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Recommendation for cultivation of winter wheat using ridge and furrow method in conditions of irrigation in southern Kazakhstan

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Authors:
Sydyk, D.A., Dr. of Agricultural Sciences, professor;
Karabalayeva, A.D., Dr. of Agricultural Sciences;
Sydykov, M.A., Dr. of Agricultural Sciences.

Address: South-Western Research Institute of Livestock and Plant Science (SWRILPS), Tassai vil., Sairam District, South Kazakhstan Province.
Tel.: +7 7252 55 40 13, nii-tassai@rambler.ru

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The recommendation summarizes the results of scientific-research works on water-resource-saving technologies of cultivation of winter wheat using ridge and furrow method, with substantiation of optimal methods and timing of irrigation.

Models of technologies for winter wheat cultivation using ridge and furrow sowing method are proposed, taking into consideration climatic conditions of irrigated agriculture in southern Kazakhstan.

The recommendations are intended for managers, specialists and farmers of various agricultural companies, researchers and students of higher and secondary educational institutions.

The recommendations were approved at the sessions of the SWRILPS Academic Board (protocol No.4 of 17 September 2014).

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Introduction

Raised-bed planting of crops has seen a widespread adoption in foreign countries in the recent years. In Mexico, Syria, Pakistan, Indonesia, the United States, Canada and other states, this technology accounts for 2 to 18 percent of irrigated areas, helping to significantly increase yields. Adaptation of this advanced planting technology and its adjustment to soil and climate conditions of Kazakhstan would increase the yield of winter wheat and improve the welfare of farmers.

Winter wheat cultivated on irrigated lands occupies 110,500 hectares of a total 1,144,1000 hectares of irrigated land in the South and South-East Kazakhstan.

Duration of the warm period, amount of rainfall in autumn, winter and early spring, abundance of sunlight and heat allow receiving high harvest of winter crops. However, in recent years, the yield of winter wheat under irrigation has made up 25-30 kg per hectare. The main reason for low yields is the failure to comply with the range of recommended agricultural technologies of crop cultivation and lack of resource-saving cultivation technologies, which take into account soil and climatic pecularities of the region.

The proposed recommendation contains new approaches to ridge planting method for winter wheat, with consideration of biological characteristics of new zoned varieties in conditions of irrigated agriculture in southern Kazakhstan.

1. Agrotechnology of cultivation of winter wheat using ridge and furrow method in conditions of irrigation in southern Kazakhstan

1.1 Crop rotation for irrigated lands

In conditions of irrigation, winter wheat is grown in cotton and alfalfa (reclamation field), vegetable and specialized grain crop rotation cycles.

Recommended short-term crop rotations for irrigated agriculture in southern Kazakhstan are as follows:

Option I

1. Winter wheat + Lucerne of 1st year
2. Lucerne of 2nd year
3. Lucerne of 3rd year
4. Winter wheat
5. Winter wheat
6. Corn for grain

Option II

1. Lucerne of 1st year
2. Lucerne of 2nd year
3. Lucerne of 3rd year
4. Winter wheat
5. Corn for grain
6. Winter wheat

When using ridge and furrow cultivation technology, winter wheat in crop rotation should be placed after row crops, so it is necessary to use elements of minimization of tillage with heavy disk tools like BDT-7.0 or BDT-3.0 with current layout with small levelers MV-6.

In conditions of southern Kazakhstan, the latest hybrids approved for use ripen in late September. Therefore, in late September, after corn harvesting, it is necessary to treat the soil with heavy disk tools on two tracks on the diagonal (BDT-3.0 or BDT-7.0). This agrotechnical method ensures minimization of soil treatment to depth of 18-20 cm. If necessary, current layout with small levelers MV-6 is carried out.

1.2 Recommended varieties of winter wheat for cultivation using ridge and furrow technology in conditions of irrigation

The variety of the crop plays an important role in increasing the productivity. New zoned varieties are able to generate high yields on irrigated lands. As literary data prove, the same variety responds differently to certain agricultural practices in various regions.

The problems of efficient use of arable land and increasing crop productivity can be solved by selecting varieties adapted to local soil and climatic conditions.

