Application of ecologically balanced technologies of rice cultivation in the Krasnodar Territory

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Abstract. The domestic and foreign research in the field of rice cultivation carried out over the past 10-15 years has identified four main promising technologies that can reduce the cost of rice produced: 1 - intermittent flooding; 2 - periodic moistening without creating a layer of water; 3 - sprinkling, including surface irrigation; 4 - drip irrigation. Drip irrigation of rice is the most priority area of research, since it can significantly reduce the irrigation rate, labor costs, the cost of rice production and anthropogenic load. The purpose of our research was to develop a new technology of rice cultivation with drip irrigation adapted for the climatic and soil conditions of the Krasnodar Territory. As a result of the research carried out, a drip irrigation technological scheme was developed and implemented for LLC "Chernoerkovskoye" of the Slavyansky District of the Krasnodar Territory. The developed scheme of rice cultivation on drip irrigation has proven its effectiveness, which was expressed in improving the reclamation state of soils, increasing the profitability of production by 22% and increasing the yield by 20%, reducing the irrigation rate by an average of 5.3 times, the cost of rice grain by 15% and labor intensity by 34%.

1 Introduction

It is known from the world practice of rice production [1-6] that rice is a moisture-loving crop that requires large volumes of irrigation water and labor costs for its production. Therefore, scientific research to find new solutions to reduce the cost of rice production has always been relevant, including in the historical aspect of rice cultivation [7-9]. However, in the last decade, due to the stable positive dynamics of demographic growth of the population, a decrease in irrigation water volumes and, in connection with this, the limited irrigation fund of land, as well as an increase in prices for all components of rice production: seed material, fertilizers, fuel and lubricants, payment for water supply to rice irrigation systems [10-13], the problem of the transition of rice producers to less costly cultivation technologies has reached its apogee, and ways to solve it have become a priority at the state level.

In connection with the above, the purpose of our research is to develop new

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technological solutions for the cultivation of rice with a significant reduction in direct costs of its production.

The modern level of scientific and technological progress allows minimizing the use of resources to obtain consistently high yields of high-quality rice grain without prejudice to the reclamation state of soils and the ecosystem of the region [14]. The most promising technology is the cultivation of rice using drip irrigation. This is confirmed by more than ten years of successful experience in the cultivation of rice with drip irrigation in China [15], as well as domestic developments of technologies for cultivation of rice with drip irrigation, which have been successfully tested in the farms of the Volgograd and Rostov regions [16-19], and have proven the effectiveness and feasibility further research in this direction. The effectiveness of drip irrigation is due to a number of factors [20]: a reduction in the irrigation rate, the possibility of rice cultivation on the lands of non-irrigation fund, the development of fundamentally new rice crop rotations with the inclusion of melons and vegetables in them. It should be noted that the areas of the irrigation fund of the Krasnodar Territory available for planting rice annually decrease as a result of partial and sometimes complete non-compliance with crop rotations and rice cultivation technologies, which leads to a decrease in soil fertility up to partial and / or complete withdrawal of lands from agricultural purposes [21]. In such cases, the rice irrigation systems require major repairs that are not economically viable. All of the above confirms the relevance of our research, and the research results can be used to develop mathematical models that help workers in the agro-industrial complex make timely management decisions to develop optimally adapted flow charts for rice production using drip irrigation in order to obtain guaranteed high yields of rice without reducing reclamation state of soils.

2 Materials and methods

Tests of the method of rice cultivation were carried out in the Krasnodar Territory at LLC "Chernoerkovskoe" of the Slavyansky District (2nd department) on a rice check (hereinafter "experimental field") with an area of 4.5 hectares each.

The farm uses a diagram of an engineering rice plot of the Krasnodar type.

The cultivated rice crop was the Rapan variety.

The predecessor in the first year of the implementation of the method is rice.

On the experimental field from 2016 to 2019, the following crop rotation was applied:

- 2016: rice (seedling) + tomato (seedling);
- 2017: rice (seedling) + peas (seminal);
- 2018: rice (seedling) + sweet pepper (seedling);
- 2019: rice (seedling) + lupine (seminal).

The method of cultivating rice on the checks of the rice irrigation system with drip irrigation under polyethylene and/or biodegradable mulching perforated film included a list of technological operations presented in Table 1.

Table 1. The list of technological operations for the cultivation of rice on drip irrigation under perforated plastic and / or mulch film.

№	Name of technological operations	Unit composition	
		tractor	agricultural machine
1	2	3	4
Autumn 2015 (first year of implementation of the method)			
1	Cutting and restoration of peripheral grooves (depth 0.4-0.6 m, along the perimeter of the check)	DT-75B	MK-23
2	Aligning checks	DT-75B	D-569
3	Basic tillage (depth 0.22-0.25 m)	T-150 (DT-75B)	PLN-5-35 (PCN-3,2)

4	Cleaning of irrigation and waste canals	EO-2621	–
5	Backfilling of check rollers up to design marks	DT-75B	D-569
6	Deep loosening (chiseling, depth 0.16-0.18 m)	DT-75B	KZU-0,3V
7	Loading organic fertilizer into an organic fertilizer spreader	JCB 3CX	–
8	Organic fertilization	MTZ-1221	ROUM-14
7	Disking with incorporation of organic fertilizers (depth 0.10-0.12 m) and application rate of 50 t/ha	DT-75B	BDT-3,0
Spring-Autumn 2016 (first year of implementation of the method)			
9	Harrowing with tooth harrows in two tracks to a depth of 0.08 m	DT-75B	MVTZ-1,2
10	Formation of technological driveways and passages to a depth of 0.2 m	DT-75B	MK-17
11	Delivery of non-woven geosynthetic material	MTZ-1221	2 PTS-4
12	Coating with nonwoven geosynthetic material of technological passages and driveways	Manually	
13	Delivery of drip irrigation and fertigation system elements (pumps, filters for fine and coarse water purification, water meter, liflet hose, drip tape, taps, valves, tees, splitters, plugs, injector, fertilizer tank, etc.)	MTZ-1221	2 PTS-4
14	Drip irrigation system assembly including fertigation system (no drip tape laying)	Manually	
15	Laying of Netafim drip tapes, water consumption of each dropper 1.8 l/h, diameter and wall thickness of the drip tape - 16 mm and 0.2 mm, respectively, distance between droppers 0.2 m, distance between drip lines - 0.24 m	MTZ-1221	Drip irrigation tube unwinder tm "GreenBull"
16	Single pre-sowing treatment of seeds with a growth regulator "Albit" at a dose of 50-100 ml/t	Manually	
17	Planting rice seedlings (Rapan variety) in nutrient pots in a phytotron, a mixture of various components is used as a substrate: highly fertile field land, sod land, humus, high peat, coarse sand with the addition of microelements to the substrate before planting rice seeds with a norm of N80P120K60 in kg a.d./ha, the humus content in the substrate is not less than 40%, the substrate density is less than one, the porosity is 60–90%, the air content is not less than 10%. Maintaining the temperature regime: in the daytime 20-24 ° C, in cloudy weather - 16-18 ° C, at night - 15-16 ° C, optimal pre-irrigation humidity - at the level of 55-65% of HB, relative humidity - 60-70%. To maintain a stable regime when these parameters were increased, ventilation was switched on. During the period of seedling growing, the lighting was controlled using fluorescent lamps and turned off at night. Seedlings in the phase of 2–3 leaves were fed with nitrogen fertilizers in dissolved form at the rate of N40 in kg a.d./ha. Before planting in the ground, the seedlings corresponded to the standard, had 6–7 leaves with a green color, with a well-developed root system and not infected with pests and diseases.	Manually	
18	Pre-planting irrigation with an irrigation rate providing soil moisture of 90% of HB in a layer of 0.6 m	Drip irrigation system	
19	Spraying the soil surface with soil herbicides: "Ordram" 720 EC (5.0 l / ha, treatment rate 1) + Gezagard with a rate of 60–80 ml/10 l of water to combat annual dicotyledonous and cereal weeds	Self-propelled sprayer IBIS-2500-18P	
20	Shelter of ridges with perforated polyethylene mulch film	MTZ-1221	Film stacker
21	Spraying BAS "Epin Extra" in the norm of 5-6 drops per 0.5 l of water two days before planting seedlings to increase survival rate and increase stress resistance	Cordless sprayer Clever OE-12.5L-N	
22	Planting rice seedlings	MTZ-1221	Transplanter FTM 2

