determination of optimal elements of an irrigation technique guaranteeing the possibility of high lucerne yield and preservation and improvement of the reclamation state of irrigated lands.

2 *Scientific and technical approaches:*

Irrigation methods used in tests were studied as equivalent ones with all their advantages and disadvantages. This allowed to estimate their influence on the water regime of soils and crop capacity, moistening uniformity of an irrigated plot and irrigation water saving; and on water-physical, agrochemical and structural properties of soils.

Studies of irrigation technique elements under different irrigation methods included observations over water flow velocity in a check, moistening uniformity, depth of moisture distribution, irrigation and waste water flow rate, duration of water standing in a check, lucerne soaking, etc.

3 *Environment characteristics:*

The climate is characterized by a high thermal potential (4600-4800^{0}C) with considerable amplitudes of temperature reaching 45^{0}C. Annual precipitation is 165-200 mm, the maximum precipitation is in spring and autumn. Relative humidity of a warm period does not exceed 45-35%, minimum humidity is in June-August (18%). Dryness of air and wind result in a hot dry wind character of a growing season. On the testing plots meadow-gray soils predominate, their distinctive feature is complexity and heterogeneity of texture. In soils 0,05-0,001 mm fractions predominate (60-70%). Sand percentage (1,00-0,05 mm) in 0-60 cm soil layer is 10-20%; its percentage in lower layers reaches 60-80%. Water-physical properties of a rooting zone are the following: volume weight is 1,45-1,48 g/cm^3, specific weight is 2,71-2,74 g/cm^3, total porosity is 48-51%, the limit field capacity is 21,8-24,6%. Rate of water absorption is 0,26 m/day, coefficient of permeability is 0,24 m/day. Gross salt content in 0-140 cm soil layer is 159,3-247,4 t/ha; in 0-60 cm layer it is 96,1-142,2 t/ha. According to Astapov classification (1958) the soils are medium-salinizated. Ground waters are in a quaternary deposit and lay at the depth of 1,2-1,5 m in a growing season; in autumn-winter period the water table is depleted down to 2,7-3,0 m from the surface.

4. *Parameters of Pilot Projects and Technical Solutions:*

Testing plots with the area of 35-40 ha each have a rice irrigation system design with rectangular checks of the Krasnodar type. A rectangular check is 160-200 m wide and 800-1000 m long with the area of 12-15 ha. Average area of checks is 3-4 ha. Checks are located across a rectangular field and have their own water outlet and importation works. As a rule, leveling of checks is broken after rice growing, differences of check surface height reach 30 cm. Irrigation release canals are of a two-side command.

Suggested technical decisions include coordination of elements of an irrigation technique under different irrigation methods with design peculiarities of a rice irrigation system with rectangular checks of the Krasnodar type.

5 *Methodology:*

Lucerne irrigation methods were studied under the optimal irrigation regime. The area of a variant was determined by sizes of checks and was 3-4 ha. The following variants were studied: usual check flooding; irrigation through strips within a check; furrow irrigation; border irrigation using PPA-165. For all the variants observations included water flow rate; velocity of a water flow on a check surface; depth of flooding; depth of soil moistening along the irrigation element; moistening uniformity; soaking and lodging of plants; volumetric, aggregate and microaggregate composition of soil. Additional observations were carried out over the dynamics of soil moisture; water table depth; increase of a green mass and a root system; phenology; chemical composition of soils and ground waters. Pilot plots were provided with necessary measuring and accounting equipment.

6 *Results*:

Result of studies on lucerne irrigation methods in the rice crop rotation:

<u>Usual check flooding irrigation</u>. Flow rates were maximum. Specific flow rate was 21-29 l/sec. per ha. Water application duration was 17,5-22,3 hours. Productivity was 0,15-0,25 ha/hour. Depth of irrigation was 1650-1910 m^3/ha. Velocity of a watering jet flow was 0,1-0,3 m/min., maximum velocity was at the beginning of a check where the hydraulic head was sufficient. Depth of water after cutting off the water supply was 5-10 cm on 50-60% of a check area, in some low places a water layer reached 25 cm. Water was released from a check for 16-23 hours with a flow rate equal to 11-24 l/sec. in the first moment, than decreased down to 3-4 l/sec. In some low places water stayed for 4 days where plants were soaked on 28,1% of a check area. Depth of moistening near a check ditch was 85-90 cm, it was 30-40 cm near a check waste channel; moistening non-uniformity was 40-45% of the average depth of irrigation. Water table rose by 20-30 cm after each irrigation and depleted during 7-8 days. Check flooding irrigation compacted the arable soil layer from 1,40 g/cm^3 to 1,46 g/cm^3. Lucerne flooding caused destruction of clod particles (more than 10 mm) by more than 10-15% and valuable aggregates (0,25-1,0 mm) by 2-3%. Irrigation reduced total soil salinity of an aeration zone by 0,17-0,18% with initial salinity equal to 0,910%. Under usual flooding plants were oppressed, their height before hay harvesting did not exceed 50 cm. The main mass of roots was in 0-60 m soil layer and was equal to 7,82-8,46 t/ha. First year lucerne yield was 4,65 t/ha with irrigation water expenditures equal to 875 m^3/t, second year lucerne yield did not exceed 10 t/ha with irrigation water expenditures equal to 328 m^3/t. Profitability of lucerne growing with usual flooding irrigation did not exceed 60%.