In this regard, we have researched and recommended the following varieties of spiked cereals, which are most adapted to local climatic conditions of South Kazakhstan Region. The crp[s most adapted to ridge and furrow planting method are: winter wheat Almaly — a promising variety, Zhetysu, Intensivnaya, Steklovidnaya 24 and Yuzhnaya 12 — zoned varieties**.**

Table 2 - Recommended varieties of winter wheat for cultivation using ridge and furrow technology

Administrative districts	Recommended varieties
Tolebi, Tyulkubas, parts of Sairam and Kazygurt districts	Winter wheats Zhetysu, Yuzhnaya 12, Oktyabrina 70, Almaly, Intensivnaya (Dvuruchka — for winter sowing)
Saryagash, parts of Sairam, Kazygurt, Baidybek and Ordabasi districts	Winter wheats Zhetysu, Oktyabrina 70, Yuzhnaya 12, Almaly, Intensivnaya (Dvuruchka — for winter sowing)
Arys, Maktaaral, Otyrar, Sozak, Shardara, parts of Baidybek and Ordabasi districts	Winter wheats Zhetysu, Yuzhnaya 12, Intensivnaya (Dvuruchka — for winter sowing)

Almaly — Almaly variety was bred by the Kazakh Research Institute of Agriculture named after V.R.Vilyams (now NPC of Agriculture and Plant Science) by intervarietal hybridization method followed by individual selection from F_4 hybrid population from crossing Bulgarian sample 6862/50431 with Bezostaya-1. Variation: nigriaristatum-erythrospermum.

The head is spindle-like, elongated (11-12 cm), with medium density (18-20 spikelets per 10 cm of rod's length). The grain is large, oval, red. The grain base is slightly lowered, with shallow furrow; weight of 1,000 seeds is 47-54 g. The stalk is of average height (90-100 cm), resistant to lodging.

Almaly variety is mid-season, high-yielding, flexible; acknowledged as promising in the south and southeast Kazakhstan and Kyrgyzstan. Growth season is 270-290 days, matures 3-4 days later than Progress variety. Winter hardiness is average (96-98

percent). The variety has low susceptibility to yellow rust (1-2 points) and septariose (1-2 points), middle susceptibility to leaf rust (2-3 points) and smut (2-3 points).

After competitive variety trials in 1994-98 against predecessors — alfalfa and sugar beet — the yield of the variety made up 45-75 centners per hectare, with average yield of 62 centners per hectare (average yield of Zhetysu standard was 55 centners per hectare). State variety trials among 25 varieties ranked Almaly first in grain yield in four winter wheat growing areas of Kazakhstan.

Since 2002, the variety has been approved for use in Almaty region on irrigated and rainfed lands.

Zhetysu — Zhetysu variety was bred by the Kazakh Research Institute of Agriculture named after V.R.Vilyams (now NPC of Agriculture and Plant Breeding) by intervarietal hybridization method followed by individual selection from hybrid population Almatinskaya polukarlikovaya x Kharkovskaya-38. Variation: erythrospermum.

The head is cylindric, white, 7-8 cm long, density is 18-20 spikelets per 10 cm of rod's length. The grain is medium size. The weight of 1,000 seeds is 44-46 g. The variety is average height, height of stalk is 90-100 cm, highly resistant to lodging. Bush form is half sprawling, leaf is green, with weak wax spew, raised, broad-leaved.

The variety is mid-season. Growth season is 265-275 days. Winter hardiness is high. Susceptible to rusts, powdery mildew and smut is high.

Zhetysu variety is high-yielding, flexible. State variety trials (1990-1995) of grain yield in 5 regions of Kazakhstan (of 7) at 12 variety lands overcame standards Bezostaya-1, Prikumskaya-36 and Intensivnaya by 13-16 centners per hectare.

Grain yield during the years of competitive variety trials made up 40-76 centners per hectare (56 centners per hectare).

Starting from 1993, the variety has been allowed for use in Almaty, Zhambyl and South-Kazakhstan regions of the Republic of Kazakstan.

Intensivnaya — Intensivnaya, a facultative wheat variety, was bred at the Kyrgyz Research Institute of Agriculture by intraspecific hybridization of Bezostaya 1 x Kazakhstan-126. Variation: ferrugineum. Dvuruchka.

The head is red, raised, cylindrical, average density, length is 10-12 cm. Grain is red, glazed. Weight of 1,000 seeds is 38-45 g, stalk height is 90-110 cm, relatively resistant to lodging.