23	Drip irrigation of rice through a drip irrigation system during the growing season of rice with the frequency and rate of irrigation depending on compliance with the condition for ensuring constant soil moisture 80% of HB in a layer of 0.4 m	Drip irrigation system	
24	The introduction of microelements after complete survival of rice seedlings (in the phase of 8-9 leaves) by fertigation through a drip irrigation system by the norm $N_{30}P_{30}K_{30}$ at kg a.d./ha	Drip irrigation system	
25	Treatment with herbicides Bazagran, v.r., (bentazone, 480 g/l), "BASF AG" of rice crops in the tillering phase, with a consumption rate of 2.0-4.0 l/ha and a working fluid consumption of 200-300 l/ha	Self-propelled sprayer IBIS-2500-18P	–
26	Spraying of seedlings of young seedlings of BAS "Albid" at the end of tillering before the start of emergence into the tube at a dose of 30 mg/ha to prevent lodging	Self-propelled sprayer IBIS-2500-18P	–
27	Introduction of microelements into the tillering phase of rice by the method of fertigation through a drip irrigation system with the norm N_{30} kg a.d./ha	Drip irrigation system	
28	Treatment with fungicides in the phase of entering the tube for prophylaxis (blast, fusarium, septoria), Kolosal, EC (250 g/l) rate 0.75 l / ha	Self-propelled sprayer IBIS-2500-18P	–
29	Rice harvesting	Harvester Don 1500	–
30	Transfer of rice seeds	Kamaz grain carrier 6360	–
31	Presowing soaking of tomato seeds in Fitosporin-M universal (paste) for 1-2 hours at a rate of 1 drop per 100 g	Manually	
32	Planting tomato seeds (variety Zagadka) 55-60 days before planting in open ground, planting is carried out in containers with a depth of 8-10 cm filled with soil consisting of fine-grained sand, peat and humus with soddy soil in a ratio of 1:1:1:1, respectively, after which grooves 2-3 cm deep are made at a distance of 4 cm each, into which the seeds are laid out and sprinkled with a thin layer of earth with light compaction and watering, then the containers are covered with transparent polyethylene, while the following air temperature regime is maintained in the room: the first seven days after the emergence of seedlings during the day 17° C (± 2° C) at night 14 ° C (± 2° C), then to the phase of 2-3 true leaves during the day 22 ° C (± 2° C) at night 18 C (± 2° C), soil temperature day and night and 15 0C (± 2 0C) in the first week after germination, while when the first sprouts appear, the film is removed from the containers, at the same time, during the cultivation of seedlings, two fertilizing with mineral fertilizers "Intermag vegetable garden" are performed: the first at the phase of the 2nd present sheet, the second at the phase of the 3rd present sheet with the norm of 1 tbsp. spoon for 3 liters of water, at the same time, during the cultivation of seedlings, two fertilizing with mineral fertilizers "Intermag vegetable garden" are performed: the first at the phase of the 2nd true leaf, the second at the phase of the 3rd true leaf with a rate of 1 tbsp. spoon for 3 liters of water, while throughout the cultivation of seedlings, soil moisture is maintained within 70-75% of the PPV, the recommended water temperature is 20° C (± 2° C).	Manually	

33	After the appearance of 2-3 true leaves, tomato seedlings are picketed into peat cups, while it is necessary to maintain a distance between seedlings of at least 15 cm from each other, while the following temperature regime is maintained in the room: during the first three days after the emergence of seedlings in the daytime 21 0C (± 1° C) at night 17 ° C (± 1° C), then in the daytime 19 ° C (± 1° C) at night 15° C (± 1° C), at the same time, during the cultivation of seedlings, three additional fertilizing with mineral fertilizers "Intermag Ogorod" is carried out: the first after 12 days after picking the norm of 2 tbsp. tablespoons per 10 liters of water, the second 10-12 days after the first feeding with the rate of 1 tbsp. spoon for 10 liters of water, the third 10 days before planting in the ground while throughout the cultivation of seedlings, soil moisture is maintained within 65-70% of the PPV.	Manually	
34	Cutting 2-3 lower true leaves 2-3 days before planting tomato seedlings, to improve the development of the first flower cluster and reduce the likelihood of diseases, while the leaf cut is made so that stumps remain 1.5-2.0 cm long and disappear by themselves after drying	–	
35	Pre-planting irrigation with the introduction of mineral fertilizers by fertigation through a drip irrigation system with a rate of 0.5 kg of potassium sulfate with superphosphate and 250-300 g of ammonium nitrate per area of 10 m^2 with an irrigation rate providing soil moisture of 90% of HB in a layer of 0.4 m	Drip irrigation system	
36	Planting seedlings in open ground (before planting in open ground, the seedling bush should be at least 20 cm high, have 10 (± 2) well-developed leaves and one or two inflorescences, while the rice stubble is removed and a peat pot is placed in the formed hole with seedlings with powder to the first fox and light compaction of the soil, while a peg 40–50 cm high is placed near each tomato plant, to which the tomato seedlings are tied	MTZ-1221	Platform for harvesting and planting seedlings of vegetables PUO-1A
37	Drip irrigation of tomatoes through a drip irrigation system during the growing season with the frequency and rate of irrigation, depending on compliance with the condition for ensuring constant moisture in the soil layer of 1 m: 65-70% of the PPV from planting to the beginning of flowering, 75-80% of the PPV in the flowering phase, 80–85% of PPV in the fruiting phase	Drip irrigation system	
38	3-4 times spraying tomato plants with the fungicide "Ridomilgold" in the form of a working solution of standard concentration (0.5%) - 5 g per 1 l of water with an interval of 1-2 weeks, regardless of the causative agent and the affected crop during the growing season to combat with fungal diseases from the consumption rate of working fluid 1 liter per 20 m2 to combat fungal diseases, while the waiting period from the last treatment to harvesting the fruits is 14 days	Self-propelled sprayer IBIS-2500-18P	–
39	Spraying of crops in the phase of 2–4 leaves in weeds, regardless of the phase of development of the tomato culture with pesticides Panther, EC (40 g / l) or Bagheera, EC (40 g/l) with a rate of 0.75-1.0 l (kg) / ha for the control of annual cereals (chicken millet, field sorghum, bristle grass) weeds	Self-propelled sprayer IBIS-2500-18P	–
40	Spraying of crops at a weed height of 10-15 cm, regardless of the phase of culture development with pesticides Panther, EC (40 g / l) or Bagira, EC (40 g / l) with a rate of 1.0-1.5 l (kg) / ha for control with perennial cereal (wheatgrass creeping) weeds	Self-propelled sprayer IBIS-2500-18P	–