<u>Check irrigation through strips</u>. Variants with strips 7,2 m, 14,4 m and 28,8 m wide were studied. To create 15-20 cm hydraulic head, borders had to be made at the head of a strip, which reduced land use efficiency down to 0,83 with a strip 7,2 m wide and to 0,87 with a strip 14,4 m wide. Such a low land use efficiency shows inefficiency of dividing a check into small strips. Land use efficiency for a check area equal to 0,94 with strips 28,8 m wide allows to use them under the conditions of rice irrigation schemes, specific flow rate is 1,9-2,6 l/sec. per long meter of the strip width. The main factor of water flow along the strip without inclination was hydraulic head with water surface inclination equal to 0,0003. Water flow velocity in a strip varied from 2,5-3,7 m/min at the beginning of a strip to 0,6-1,4 m/min at the end of a strip. Water application duration was 2,3-3,5 hours. Irrigation productivity was 0,26-0,3 ha/hour. Depth of irrigation was 1130-1329 m^3/ha. Water depth in a strip was 5-15 cm, decreasing from the beginning to the end of a strip. In some low places water layer reached 20 cm with duration of water staying equal to 26-30 hours, plant soaking was on 13,7% of the check area. Average depth of moistening was 60 cm. Difference in

moistening of the head and end parts of strips was 260-300 m^3/ha, irrigation non-uniformity was 1,28. Irrigation caused rise of water table by 10-20 cm, it was depleted in 3-4 days after irrigation. Under strip irrigation arable layer was compacted from 1,41 g/cm^3 to 1,46 g/cm^3. Aggregate and microaggregate soil texture under strip irrigation was almost the same with the control variant (usual check flooding irrigation). Strip irrigation reduced soil salinity of an aeration zone by 0,114% with the initial salinity equal to 1,109%. Under strip irrigation root mass was 8,60 t/ha formed mainly in a soil layer 60 m deep. Height of plants reached 55 cm. First year lucerne yield was 6,78 t/ha, irrigation water expenditures were 487 m^3/t; second year lucerne yield was 12,14 t/ha, irrigation water expenditures were 183 m^3/t. Profitability of strip irrigation of lucerne is 73,2%.

<u>Lucerne furrow irrigation</u>. Medium-deep furrows (12-15 cm) were made across planting every 70 cm. During tests specific flow rate for a furrow was 0,3-1,5 l/sec, water application duration was 7,5-2,1 hours. Depth of irrigation was 1410-1040 m^3/ha. Water flow velocity was 1,6-2,4 m/min in the furrow head and 0,7-0,8 m/min. in the furrow end. Water surface inclination in a furrow was 0,003-0,0005. During irrigation water overflow from one furrow to another is permitted, which is inevitable as a result of the absence of check inclination. Depth of check flooding was 0-5 cm on 29-37% of the area, 5-10 cm on 31-43% of the area, 10-15 cm on 28-31% of the area. On 70-75% of the check area furrow crests were not flooded, which favored soil aeration and prevented plant soaking (soaking per cent did not exceed 1,2). Under lucerne furrow irrigation water application duration did not exceed 8 hours with productivity of 0,25-0,53 ha/hour. Water was not released. Soil in checks was moistened for the depth of 40-80 cm. Irrigation quality evaluated by an non-uniformity coefficient (ratio of actual depths of irrigation in the head and end part of an irrigation plot) was 1,12. Observations over deformation of furrows showed that their subsidence, slipping of slopes and silting took place. Furrows became more rounded, their depth reduced down to 9-12 cm. Compression of an arable soil layer was insignificant and varied from 1,41 g/cm^3 to 1,43 g/cm^3 after two years of lucerne growing. Furrow irrigation favored increase of the content of valuable aggregates by 10-15% and reduction of the content of fractions with the diameter less than 0,25 mm by 2-4%. Under furrow lucerne irrigation salinity of an aeration zone was reduced from 1,125% to 1,043%. In this irrigation variant a root system was the best (10,65 t/ha). Height of plants reached 57,4 cm. First year lucerne yield was 7,52 t/ha, irrigation water expenditures were 378 m^3/t; second year lucerne yield was 15,23 t/ha, irrigation water expenditures were 153 m^3/t. Profitability of furrow irrigation of lucerne is 108,9%.