The variety is early-season, vegetative period is 104-114 days in spring sowing and 245-250 days in winter. Relatively resistant to local races of yellow, stem and leaf rust and hard smut, medium susceptibility to powdery mildew and loose smut.

Grain yield is 34.2-58.2 centners per hectare. Potential yield on irrigated lands is 100 centners per hectare in winter sowing and 80 centners per hectare in spring sowing, on

rainfed black fallow — 70 centners per hectare. The grain has high flour and baking qualities. Variety belongs to strong wheats.

Since 1978, approved for use in Kyrgyz Republic, since 1981 — in Uzbekistan (Kashkadarya, Samarkand and Tashkent regions), since 1987 — in Kazakhstan (South-Kazakhstan region).

Steklovidnaya-24 - Steklovidnaya-24 was bred at the Kazakh Research Institute of Agriculture named after V.R.Vilyams (now NPC of Agriculture and Plant Breeding) from hybrid population Bogarnaya-56 x Teploklyuchenskaya-2 x Rostovchanka, followed by individual selection. Variation: erythrospermum.

The head is bearded, white, pyramid-shaped, long, has medium density (18-21 spikelets per 10 cm rod). Grain is red, egg-shaped, with lowered basis, average streak, large. Weight of 1,000 seeds is 44-49 g, the variety has solid straw, medium thickness. Leaf is green, with medium intensity.

The variety is mid-early-season, ripens in 251-263 days (3-4 days before Bezostaya 1). Winter hardiness and drought resistance are high. Weakly affected by yellow rust, dust and hard smut, has medium susceptibility to stem and leaf rust.

Average yield during competitive variety trials without irrigation made up 35.3 centners per hectare. The variety belongs to Central Asian rainfed ecological group. It belongs to strong wheats.

From 1995, the variety is approved for use in Almaty, Zhambyl and South-Kazakhstan regions of the Republic of Kazakhstan, as well as Osh and Jalal-Abad regions of the Kyrgyz Republic on rigid rainfed lands.

Yuzhnaya-12 — Yuzhnaya-12 variety was bred at Krasnovodopad State Breeding Station (Kazakhstan) by hybridization of varieties Krasnovodopad-25 x Bezostaya-1 x Erythrospermum-7020. Variation: erythrospermum.

The head is cylindrical, slightly spindle-like, 9-11 cm long, medium-density is 17-19 cm. Grain is red, large, base is lowered, oval, egg-shaped, nature of streak is average. Mass of 1,000 grains is 42.2-47.2 g. Stem is 103-118 cm high, thick, durable, resistant to lodging, aligned.

Plant height is 76-85 cm. Leaves are dark green in color, downiness in the period of tillering is weak.

The variety is mid-season. Growing season is 163-167 days. Winter hardiness is medium. Disease susceptibility is weak. Resistant to powdery mildew, brown rust and smut.

Average yield is 60-65 centners per hectare. Yuzhnaya-12 belongs to valuable wheats. At Nookat variety testing station (Kyrgyzstan), record grain yield of 115.5 centners per hectare was received. Best predecessors are fallow, alfalfa circulation formation and corn. Nitrogen fertilization is carried out in the phase of tillering. The protein content in grain is 12.5-16 percent, wet gluten is 24.5-30.2 percent.

Since 1992, the variety is approved for use in Zhambyl and South-Kazakhstan regions of the Republic of Kazakhstan, as well as in Osh and Jalal-Abad regions of the Kyrgyz Republic.

1.3 Timing and amounts of seeding using ridge and furrow sowing

Winter wheat is primary grain culture, and in recent years the area it is sown in the conditions of southern Kazakhstan varies within 180,000-220,000 hectares. Its yields on irrigated lands are still low — at 18-27 centners per hectare. One reason for low productivity of winter wheat is associated with failure to comply with agricultural technology of its cultivation, i.e. late planting dates, poor irrigation, ignoring seeding rates, wrong selection of varieties, etc.