41	Spraying the soil before planting seedlings. Working fluid consumption - 200-300 l/ha with pesticides Zino, SP (700 g/kg) with a rate of 1.1-1.4 l(kg)/ha to combat annual dicotyledonous and cereal weeds	Self-propelled sprayer IBIS-2500-18P	–
42	Spraying weeds with pesticides 15–20 days after planting seedlings in the ground. Working fluid consumption - 200-300 l/ha with pesticides Zino, SP (700 g/kg) at a rate of 1.0 l(kg)/ha to combat annual dicotyledonous and cereal weeds	Self-propelled sprayer IBIS-2500-18P	–
43	Protection of crops from pests with the insecticide Aktara, VDG in two ways: under the root by the method of fertigation through a drip irrigation system with a consumption rate of 0.4 kg/ha and a working fluid consumption of 2500-5000 l/ha; spraying during the growing season with the rate of consumption of the drug 0.08-0.12 kg/ha and the consumption of working fluid 200-400 l/ha	Under the root – drip irrigation system Spraying – Self-propelled sprayer IBIS-2500-18P	–
44	Tomato harvest	MTZ-1221	Platform for harvesting and planting seedlings of vegetables PUO-1A
45	Cleaning of plastic mulch film and drip tape	MTZ-1221	GDM EzyLift Plastic Mulch Lifter
46	Preservation and dismantling of the drip irrigation system, including the fertigation system (without removing the drip tape)	Manually	
47	Removal of elements of the drip irrigation and fertigation system	MTZ-1221	2 PTS-4
48	Peeling in two tracks to a depth of 0.06-0.08 m	MTZ-1221	LDS-2,5
Spring-Autumn 2017			
49	Restoring the geometry of ridges	DT-75M	MK-17
50	Rolling the soil of the ridges	MTZ-1221	KVG-1,4
51	Delivery of drip irrigation and fertigation system elements (pumps, filters for fine and coarse water purification, water meter, liflet hose, drip tape, taps, valves, tees, splitters, plugs, injector, fertilizer tank, etc.)	MTZ-1221	2 PTS-4
52	Drip irrigation system assembly including fertigation system (no drip tape laying)	Manually	
53	Laying of Netafim drip tapes, water consumption of each dropper 1.8 l/h, diameter and wall thickness of the drip tape - 16 mm and 0.2 mm, respectively, distance between droppers 0.2 m, distance between drip lines - 0.24 m	MTZ-1221	Drip irrigation tube unwinder TM "GreenBull"

54	Single pre-sowing treatment of seeds with a growth regulator "Albit" at a dose of 50-100 ml/t	Manually	
55	Planting rice seedlings (Rapan variety) in nutrient pots in a phytotron, a mixture of various components is used as a substrate: highly fertile field land, sod land, humus, high peat, coarse sand with the addition of microelements to the substrate before planting rice seeds with a norm of $N_{80}P_{120}K_{60}$ in kg a.d./ha, the humus content in the substrate is not less than 40%, the substrate density is less than one, the porosity is 60–90%, the air content is not less than 10%. Maintaining the temperature regime: in the daytime 20-24° C, in cloudy weather - 16-18° C, at night - 15-16° C, optimal pre-irrigation humidity - at the level of 55-65% of HB, relative humidity - 60-70%. To maintain a stable regime when these parameters were increased, ventilation was switched on. During the period of growing seedlings, the lighting was controlled using fluorescent lamps and turned off at night. Seedlings in the phase of 2–3 leaves were fed with nitrogen fertilizers in dissolved form at the rate of N_{40} in kg a.i./ha. Before planting in the ground, the seedlings corresponded to the standard, had 6–7 leaves with a green color, with a well-developed root system and not infected with pests and diseases.	Manually	
56	Pre-planting irrigation with an irrigation rate providing soil moisture of 90% of HB in a layer of 0.6 m	Drip irrigation system	
57	Spraying the soil surface with soil herbicides: "Ordram" 720 EC (5.0 l/ha, treatment rate 1) + Gezagard with a rate of 60–80 ml/10 l of water to combat annual dicotyledonous and cereal weeds	Self-propelled sprayer IBIS-2500-18P	–
58	Shelter of ridges with perforated polyethylene mulch film	MTZ-1221	–
59	Spraying BAS "Epin Extra" in the norm of 5-6 drops per 0.5 l of water two days before planting seedlings to increase survival rate and increase stress resistance	Cordless sprayer Clever OE-12.5L-N	–
60	Planting rice seedlings	MTZ-1221	–
61	Drip irrigation of rice through a drip irrigation system during the growing season of rice with the frequency and rate of irrigation depending on compliance with the condition for ensuring constant soil moisture 80% of HB in a layer of 0.4 m	Drip irrigation system	
62	Introduction of microelements after complete survival of rice seedlings (in the phase of 8–9 leaves) by fertigation through a drip irrigation system with a rate of $N_{30}P_{30}K_{30}$ in kg a.d./ha	Drip irrigation system	
63	Treatment with herbicides Bazagran, v.r., (bentazone, 480 g/l), "BASF AG" of rice crops in the tillering phase, with a consumption rate of 2.0-4.0 l/ha and a working fluid consumption of 200-300 l/ha	Self-propelled sprayer IBIS-2500-18P	–
64	Spraying of seedlings of young seedlings of BAS "Albid" at the end of tillering before the start of emergence into the tube at a dose of 30 mg/ha to prevent lodging	Self-propelled sprayer IBIS-2500-18P	–
65	Introduction of microelements into the tillering phase of rice by the method of fertigation through a drip irrigation system with the norm N_{30} in kg a.d./ha	Drip irrigation system	
66	Treatment with fungicides in the phase of entering the tube for prophylaxis (blast, fusarium, septoria), Kolosal, EC (250 g/l) rate 0.75 l/ha	Self-propelled sprayer IBIS-2500-18P	–
67	Rice harvesting	Harvester Don 1500	–
68	Transfer of rice seeds	Kamaz grain carrier 6360	–
69	Unloading pea seeds from the storage (Prizer variety)	–	Electric motor + PShP 4A