<u>Border irrigation using PPA-165</u>. Flow rate was 165 l/sec., head was 4,5 m. Specific flow rate varied from 41 to 53 l/sec. per a hectare of the check area or 0,82-0,94 l/sec. per a long meter of a conduit. Water application duration was 5-7 hours. Irrigation productivity was 0,51-0,68 ha/hour. Average water depth in a check was 10-15 cm on 13-20% of the area, 5-10 cm on 49-61% of the area and less than 5 cm on 27-37% of the area. Depth of irrigation was 870-910 m^3/ha. Irrigation water was distributed on the check surface by a flexible irrigation conduit with the diameter of 350 mm with controlled plastic outlets each 70 cm for the flow rate up to 2 l/sec. Irrigation conduit was laid down along the middle of a check from a check ditch to a check release. Velocity of water flow in a check was 0,2-1,2 m/min depending on a microrelief and distance from the irrigation conduit. In some low places (3-4% of the check area) water layer stayed for 27-36 hours after water supply was cut off. Depth of moistening was on the average 45-60 cm. Coefficient of irrigation non-uniformity was 1,11. Irrigation water was not released from checks. Border irrigation caused compression of an arable soil layer from 1,32 g/cm^3 to 1,38 g/cm^3. Aggregate and microaggregate soil texture under PPA-165 border irrigation was almost the same as in the variant with the usual check flooding irrigation. Destruction of clod particles (more than 10 mm) by more than 10-15% and valuable aggregates (0,25-1,0 mm) by 2-3% took place. In 2 years of lucerne growing under this irrigation method salt content did not change and was 1,016% -1,065%. Under border irrigation using PPA-165 plant soaking took place on

3,1% of the check area. Root mass of plants was 8,9 t/ha, height of plants did not exceed 56,1 cm. First year lucerne yield was 7,35 t/ha, irrigation water expenditures were 396 m^3/t; second year lucerne yield was 13,37 t/ha, irrigation water expenditures were 167 m^3/t. Profitability of PPA-165 border irrigation of lucerne is 76,8%.

Analysis of obtained results gives a reason for application of a furrow and PPA-165 border irrigation of lucerne on Kzyl-Kum rice irrigation scheme. Recommended irrigation methods allow to reduce the depth of irrigation down to 850-900 m/ha, which is 40-50% lower than the depth of irrigation under usual check flooding irrigation; to irrigate rapidly (7-10 hours) checks with the area of 3,5-4,0 ha; to create good uniformity of soil moistening (coefficient is 1,11-1,12) and favorable water-air conditions for lucerne. This conclusion is proved by technical-economic showing. Expenditures have the best efficiency, the coefficient of investment efficiency is the biggest (1,9-2,1), profitability is high.

H	**Suggested key-words**		
1	Irrigation methods	4	Elements of an irrigation technique
2	Specific flow rates	5	Water application duration
3	Uniformity of moistening of the check area	6	Efficiency of an irrigation method

I	**Most recent publications (maximum 3)**			
1	Author(s): Grigory Nikolaevich Zhdanov, Nikolay Sergeevich Goryunov			
	Title: Irrigation of lucerne in the crop irrigation rotation and construction of a rice irrigation scheme.			
	Publication details: Results of studies on grounding the lucerne irrigation methods in the rice crop rotation are described. Their influence on aggregate and microaggregate soil texture, the dynamics of water table depth, physiology of plants is determined. Parameters of an irrigation scheme and possibility of using different irrigation methods are described.			
	Year of publication: 1972	free access [•]	restricted [ ]	confidential [ ]
2	Author(s): Grigory Nikolaevich Zhdanov, Victor Georgievich Bykov			
	Title: Lucerne in Chimkent province			
	Publication details: Different irrigation methods for lucerne in the rice crop rotation are considered. Parameters of irrigation regimes and soil productivity are given.			
	Year of publication: 1974	free access [•]	restricted [ ]	confidential [ ]