The future harvest in the ridge and furrow sowing techology is largely determined by optimal sowing time and timeliness of water-supply irrigation. In the conditions of southern Kazakhstan, optimal sowing time of winter wheat using the ridge and furrow method is between 25 September and 15-20 October. The duration of the growing season in autumn (35-45 days) determines the efficiency of use of soil moisture reserves and growth intensity after resumption of vegetation in spring, which contributes to rapid development of plants with effective use of early spring precipitation. In spring, ridges heat up quickly, and resumption of vegetation of winter wheat comes a little earlier compared to ordinary planting.

Sowing should be done with use of modernized vegetable planters CO-4.2 with spacing of 70 cm and 20 cm in row in two-line method, with simultaneous cutting of irrigation furrows. Sowing can be combined with application of phosphate fertilizers in the amount of P_{40-60} kg/ha.

Before sowing, seeds are treated with Kolfugo Super in the amount of 2 l/t, Raxil, 6% a.s. - 0,4-0,5 l/t, Dividend Extreme — 1,0 l/t.

The highest productivity of winter wheat in ridge and furrow cultivation method is ensured if sowing is held in early October.

Depending on planting methods, high amounts do not always increase yields, on the contrary, at low seeding rates, productive tilling coefficient, head size, number of grains per head and weight of 1,000 grains increase, which contributes to higher yields. It is important to take into account the timeliness of sowing high-quality seeds, zoned and adapted to local climatic conditions of southern Kazakhstan.

Using ridge and furrow sowing method, consistently high yields of winter wheat can be obtained if the sowing amount makes up 1.5-3.0 million seeds/ha of viable seeds. The sowing amount depends largely on biological characteristics of each variety, planting dates and water-and-food regime.

With optimum sowing time in the period from 25 September to 10 October, the seeding amount for zoned varieties is recommended in the following ranges: Intensivnaya - 1.5 million seeds/ha, Steklovidnaya 2.4-2.5 million, Almaly — 2.0 million, Zhetysu - 3.0 million seeds/ha of viable seeds. At later planting dates, these seeding amounts should be increased by 0.5-1.0 million seeds/ha of vialbe seeds depending on varietal characteristics.

1.4 Methods and amounts of application of mineral fertilizers while using ridge and furrow technology of winter wheat cultivation

The territory of South-Kazakhstan Region according to soil cover is divided into several zones.

The main types of soils in the mountainous part are brown loesslike soils and gray soils. Predominant soils in central and foothills areas of the region are gray soils: dark, ordinary and mountain-chestnut soils.

The soil-forming grounds in dark and ordinary gray soils are mainly loess. Ground waters occur at a depth of 20-30 meters. The parent grounds of dark and ordinary gray soils can be found at the depth of 150 cm or more. Dark and ordinary gray soils are characterized by absence of salinity and alkalinity.

The texture of the upper horizon refers to average loam. The content of humus in the topsoil (0-30 cm) on the average makes up 1.20%, available phosphorus - 19.1 mg/kg, nitrate nitrogen - 18.2 mg/kg, exchangeable potassium - 281 mg/kg.

Depending on the level of richness in nutrition elements, soils are characterized by medium content of phosphorus and high content of potassium. The reaction of soil solution in topsoil is mildly alkaline (pH-8.0).

During cultivation of winter wheat, in order to optimize nutrient regime during sowing, it is necessary to apply rational amounts of phosphate fertilizers in the amount of P_{40-60} kg/ha of active ingredient.

It is very important to apply nitrogen fertilizers in spring (N_{90} kg/ha) by plant-feeding cultivators in the ridges. This helps intensive growth of winter wheat plants and increases coefficient of tillering and seed multiplication. The highest yield of Zhetysu winter wheat variety was obtained using raised-bed planting method in the amount of 3.0 million seeds/ha of viable seeds, with early spring application of nitrogen fertilizers in the amount of 60 kg/ha in the ridges, which during the years of research made up 50.8 centners/ha on the average.

Sowing winter wheat on ridge and furrow, with regulating nutrient status, it is possible to receive very high grain yields. The research results (2009-2011) have shown that with use of mineral fertilizers $P_{45}N_{90}$ kg/ha application rate, the grain harvest of Almaly and

Zhetysu varieties averaged 41.0-45.2 and 42.0-45.9 c/ha, respectively. Excess yield on this background, compared to that of $P_{30}N_{60}$ kg/ha application rate was 2.0-4.3%.