70	Pea seed dressing 2 weeks before planting with Fundazol, 50% c. p. - 2 kg/t, with the addition of microelements to the dressing solution: boric acid - 300 g / t, ammonium molybdate - 250 g/t, with obligatory humidification at a water consumption of 5-10 l/t and the use of adhesives (NaKMC-200 g/t).	–	PS-10A
71	Pre-planting irrigation with an irrigation rate providing soil moisture of 80% of HB in a layer of 0.8 m	Drip irrigation system	
72	Spraying with herbicides on vegetative weeds after harvesting the predecessor (rice) to combat perennial cereals: creeping wheatgrass, sow thistle and thistle and dicotyledonous plants. Roundup, 360 g/l f.th.; dominator, BP, glyphogan, BP; glialka, 360 g/l f.th. and others - 4–6 l/ha or roundup, 360 g/l f.th. + 2.4-D - 2 + 1.5-2 l, kg/ha	Self-propelled sprayer IBIS-2500-18P	–
73	Treatment of pea seeds on the day of sowing with rhizotorphin at a rate of 1 l/kg per 1 ton or sapronite-1 at a rate of 200 ml per hectare seed rate with the addition of 2 liters of water	–	PS-10A
74	Transporting seeds with loading seeders	GAZ-SAZ-53B	
75	Planting seed peas to a depth of 4-5 cm	MTZ-1221	seeder ForigoModula
76	Drip irrigation of peas through a drip irrigation system during the growing season with the frequency and rate of irrigation depending on compliance with the condition of ensuring constant soil moisture of 70-80% of HB in a layer of 0.6 m	Drip irrigation system	
77	The introduction of trace elements on the next day after planting peas by fertigation through a drip irrigation system by the norm $N_{80}P_{80}K_{80}$	Drip irrigation system	
78	Spraying with herbicide gesagard of the soil before pea shoots. Consumption rate of the drug, 2.5-3.0 l, kg/ha. Working fluid consumption - 200-300 l/ha. For the control of annual dicotyledonous and cereal weeds	Self-propelled sprayer IBIS-2500-18P	–
79	Spraying with herbicide of pea crops in the phase of 1-3 leaves by Pulsar, BP (40 g/l) (imazamox) with a consumption rate of 0.75-1.0 kg(l)/ha to combat annual cereals and dicotyledons	Self-propelled sprayer IBIS-2500-18P	–
80	Spraying with herbicide of pea crops in the phase of 3-5 leaves Herbitox, VRK (500 g/l MCPP) or Agritox, VK (500 g/l MCPA) with a consumption rate of the drug 0.5-0.8 kg(l)/ha for the control of annual cereals and dicotyledons	Self-propelled sprayer IBIS-2500-18P	–
81	Herbicide spraying of pea crops in the phase of 5-6 leaves of Bazagran, BP (480 g/l) (bentazone) or Korsar, VRK (480 g/l) (bentazop) with a consumption rate of 2.0-3.0 kg(l)/ha for the control of annual dicotyledons	Self-propelled sprayer IBIS-2500-18P	–
82	Herbicide spraying of crops irrespective of the phase of peas in the phase of 2–4 leaves of annual cereal weeds: Fuzilad Super, EC (125 g/l) (fluazifop-P-butyl) with a consumption rate of 1.0–2.0 kg(l)/ha, Miura, EC (125 g/l) (quizalofon-P-ethyl) with a drug consumption rate of 0.4-0.8 kg(l)/ha, Fuzilad Forte, EC (150 g/l) (fluazifop-P-butyl) with a drug consumption rate of 0.75-1.0 kg(l)/ha	Self-propelled sprayer IBIS-2500-18P	–
83	Herbicide spraying of crops regardless of the culture phase at 10-15 cm in wheatgrass: Panther 4% ae. - 1.0-1.5 kg(l)/ha; Targasuper, 5% k.e. - 2.0; fuselade new, 15% k.e. - 1.5–2.0 kg(l)/ha; zellek super, 10.6% ae. - 1.0 kg(l)/ha	Self-propelled sprayer IBIS-2500-18P	–
84	Spraying of pea plants in the presence of 15 or more beetles (root weevils) in crops is performed at the phase of the first pair of true leaves with the insecticide Bulldok, EC - 0.3; decis, EC - 0.2; extra decis, EC - 0.04; vismethrin, 25% ae. - 0.3 kg(l)/ha	Self-propelled sprayer IBIS-2500-18P	–

85	Marginal spraying of the strips with insecticides in the budding-flowering phase, at the beginning of settlement, with the number of aphids (pea, vetch, alfalfa, bean) at 30-50 individuals per 10 sweeps of the net: Aktara, VDG-0.1; actellik, CE-1.0; Bi-58 new, 400 g/l EC - 0.5-1.0 kg(l)/ha; bulldok, EC - 0.3 kg(l)/ha; decis, EC - 0.2 kg(l)/ha; extra decis, EC - 0.04 kg(l)/ha, zolon, EC - 1.4 kg (l) / ha; mospilan, 20% R.p. - 0.2–0.25 kg (l) / ha; rogor S, EC - 1.0-1.5 kg (l) / ha; Sumialfa, 5% ae. - 0.15-0.3 kg (l) / ha; sumicidin, 20% ae. - 0.3 kg (l) / ha; fufanon, 570 g / l EC - 0.5-1.2 kg (l) / ha	Self-propelled sprayer IBIS-2500-18P	–
86	Spraying of pea crops during the growing season when pea thrips is detected with Aktara insecticide, WDG - 0.1 kg(l)/ha	Self-propelled sprayer IBIS-2500-18P	–
87	Spraying of pea crops with an insecticide in the absence of aphids in the crops during the mass summer and egg laying of the pea moth in the budding - flowering phase: Trichogramma twice, 50 thousand individuals per 1 ha	Self-propelled sprayer IBIS-2500-18P	–
88	Spraying pea crops with an insecticide when more than 6 males are caught on a pheromone trap per week during the mass summer and egg laying of the pea moth in the budding - flowering phase: Bi-58 new, 400 g / L aq. - 0.5-1.0 kg(l)/ha; danadim, 400 g/l ae. - 0.8-1.0 kg(l)/ha; rogor S, EC - 0.5-1.0 kg(l)/ha; fufanon, 570 g/l EC - 0.5-1.2 kg(l)/ha	Self-propelled sprayer IBIS-2500-18P	–
89	Spraying pea crops with an insecticide when the first signs of disease appear (gray rot peronosporosis, ascochitosis) in the budding - flowering phase: Rex, 49.7% c.w. - 0.6 kg(l)/ha + trace elements: copper sulfate, 300 g/ha + zinc sulfate, 350 g/ha; agate-25K - 0.04 kg(l)/ha; sumilex 50% s.p. - 2-3 kg(l)/ha	Self-propelled sprayer IBIS-2500-18P	–
90	Spraying pea crops with an insecticide when the first signs of disease appear (powdery mildew) in the budding - flowering phase: PSK, 25% bw. - 2-4 kg(l)/ha	Self-propelled sprayer IBIS-2500-18P	–
91	Desiccation of pea crops 7–10 days before harvesting is performed at the yellowing phase of 2/3 of the beans on the plant for pre-harvest drying of the harvested mass and reducing the moisture content of pea seeds by 20–25%, super raglon, BP - 2 l/ha; basta, VR - 1–2 l/ha; roundup, 360 g/l f.th. - 3-4 l/ha. Working fluid consumption - 200 l/ha	Self-propelled sprayer IBIS-2500-18P	–
92	Peas harvest	Harvester Don 1500	–
93	Removal of pea seeds	Kamaz grain carrier 6360	–
94	Cleaning of plastic mulch film and drip tape	MTZ-1221	GDM EzyLift Plastic Mulch Lifter
95	Preservation and disassembly of the drip irrigation system, including the fertigation system (without removing the drip tape)	Manually	
96	Removal of elements of the drip irrigation and fertigation system	MTZ-1221	2 PTS-4
97	Peeling in two tracks to a depth of 0.06-0.08 m	MTZ-1221	LDS-2,5
Spring-Autumn 2018			
98	Restoring the geometry of ridges	DT-75M	MK-17
99	Rolling the soil of the ridges	MTZ-1221	KVG-1,4
100	Delivery of drip irrigation and fertigation system elements (pumps, filters for fine and coarse water purification, water meter, liflet hose, drip tape, taps, valves, tees, splitters, plugs, injector, fertilizer tank, etc.)	MTZ-1221	2 PTS-4

101	Drip irrigation system assembly including fertigation system (no drip tape laying)	Manually	
102	Laying of Netafim drip tapes, water consumption of each dropper 1.8 l/h, diameter and wall thickness of the drip tape - 16 mm and 0.2 mm, respectively, distance between droppers 0.2 m, distance between drip lines - 0.24 m	MTZ-1221	Drip irrigation tube unwinder TM "GreenBull"
103	Single pre-sowing treatment of seeds with a growth regulator "Albit" at a dose of 50-100 ml/t	Manually	
104	Planting rice seedlings (Rapan variety) in nutrient pots in a phytotron, a mixture of various components is used as a substrate: highly fertile field land, sod land, humus, high peat, coarse sand with the addition of microelements to the substrate before planting rice seeds with a norm of N80P120K60 in kg a.d./ha, the humus content in the substrate is not less than 40%, the substrate density is less than one, the porosity is 60–90%, the air content is not less than 10%. Maintaining the temperature regime: in the daytime 20-24° C, in cloudy weather - 16-18° C, at night - 15-16° C, optimal pre-irrigation humidity - at the level of 55-65% of HB, relative humidity - 60-70%. To maintain a stable regime when these parameters were increased, ventilation was switched on. During the period of growing seedlings, the lighting was controlled using fluorescent lamps and turned off at night. Seedlings in the phase of 2–3 leaves were fed with nitrogen fertilizers in dissolved form at the rate of N_{40} in kg ai / ha. Before planting in the ground, the seedlings corresponded to the standard, had 6–7 leaves with a green color, with a well-developed root system and not infected with pests and diseases.	Manually	
105	Pre-planting irrigation with an irrigation rate providing soil moisture of 90% of HB in a layer of 0.6 m	Drip irrigation system	
106	Spraying the soil surface with soil herbicides: "Ordram" 720 EC (5.0 l/ha, treatment rate 1) + Gezagard with a rate of 60–80 ml/ 10 l of water to combat annual dicotyledonous and cereal weeds	Self-propelled sprayer IBIS-2500-18P	
107	Shelter of ridges with perforated polyethylene mulch film	MTZ-1221	
108	Spraying BAS "Epin Extra" in the norm of 5-6 drops per 0.5 l of water two days before planting seedlings to increase survival rate and increase stress resistance	Cordless sprayer Clever OE-12.5L-N	
109	Planting rice seedlings	MTZ-1221	
110	Drip irrigation of rice through a drip irrigation system during the growing season of rice with the frequency and rate of irrigation depending on compliance with the condition for ensuring constant soil moisture 80% of HB in a layer of 0.4 m	Drip irrigation system	
111	The introduction of microelements after complete survival of rice seedlings (in the phase of 8-9 leaves) by fertigation through a drip irrigation system is normal $N_{30}P_{30}K_{30}$ in a.d./ha	Drip irrigation system	
112	Treatment with herbicides Bazagran, v.r., (bentazone, 480 g/l), "BASF AG" of rice crops in the tillering phase, with a consumption rate of 2.0-4.0 l/ha and a working fluid consumption of 200-300 l/ha	Self-propelled sprayer IBIS-2500-18P	
113	Spraying of seedlings of young seedlings of BAS "Albid" at the end of tillering before the start of emergence into the tube at a dose of 30 mg / ha to prevent lodging	Self-propelled sprayer IBIS-2500-18P	
114	Introduction of microelements into the tillering phase of rice by the method of fertigation through a drip irrigation system with the norm N_{30} in kg a.d./ha	Drip irrigation system	
115	Treatment with fungicides in the phase of coming out into the tube for prophylaxis (blast, fusarium, septoria), Kolosal, EC (250 g/l) rate 0.75 l/ha	Self-propelled sprayer IBIS-2500-18P	