1.5 Irrigation regime and pecularities of water consumption

SWRILPC scientists' research has found that the quantity and size of irrigation amounts in ridge and furrow cultivation of winter wheat depend on prevailing climatic conditions of the year and actual soil moisture.

A very important factor is timely water-supply irrigation in the volume of 700-800 m^3/ha (in the beginning), since during sowing soil moisture reserves in the upper layers of soil-ground are not sufficient to obtain uniform sprouts.

It should be noted that the quality of water-supply irrigation, that is uniformity of distribution of irrigation water by furrows and its absorbtion at a predetermined depth (70 cm) largely affect the friendly and even appearance of winter wheat, with formation of optimum plant thickness, which in the end determines the height of the future harvest.

During the winter wheat vegetation period, maintaining pre-irrigation moisture level of 70-75% requires conducting vegetation irrigation using intermittent water supply in each furrow, with moistening soil by 0.6-0.7 m depth:

- in humid years — without irrigation or one-time irrigation, in the grain filling phase (600-700 m^3/ha);
- in medium-humid years — one-time irrigation, in the end of the first third of May (7-10 May) in the end of the booting phase and the beginning of ear formation (700-800 m^3/ha);
- in severely dry years — two-time irrigation: first — in the beginning of the first half of April at the winter wheat booting phase; second – in mid-May in the grain filling phase (800 m^3/ha).

Irrigation rates, depending on soil moisture, vary within limits of 600-800 m^3/ha. At the same time, watering requirements and total water consumption by Almaly and Zhetysu varieties during intermittent water supply in each furrow make up 1,400-1,500 m^3/ha and 7,500-7,800 m^3/ha on the average, respectively.

While cultivating winter wheat using ridge and furrow method, the most efficient use of irrigation water to produce grain yield of 45-50 t/ha is ensured by two watering periods with intermittent water supply in each furrow, accompanied by application of mineral fertilizers in the amount of $R_{45}N_{90}$ (coefficients of water use during cultivation of winter wheat varieties Almaly and Zhetysu totalled 165.2 and 163.3 m^3/centner).

1.6 Eradicating weeds. Recommended herbicides

While sowings winter crops in southern Kazakhstan, more than 30 weed species are found (*Table 1*).

During ridge and furrow winter wheat sowing in early spring in the period of tillering, it is necessary to carry out, depending of weediness, one or two inter-row cultivation using plant-feeding cultivator KRN-4.2 with simultaneous fertilizing, i.e. applying nitrogen fertilizer in the amoung N_{90} kg/ha of active substance (ammonium nitrate - 245 kg/ha).

However, inter-row cultivation does not provide desired effect in fighting weediness on irrigation. This is why winter wheat, depending on weed species composition, should be treated with herbicides in the tillering phase.

The highest damage to winter wheat in the conditions of southern Kazakhstan is brought by annual and perennial dicotyledonous weeds, and extensive damage to crops is made by harmful wild oat and wild barley.

Wild oat (Avena fatua) is locally called "karasuly", is one of the worst weeds, damaging grain crops (wheat, barley) and dramatically reducing yields and quality of grain. It's appearance is similar to oat, but differently from that, wild oat plants are slightly higher, its whisk is looser and weevil has a cranked axle. It grows mostly in heavier soils, mainly in low areas.

Wild oat seeds germinate at temperature of 8-10 Celsius at its depth (4-5 days after buds appear on birch trees). Maximum depth of germination is 15-18 cm, but, at the same time, shoots are weakened. Most viable seedlings grow from seeds lying at the depth of 10 cm.

Wild oat seeds germinate very disjointed and stretched. The seed viability in the soil maintains for 3-4 years.

Table 1 - Species composition of weeds on cereal crops in the conditions of southern Kazakhstan

Name of weeds	Biotype	Biogroup	Weedliness degree (score) by zones			
			I	II	III	IV
Wild oat	anual		1	2	1	1
Wild barley	anual	winter	3	3	2	1
Field peas	anual	spring	3	2	1	1
Black bindweed	anual	spring	2	3	2	1
Field mustard	anual	spring	3	2	3	2
Field poppy	anual	winter	2	3	4	3
Blindweed	anual	winter	2	1	1	1
Goose grass	anual	winter	3	4	3	3
False carrot	anual	spring	3	3	2	1
Mayweed	anual	spring	2	1	1	1