116	Rice harvesting	Harvester Don 1500	–
117	Transfer of rice seeds	Kamaz grain carrier 6360	–
118	Presowing soaking of pepper seeds of the "Red Bison" variety for 2-3 days, while at the last hour the pepper seeds are soaked in a solution of the biological product Fitosporin-M with a rate of 1.5 g per 1 l of water	Manually	
119	Planting pepper seeds 50–65 days before planting in open ground, planting is carried out in peat cups with a cross section of at least 100 mm to a depth of 0.5–1.0 cm in "BIO Soil Ecoflora for Vegetables" from "Hera" and then covered with foil at the same time, it is necessary to observe the distance between the seedlings at least 15 cm from each other, while the temperature in the soil is maintained at 27° C (± 20° C), the air temperature before the emergence of shoots is 28 ° C around the clock, then after the emergence of shoots until the formation of the 1st leaf 17° C (± 1° C) around the clock, in the next plant phases during the day 23-28° C, at night 16-17° C, the temperature of irrigation water is 25-30° C; at the same time, during the growing of seedlings, fertilizing is performed, while for the first time fertilizers are applied at the emergence phase 1– 2 real sheets with the following composition: dilute 5 grams in 10 liters of water ammonium nitrate, 10 g potassium-based dressings, 30 g. superphosphate fertilizers. The next feeding is in two weeks according to the same scheme, but with a doubling of the dosage. The third feeding is performed a couple of days before planting the seedlings, in which the dosage of potassium in the solution is increased to 80 g per 10 l of water, while during the growth of seedlings, soil moisture is maintained at 70% of HB, and before planting in the ground, 75% of HB.	Manually	
120	Treatment with a pesticide (systemic fungicide) propamocarb hydrochloride 3-4 days before planting seedlings at a concentration of 607 g/l and a consumption rate of 15 ml per 10 l of water to combat soil, root and leaf diseases	Drip irrigation system	
121	Application of herbicide Treflan, 24% (3.6-4.8 l/ha) 12-14 days before planting seedlings to combat annual cereals and a number of dicotyledonous weeds	Drip irrigation system	
122	Pre-planting irrigation with the introduction of mineral fertilizers based on potassium, nitrogen and phosphates at the rate of 30 grams per 1 m² by fertigation through a drip irrigation system and an irrigation rate providing soil moisture of 90% of HB in a layer of 0.8 m	Drip irrigation system	
123	Planting seedlings in open ground (a bush of seedlings before planting in open ground should be at least 20 cm high, have up to 12 well-developed leaves and developing inflorescences, and the crown bud should be removed), while the rice stubble is removed and a peat bush is placed in the formed hole a pot of pepper seedlings with a light compaction of the soil	MTZ-1221	Platform for harvesting and planting seedlings of vegetables PUO-1A
124	Introduction of biostimulants for the development of the root system 10-12 days after transplanting pepper seedlings at the rate of 30 ml / 10 l of water with an interval of 10-12 days	Drip irrigation system	
125	Introduction of biopreparations and growth stimulants 10-12 days after transplanting pepper seedlings at the rate of 30 ml / 10 l of water and then at the same rate every 5-10 days to protect plants from stress	Drip irrigation system	

126	Foliar application on the Omex 3X leaf (50 ml/10 l of water) at intervals of 3-7 days	Self-propelled sprayer IBIS-2500-18P	
127	Top dressing with ammonium nitrate 75 g/10 l of water at intervals of 3-7 days	Drip irrigation system	
128	Two-time spraying with Fitoverma insecticide (thrips, mealybug and spider mite), consumption of 10 ml per 1 liter of water	Self-propelled sprayer IBIS-2500-18P	
129	Single spraying with an insecticide (aphid), the consumption of the product is 8 ml per 1 liter of water.	Self-propelled sprayer IBIS-2500-18P	
130	Drip irrigation of sweet pepper through a drip irrigation system during the growing season with the frequency and rate of irrigation depending on compliance with the condition for ensuring constant moisture in the soil layer 0.8-0.9 m: 80% of HB during the growing season	Drip irrigation system	
140	Mineral fertilization during planting $N_{80}P_{160}K_{240}$ (ratio NPK 1:2:3) then a week further after the first cleaning and then every week $N_{25}P_{25}K_{25}$	Drip irrigation system	
141	Boron introduction at the rate of 25-30 ml / 10 l of water in the flowering phase	Drip irrigation system	
142	Application of mineral fertilizers on a leaf - leaf microfertilizers 5:15:45 (25 g / 10 l of water) with an interval of 4-10 days	Self-propelled sprayer IBIS-2500-18P	–
143	Harvesting sweet peppers	MTZ-1221	Platform for harvesting and planting seedlings of vegetables PUO-1A
144	Cleaning of polyethylene mulching film and / or drip tape	MTZ-1221	GDM EzyLift Plastic Mulch Lifter
145	Preservation and dismantling of the drip irrigation system, including the fertigation system (without cleaning from the drip tape ridges)	Manually	
146	Removal of elements of the drip irrigation and fertigation system	MTZ-1221	2 PTS-4
147	Peeling in two tracks to a depth of 0.06-0.08 m	MTZ-1221	LDS-2,5
	Spring-Autumn 2019		
148	Restoring the geometry of ridges	DT-75M	MK-17
149	Rolling the soil of the ridges	MTZ-1221	KVG-1,4
150	Delivery of elements of the drip irrigation and fertigation system (pumps, filters for fine and coarse water purification, water meter, lifelet hose, drip tape, taps, valves, tees, splitters, plugs, injector, fertilizer container)	MTZ-1221	2 PTS-4
151	Drip irrigation system assembly including fertigation system (no drip tape laying)	Manually	
152	Laying of Netafim drip tapes, water consumption of each dropper 1.8 l/h, diameter and wall thickness of the drip tape - 16 mm and 0.2 mm, respectively, distance between droppers 0.2 m, distance between drip lines - 0.24 m	MTZ-1221	Drip irrigation tube unwinder TM "GreenBull"
153	Single pre-sowing treatment of seeds with a growth regulator "Albit" at a dose of 50-100 ml/t	Manually	

154	Planting rice seedlings (Rapan variety) in nutrient pots in a phytotron, a mixture of various components is used as a substrate: highly fertile field land, sod land, humus, high peat, coarse sand with the addition of microelements to the substrate before planting rice seeds by the norm $N_{80}P_{120}K_{60}$ in kg a.d./ha, humus content in the substrate is not lower 40 %, the density of the substrate is less than one, the porosity is 60–90%, the air content is not less than 10%. Maintaining the temperature regime: during the day 20-24° C, in cloudy weather - 16-18° C, at night - 15-16° C, optimal pre-irrigation humidity - at the level of 55-65% of HB, relative air humidity - 60-70%. To maintain a stable regime when these parameters were increased, ventilation was switched on. During the period of seedling growing, the lighting was controlled using fluorescent lamps and turned off at night. Seedlings in the phase of 2–3 leaves were fed with nitrogen fertilizers in dissolved form at the rate of N_{40} in kg a.d./ha. Before planting in the ground, the seedlings corresponded to the standard, had 6–7 leaves with a green color, with a well-developed root system and not infected with pests and diseases	Manually	
155	Pre-planting irrigation with an irrigation rate providing soil moisture of 90% of HB in a layer of 0.6 m	Drip irrigation system	
156	Spraying the soil surface with soil herbicides: "Ordram" 720 EC (5.0 l/ha, treatment rate 1) + Gezagard with a rate of 60–80 ml / 10 l of water to combat annual dicotyledonous and cereal weeds	Self-propelled sprayer IBIS-2500-18P	
157	Shelter of ridges with perforated polyethylene mulch film	MTZ-1221	
158	Spraying BAS "Epin Extra" in the norm of 5-6 drops per 0.5 l of water two days before planting seedlings to increase survival rate and increase stress resistance	Cordless sprayer Clever OE-12.5L-N	
159	Planting rice seedlings	MTZ-1221	
160	Drip irrigation of rice through a drip irrigation system during the growing season of rice with the frequency and rate of irrigation depending on compliance with the condition for ensuring constant soil moisture 80% of HB in a layer of 0.4 m	Drip irrigation system	
161	The introduction of microelements after complete survival of rice seedlings (in the phase of 8-9 leaves) by fertigation through a drip irrigation system by the norm $N_{30}P_{30}K_{30}$ in kg a.d./ha	Drip irrigation system	
162	Treatment with herbicides Bazagran, v.r., (bentazone, 480 g/l), "BASF AG" of rice crops in the tillering phase, with a consumption rate of 2.0-4.0 l/ha and a working fluid consumption of 200-300 l/ha	Self-propelled sprayer IBIS-2500-18P	
163	Spraying of seedlings of young seedlings of BAS "Albid" at the end of tillering before the start of emergence into the tube at a dose of 30 mg/ha to prevent lodging	Self-propelled sprayer IBIS-2500-18P	
164	Introduction of microelements into the tillering phase of rice by the method of fertigation through a drip irrigation system with the norm N_{30} in kg a.d./ha	Drip irrigation system	
165	Treatment with fungicides in the phase of entering the tube for prophylaxis (blast, fusarium, septoria), Kolosal, EC (250 g/l) rate 0.75 l/ha	Self-propelled sprayer IBIS-2500-18P	
166	Rice harvesting	Harvester Don 1500	–
167	Transfer of rice seeds	Kamaz grain carrier 6360	–
168	Unloading soybean seeds from storage (Irbis variety)	–	Electric motor + PShP 4A

169	Treating soybean seeds with a fungicide on the day of sowing with Fundazol, SP (Agro-Kemi Kft.) (500 g/kg), application rate 3 kg/t or MAXIM, KS (Syngenta LLC) (25 g/l) with consumption working fluid 7–8 l/t with obligatory moistening at a water consumption of 5–10 l/t and the use of adhesives (NaKMTs-200 g/t)	–	PS-10A
170	Presowing treatment of soybean seeds with Agropon C growth regulators, HRV (1 g/l), working fluid consumption 10 l/t to enhance growth and development processes, increase seed yield, increase fat and protein content and/or Mival Agro, KRP (760 + 190 g/kg) at a rate of 15 g/t to increase the number of beans per plant and increase yields	–	PS-10A
171	Pre-planting irrigation with an irrigation rate providing soil moisture of 80% of HB in a layer of 0.8 m	Drip irrigation system	
172	Spraying with herbicides Trophy 90, EC (900 g/l) before sowing (with incorporation with a lack of moisture) or before crop sprouting with a rate of application of 1.5-2.0 l/ha with a working fluid flow rate of 200-300 l/ha to combat with annual cereals and some dicotyledonous weeds	Self-propelled sprayer IBIS-2500-18P	–
173	Transportation of soybean seeds with loading seeders	GAZ-SAZ-53B	–
174	Planting seed soybeans to a depth of 2-3 cm	MTZ-1221	seeder ForigoModula
175	Drip irrigation of soybeans through a drip irrigation system during the growing season with the frequency and rate of irrigation depending on compliance with the condition of ensuring constant soil moisture of 70-80% of HB in a layer of 0.6 m	Drip irrigation system	
176	Application of mineral fertilizers on the next day after planting soybeans by the method of fertigation through a drip irrigation system as normal $N_{20}P_{30}K_{60}$	Drip irrigation system	
177	Spraying with herbicides Bazagran, BP (480 g/l) starting from the phase of the 1st true leaf of the culture in the early phases of weed growth (2–6 leaves), the application rate is 1.5–3.0 l/ha with a flow rate of the working fluid - 200–300 l/ha for control of annual dicotyledonous weeds, incl. cocklebur	Self-propelled sprayer IBIS-2500-18P	–
178	Spraying with herbicides Zellek-super, EC (104 g/l) during the period of their active growth in the phase from 2 leaves to tillering (regardless of the phase of crop development) with a rate of application of 0.5 l/ha with a working fluid consumption of 200-300 l/ha for the control of annual dicotyledonous weeds, incl. cocklebur	Self-propelled sprayer IBIS-2500-18P	–
179	Spraying with herbicides Fusilad Forte, EC (150 g/l) in the phase of 2–4 leaves (regardless of the phase of crop development) with a rate of application of 0.75–2.0 l/ha with a working fluid consumption of 200–300 l/ha to combat with annual and perennial cereal weeds	Self-propelled sprayer IBIS-2500-18P	–
180	Spraying with herbicides Galaktion, EC (104 g/l) during the period of their active growth (in the phase from 2-6 leaves to tillering) with a rate of application of 0.5 l / ha with a working fluid consumption of 200-300 l/ha for fight against annual millet (chicken millet, weed-field millet, types of bristles)	Self-propelled sprayer IBIS-2500-18P	–
181	The introduction of microelements "Meristem NPK 20:20:20" at the budding phase by fertigation through a drip irrigation system at a rate of 1.0–2.0 kg/ha	Drip irrigation system	

182	Spraying of soybeans with insecticides "Bi-58 new" 40% eq. at a dose of 1.0 l/ha in the presence of spider mites and acacia moths in the crops	Self-propelled sprayer IBIS-2500-18P	–
183	2-3 times spraying of soybean crops with Sumicidin insecticide, 20% eq. (0.5 l/ha) for the extermination of the acacia moth during the mass summer of the butterfly and the laying of eggs	Self-propelled sprayer IBIS-2500-18P	–
184	Application of mineral fertilizers N6P26K18 (ammophos and potassium chloride during sowing) + 4 foliar dressings (in the phases of formation of 2-3 leaves, budding, before flowering and seed formation or ripening), consisting of a complex water-soluble fertilizer "AgroMaster 18-18-18 + 3 "containing 18% N, 18 % P_2O_5 and 18% K_2O, Mg, S and microelements (B, Cu, Fe, Mn, Mo, Zn) at a solution concentration of 0.53% and consumption of 200 l/ha (1.05 kg of fertilizer/ha).	Root dressing – drip irrigation system Foliar dressing – self-propelled sprayer IBIS-2500-18P	–
185	Desiccation of crops 6 days before harvesting is carried out at the stage of the beginning of brown beans of the lower and middle tiers for pre-harvest drying of the harvested mass and reducing the moisture content of pea seeds by 14-16%, Reglon forte, RK - 1.50-2.25 l/ha. Working fluid consumption - 250–400 l/ha	Self-propelled sprayer IBIS-2500-18P	–
186	Soybean harvest	Harvester Don 1500	–
187	Transfer of soybean seeds	Kamaz grain carrier 6360	–
188	Drip tape cleaning	MTZ-1221	GDM EzyLift Plastic Mulch Lifter
190	Preservation and dismantling of the drip irrigation system, including the fertigation system (without cleaning from the drip tape ridges)	Manually	
191	Removal of elements of the drip irrigation and fertigation system	MTZ-1221	2 PTS-4
192	Peeling in two tracks to a depth of 0.06-0.08 m	MTZ-1221	LDS-2,5

3 Results and its discussion

As a result of approbation of the method of rice cultivation on checks of the rice irrigation system with drip irrigation under polyethylene and biodegradable mulching perforated film, it was possible to prove the effectiveness of not only rice cultivation (Table 2), but also rice crop rotation crops (Table 3).