Name of weeds	Biotype	Biogroup	Weedliness degree (score) by zones			
			I	II	III	IV
Sandweed	anual	spring	3	3	2	1
Field pennycress	anual	winter	2	3	2	2
Common tribulus	anual	spring	1	2	2	1
Camelthorn	perennial	sprouting	1	2	3	2
Corn bindweed	perennial	sprouting	2	2	1	1
Mountain bluet	perennial	sprouting	2	3	3	2
Pink knapweed	perennial	sprouting	1	3	2	2
Saltwort	perennial	sprouting	1	2	1	3
Field sow thistle	perennial	sprouting	2	3	3	2
Coleseed	perennial	rootstock	4	3	2	3
Couch grass	perennial	rootstock	2	2	1	1
Scutch	perennial	rootstock	2	2	1	1
Salt grass	perennial	rootstock	2	3	3	2
Blue false indigo	perennial	rootstock	1	2	2	2
Thick-fruited pagoda tree	perennial	rootstock	2	3	2	1
Creeping crowfoot	perennial	rootstock	1	3	2	2
Stinky ferule	perennial	rootstock	2	2	1	1
Wide-wing ferule	perennial	root stem	2	2	1	1
Trichodesma incanum	perennial	root stem	1	1	2	2
Smooth goldbach	perennial	root stem	1	1	2	2
Common colza	perennial	root stem	1	2	3	2
Mugwort	perennial	root stem	1	1	2	3

Stocks of wild oat grains in the soil are very large — they number in tens of millions per hectare.

Damage from wild oats is not confined only to decreased yields and colossal grain shortfalls. Mixture of wild oats in commercial grain dramatically reduces quality of bread products, causing additional costs for sorting and transportation. Main reasons for increase of grain crop rowding with wild oats are the following:

- not complying with zonal agricultural technology of growing grain crops (delays in planting, lack of fumes, poor quality of sowing works, lack of pre-sowing and autumn treatment);
- sowing seeds which contain wild oat, which do not correspond to sowing standard, due to lack of grain cleaners with indented blocks at farms;
- insufficient use of herbicides against wild oat in the pre-sowing and post-sowing periods;

- presence of large areas of wastelands, which serve as wild oat growing fields.

The necessity to fight wild oat is proved by its high harmfulness. A single stalk of wild oat per one square meter reduces yields of spring wheat by 10 kg/ha. The main measures to combat wild oat are agrotechnical and chemical. Agrotechnical practices to combat wild oat are aimed at reducing stocks of weed seeds in the soil, by provoking it to germinate with subsequent destruction of seedlings and preventing fraying in crops. However, application of agrotechnical measures to combat wild oat is not enough. Therefore, use of herbicides becomes necessary in fighting this pernicious weed.

The following herbicides are recommended: Topic 080, e.k. – 0.3-0.5 l/ha, Dialen super 480 s.k. + Topic 080 e.k — 0.6 l/ha + 0,35 l/ha.

Wild barley – (Hordeum spontaneum C. Koch), local name is "tak-tak" or "Karakyltyk" is the parent of barley. Wild barley in the conditions of southern Kazakhstan has in the process of natural selection in recent years easily adapted to growing with winter wheat and barley, the weed severely clogs and suppresses alfalfa. Wild barley by biological base is close to grain crops, where weed seedlings appear simultaneously with the culture, and further phases of development are almost identical. However, maturation of wild barley occurs 10-14 days earlier than winter crops, and they intensively shed on the field before the harvest of winter barley and winter wheat. The weed reproducted by seeds.

The following herbicides are recommended: Topic 080, e.k. – 0.3-0.5 l/ha, Dialen super 480 s.l. + Topic 080 e.k. - 0.6 l/ha + 0.35 l/ha.

Goose grass – (Galium aparine), local name is “Zhabyskak kyzylboyau” - annual plant of the Rubiaceae family, refers to wintering weeds. Reproduced by seeds, plants are low-growing, clinging and very fertile. Seeds significantly pollute the ground. Blooms in early April and bears seeds in May.

The following herbicides are recommended: Dialen super 480 s.e. 0.5-0.7 l/ha, Diamin, 72% s.e. - 1.0-1.2 l/ha, Esteron e.k. – 0.4-0.8 l/ha.

Mountain bluet – (Acroptilon repens D.C.), sprouting perennial belonging to Aster family (composite). Plants have strong root system. Stem is straight, weblike and lowered, 25-50 cm high. Reproducted by seeds and shoots from radial buds. Shoots appear in early spring, blooms in the first year of life, but does not give seeds, they appear in the second year, and fertility is high. In safflower crops, mountain bluet strongly inhibits the plants in the initial period of growth, forming dense thickets.

The following herbicides are recommended: Dialen super 480 s.e. 0.5-0.7 l/ha, Diamin, 72% s.e. - 1.0-1.2 l/ha, Esteron e.k. – 0.4-0.8 l/ha.

Coleseed – (Brassica campestris), local name is “Toye karyn”, rootstock weed. Reproducted not only by seeds, but also from remnants of deep roots that are in the topsoil and are not affected by tillage. In the summer, coleseed with its ripe seeds is easily compacted by the wind away from its habitat in any direction. Naturally, mature seeds are continuously dispersed along the route to the soil, which leads to intensive clogging of fields. The weed is very fertile.

The following herbicides are recommended: Dialen super 480 s.e. 0.5-0.7 l/ha, Diamin, 72% s.e. - 1.0-1.2 l/ha, Esteron e.k. – 0.4-0.8 l/ha.

2. Economic and energy efficiency in ridge and furrow method of cultivation of winter wheat

On ridge and furrow winter wheat fields, application of mineral fertilizers in the amount $P_{45}N_{90}$ kg/ha of active ingredient and watering with intermittent water supply in each furrow are the most cost-effective agricultural practices, where labor costs are on average 42,000-43,800 tenge/ha. The conditional net income is 84,000-87,500 tenge/1ha, and cost of grain production is 850-970 tenge/centner.

In modern conditions, with systematic changes of prices for materials and services, an objective assessment of energy efficiency of cultivation of a given crop may be crop cultivation and the harvest's energy content. This energy assessment, if necessary, can be transferred in any monetary units, if the value of one MJ is known, which means giving its economic assessment.

Soil tillage requires 24% of all energy costs, planting - 14%, application of mineral fertilizers - 4.4%, introduction of herbicides - 5.6%, irrigation - 11%, and harvesting - 41%.

Applying fertilizers and use of intermittent irrigation method contribute to receiving the highest net energy yield (34,489 MJ for Almaly and 34,817.6 MJ for Zhetysu), and are energy efficient agricultural methods in furrow and ridge cultivation of winter wheat, where coefficients of energy and bioenergetic efficiency for both varieties account for 0.90 and 1.90, respectively.

Additional costs for mineral fertilizers with high amount of $P_{45}N_{90}$ kg/ha of active ingredient ensure increased productivity, where increase of energy in yield during the years of research (2009-2011) on the average was 1,316.1-2,413.3 MJ and 2,194.2-3,126.1 MJ for Almaly and Zhetysu respectively.

Appendix A

Scheme of technological process of winter wheat cultivation using ridge and furrow method in the conditions of irrigation in southern Kazakhstan

Forecrop	Technological operations	Agricultural machinery and equipment		Timing	Agrotechnical standards
Pulses, Corn, Vegetables	Disking crop remains	T-150 K-700	БДТ-3,0 БДТ-7,0	September-early October	Two-time disking of crop remains using heavy disk equipment.
	Current planning with harrowing	MTZ-80	MV-6 ZBTS-1,0	September-early October	When required, carry out current planning with harrowing (if the land is perfectly flat, current planning may be skipped and presowing harrowing only may be dealt with).
	Seed treatment	electrical energy	PS-10 PSSH-5 mobitox	September	Seed treatment with: Raxil, 6% w.m.- 0.4-0.5 l/t Dividend extreme – 1.0 l/t Kolfugo super 20 % - 2.0-2.5 l/t
	Sowing with simultaneous applying R_{-45} kg/ha of active ingredient	MTZ-80	SO-4,2	1st-2nd ten days of October	Ridge sowing with spacing of 70 cm and 2-line conveyor method (20 cm between rows) to depth of 4-5 cm with cutting irrigation furrows.
	Water-supply irrigation	manual		October	Should be conducted on the following day after sowing (in furrows), in the amount of 700-800 m^3/ha.
	Treatment with nitrogen fertilizers if spring vegetation resumes	MTZ-80	KRN-4,2	2nd-3rd ten days of March	Cultivation between rows in the tillering phase with simultaneous application of fertilizers N_{60-90} kg/ha in ridge or furrow.
	Vegetational irrigation	Intermittent irrigation in each furrow (manual)		2nd-3rd ten days of May end of 1st ten days of May 1st watering – first half of April; 2nd watering – mid-May	In humid years – without irrigation or one-time irrigation, in grain filling phase (600-700 m^3/ha); - in medium-humid years — one-time irrigation, in the end of booting and beginning of earing phase (700-800 m^3/ha); - in severely dry years — two-time irrigation: first — in winter wheat booting phase; second — in grain filling phase (800 m^3/ha).