Table 2. Quantitative, qualitative and biological characteristics of the Rapan rice variety.

№	Name	Years			
		2016	2017	2018	2019
1	Vegetation period	117	119	118	120
2	Panicle height, cm	90,4	90,8	91,4	91,2
3	Panicle length, cm	17,6	18,3	18,8	18,9
4	The number of spikelets in a panicle, pcs.	204	208	210	215
5	Number of grains, pcs.: – general – empty	75 2	77 2	79 1	82 1
6	Emptyness, %	2,6	2,2	1,8	1,5
7	Caryopsis length to width ratio (l/b)	1,9	2,0	2,1	2,2
8	Weight g/plant: – grain – straw	2,5 2,3	2,6 2,3	2,6 2,3	2,6 2,4
9	Straw to grain ratio	0,92	0,88	0,88	0,92
10	Weight of 1000 grains, g	28	27	29	30
11	Productivity, t/ha	11,3	11,6	12,1	13,4
12	Yield control, t/ha	10,5	10,7	10,8	10,5
13	Increase in yield – t/ha – %	0,8 7,1	0,9 7,8	1,3 10,7	2,9 21,6

Table 3. Characteristics of the accompanying crop – peas.

Rice crop yield			
Tomato - variety Riddle, kg/m^2	Peas – variety Prizer, c/ha	Sweet pepper - variety Bison, kg/m^2	Lupine - variety Irbis, c/ha
22	45,6	7,5	26,8

The use of the claimed method of rice cultivation made it possible to improve the reclamation state of soils (Table 4).

Table 4. The dynamics of the reclamation state of soils in the experimental field in LLC "Chernoerkovskoe" of the Slavyansky district of the Krasnodar Territory, with an area of 4.5 hectares for 2016–2019 when cultivating rice on drip irrigation under mulching perforated film.

№ indicator	Name	Indicator unit	Year research	Indicator value	Assessment of the reclamation state of soils
1	2	3	4	5	6
1	Groundwater level / Groundwater salinity	m/(g/l)	2016	1,5 2,98	1
			2017	1,6 2,82	1
			2018	1,7 2,64	1
			2019	1,8 2,28	1
2	Soil pH	-	2016	6,7	1
			2017	6,8	1
			2018	7,0	1
			2019	7,0	1
3	Humus content	%	2016	3,9	4
			2017	3,9	4
			2018	4,0	3
			2019	4,2	3

4	Humus reserves in the layer 0-100 cm	t/ha	2016	184	4
			2017	189	4
			2018	194	4
			2019	202	3
5	Hydrolysable nitrogen supply (according to Tyunin - Kononova)	mg/100 g	2016	4,9	4
			2017	5,3	3
			2018	5,4	3
			2019	5,7	3
6	Availability of mobile phosphorus (according to Chirikov)	mg/100 g	2016	4,2	4
			2017	4,6	4
			2018	5,0	4
			2019	5,2	3
7	Availability of mobile potassium (according to Chirikov)	mg/100 g	2016	3,5	4
			2017	3,8	4
			2018	4,1	3
			2019	4,8	3
8	Enrichment with nitrogen C:N	-	2016	11,2	4
			2017	10,3	3
			2018	9,7	3
			2019	9,1	3
9	The content of exchangeable magnesium in the soil (MgO)	mg/kg of soil	2016	57	4
			2017	62	3
			2018	68	3
			2019	74	3
10	Sulphate (mobile) sulfur content, S	mg/kg of soil	2016	9,4	4
			2017	9,9	4
			2018	10,4	3
			2019	10,8	3
11	Saturation with bases, V	%	2016	29	4
			2017	32	4
			2018	38	4
			2019	46	3
12	Structure factor, K_{str}	-	2016	0,76	4
			2017	0,84	4
			2018	0,91	4
			2019	0,99	3
13	Total porosity	%	2016	40	5
			2017	47	4
			2018	53	3
			2019	61	2
14	Soil density (according to N.A.Kachinsky)	g/sm^3	2016	1,30	3
			2017	1,26	2
			2018	1,21	2
			2019	1,17	1
15	Soil nitrification capacity	mg $N0_3$/ kg	2016	19,0	3
			2017	24,0	3
			2018	29,0	3
			2019	34,0	2
16	Content of water-resistant aggregates in a layer of 0-30 cm	%	2016	22	4
			2017	28	4
			2018	35	3
			2019	41	2

17	Salt content / Salinity type	% / -	2016	1,4	3
			2017	1,3	3
			2018	1,1	3
			2019	0,8	2
18	The "cumulative effect" of toxic CO_3^{2-}, HCO_3^-, Cl^-, SO_4^{2-} (N. I. Bazilevich, E. I. Pankova)	mg Cl^-	2016	1,94	3
			2017	1,76	3
			2018	1,43	3
			2019	1,08	2
19	Issue rate of CO_2 in soil	mg CO_2/(10 g/day)	2016	9,8	4
			2017	11,4	3
			2018	13,9	3
			2019	15,6	2
20	Trace element content:				
	Manganese (Mn) (in 0,1 n. H_2O_4)	mg/kg of soil	2016	19	0,8
			2017	21	0,6
			2018	24	0,6
			2019	26	0,6
	Cuprum (Cu) (in 0,1 n. KCl)		2016	1,80	0,6
			2017	2,10	0,6
			2018	2,40	0,6
			2019	2,50	0,6
	Zinc (Zn) (in 0,1 n. KCl)		2016	0,40	0,8
			2017	0,60	0,8
			2018	0,80	0,8
			2019	1,10	0,6
	Cobalt (Co) (in 0,1 n. HNO_3)		2016	1,10	0,8
			2017	1,40	0,8
			2018	1,80	0,6
			2019	2,10	0,6
	Molybdenum (Mo) (in the extract of oxalate)		2016	0,18	0,8
			2017	0,21	0,6
			2018	0,25	0,6
			2019	0,28	0,6
The sum of the points of the indicators of the reclamation state of the soil / Assessment of the reclamation state of the soil			2016	71	
				Satisfactorily	
			2017	64	
				Satisfactorily	
			2018	59	
				Satisfactorily	
			2019	48	
				Good	

4 Output

The efficiency of the developed technology of cultivation of rice on drip irrigation under polyethylene and mulching perforated film on the lands of the irrigation fund has been proved.

The main performance indicators are:

- reduction of the irrigation rate by 5.3 times relative to the traditional technology of rice cultivation by flooding;
- improvement of the reclamation state of soils;
- reduction of labor intensity on average by 34 %;
- increasing the yield by an average of 20% and the quality of the resulting grain;
- reducing the cost of rice production on average by 15 %;
- decrease in the amount of introduced macro and microelements on average by 30 %;
- increasing profitability by 22%.

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