Forecrop	Technological operations	Agricultural machinery and equipment		Timing	Agrotechnical standards
	Harvesting	Niva Laverda etc.		3rd ten days of June or early July	In the full ripeness phase, direct combining with straw crushing and throwing.
	Transportation of grain from field to barn-floor	GAZ-53 KamAZ		3rd ten days of June, early July	In a car with an encapsulated bed.

Appendix B

Model of winter wheat cultivation using ridge and furrow method in the conditions of irrigation in southern Kazakhstan

Name of works	Parameters of agrotechnological operations	Timing	Aggregate composition technique	
			Tractor	Equipment
Disking crop remains	Two-time disking of crop remains using heavy disk equipment.	September-early October	T-150 K-700	BDT-3,0 BDT-7,0
Current planning with harrowing	When required, carry out current planning with harrowing (if the land is perfectly flat, current planning may be skipped and presowing harrowing only may be dealt with).	September-early October	MTZ-80	MV-6 ZBTS-1,0
Seed treatment	Seed treatment with: Raxil, 6% w.m.- 0.4-0.5 l/t Dividend extreme – 1.0 l/t Kolfugo super 20 % - 2.0-2.5 l/t	September	Electrical energy	PS-10 PSSH-5 mobitox
Sowing with simultaneous applying R_{-45} kg/ha of active ingredient	Ridge sowing with spacing of 70 cm and 2-line conveyor method (20 cm between rows) to depth of 4-5 cm.	1st-2nd ten days of October	MTZ-80	SZ-3,6 SZP-3,6
Water-supply irrigation	Should be conducted on the following day after sowing (in furrows), in the amount of 700-800 m^3/ha.	October	MTZ-80 or manually	гибкие полиэти-леновые шланги
Treatment with nitrogen fertilizers if spring vegetation resumes	Cultivation between rows in the tillering phase with simultaneous application of fertilizers N_{60-90} kg/ha in ridge or furrow.	2nd-3rd ten days of March	MTZ-80	KRN-4,2

Name of works	Parameters of agrotechnological operations	Timing	Aggregate composition technique	
			Tractor	Equipment
Vegetational irrigation	In humid years – without irrigation or one-time irrigation, in grain filling phase (600-700 m^3/ha); - in medium-humid years — one-time irrigation, in the end of booting and beginning of earing phase (700-800 m^3/ha); - in severely dry years — two-time irrigation: first — in winter wheat booting phase; second — in grain filling phase (800 m^3/ha).	2nd-3rd ten days of May end of 1st ten days of May 1st watering – first half of April; 2nd watering – mid-May	Intermittent irrigation in each furrow (manual)	
Harvesting	In the full ripeness phase, direct combining with straw crushing and throwing.	3rd ten days of June or early July	Niva Laverda etc.	
Transportation of grain from field to barn-floor	In a car with an encapsulated bed.	3rd ten days of June, early July	GAZ-53 KamAZ	

Photo 1 — Ridge and furrow method of sowing winter wheat

Photo 2 — Winter wheat of Almaly variety in the booting phase with ridge and furrow sowing method

Photo 3 — Winter wheat sown using ridge and furrow method in the tillering phase

Photo 4 — Cultivation of winter wheat in the booting phase using ridge and furrow sowing method

Photo 5 — Ridge and furrow method of sowing winter wheat (Zhetysu variety), full ripeness phase

Photo 6 - Ridge and furrow method of sowing winter wheat (Almaly variety), full ripeness phase

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