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ЎЗБЕКИСТОН РЕСПУБЛИКАСИ
ОЛИЙ ВА ЎРТА МАХСУС ТАЪЛИМ ВАЗИРЛИГИ

ТОШКЕНТ ИРРИГАЦИЯ ВА ҚИШЛОҚ ХЎЖАЛИГИНИ МЕХАНИЗАЦИЯЛАШ МУҲАНДИСЛАРИ ИНСТИТУИ МИЛЛИЙ ТАДҚИҚОТ УНИВЕРСИТЕТИ

Иқтисод фанлари доктори, профессор УМУРЗАКОВ ЎКТАМ ПАРДАЕВИЧнинг 70 ёши ва ёрқин хотирасига бағишлаб ўтказилаётган “Construction Mechanics, Hydraulics and Water Resources Engineering – CONMECHYDRO 2022” халқаро илмий анжуман конференция

МАТЕРИАЛЛАРИ

MATERIALS

of the international scientific conference "Construction Mechanics, Hydraulics and Water Resources Engineering - CONMECHYDRO 2022" dedicated to the 70th birthday and bright memory of Doctor of Economics, Professor UMURZAKOV OKTAM PARDAEVICH

23 – 24 avgust 2022 yil, Toshkent
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УДК 378

НАУКА С МОЛОДЕЖЬЮ ДЛЯ ИННОВАЦИОННОГО РАЗВИТИЯ МОЛОДОГО СУВЕРЕННОГО ГОСУДАРСТВА: «НОВАЯ ОСЬ» ПРОФЕССОРА УМУРЗАКОВА

Ганчеренок И.И., *доктор физ.-мат. наук, профессор, директор Белорусско-Узбекского межотраслевого института прикладных технических квалификаций, Минск, Республика Беларусь*

Жабборов Н.М., *доктор физ.-мат. наук, профессор, исполнительный директор Белорусско-Узбекского межотраслевого института прикладных технических квалификаций, Ташкент, Республика Узбекистан*

Аннотация

В контексте педагогического наследия профессора У. Умурзакова представлены международные тренды инновационного развития современного государства на основе науки и образования.

Ключевые слова: аспирантура, интернационализация, инновации, исследовательский университет

Science with Youth for Innovation Development of Young Souvereign State: “New Axis” of Professor Umurzakov

Hancharonak I.I., *D. Sci., Professor, Director of the Belarus-Uzbek Intersectoral Institute of Applied Technical Qualifications, Minsk, Republic of Belarus*

Zhabborov N.M., *D. Sci., Professor, Executive Director of the Belarus-Uzbek Intersectoral Institute of Applied Technical Qualifications, Tashkent, Republic of Uzbekistan*

Summary: In the context of pedagogical heritage of Professor Umurzakov international trends of innovation development of modern state on the basis of education and science are presented.

Keywords: doctoral education, internationalization, innovationы, research University

Введение - «Наука и образование — это новая ось, вокруг которой структурируется современное общество».

В 2021 году вышел очень обстоятельный аналитическом обзор ведущих российских ученых из Высшей школы экономики под интригующим названием «Наука без молодежи? Кризис аспирантуры и возможности его преодоления», в котором был представлен обстоятельный анализ текущего состояния подготовки кадров высшей научной квалификации в России, отмечена отрицательная динамика основных показателей в сфере послевузовского образования (аспирантура и докторантура) определены ключевые проблемы и перспективы их решения, несмотря на неутешительный вывод, что аспирантура остается самым «отстающим» уровнем образования в России, что является безусловной угрозой для инновационного развития национального государства.

В нашем докладе на конференции, посвященной 70-летию со дня рождения выдающегося узбекского ученого, педагога, наставника, бывшего ректора НИУ «ТИИМСХ» профессора У. Умурзакова вопросительную риторику названия работы [1] мы

заменили на утвердительную для динамично развивающегося узбекского государства, где молодежь в возрасте до 30 лет составляет почти 64% населения страны [2]. Таким образом, Узбекистан не только молодое и суверенное государство, но стран молодых людей. Более того, ожидается, что в ближайшие 20 лет молодое поколение станет преобладающей рабочей силой в истории Узбекистана и с учетом должного развития системы образования обеспечит реализацию объявленной Президентом Ш. Мирзиеевым благородной идеи «Жить в новом Узбекистане – свободной и процветающей стране». Принципиальным в этом плане являются разработки узбекских ученых и практиков, среди которых мы особо выделяем педагогическое наследие профессора У. Умурзакова, определив названиями структурных элементов настоящей работы его высказывания.

В условиях современных вызовов и угроз, среди которых в докладе мы выделили (глобализацию и интернационализацию, переоценка и «недооценка» научного знания, нестабильность и неустойчивость ценностей, новые принципы реальности, социальное расслоение и «цифровое» неравенство, расшатывание политических систем, «прозрачность» мира, усиление идей популизма, радикализма) формируется устойчивое понимание, что мы образовываем людей для неопределенного будущего, которое будет только возрастать. Логичным в этой связи является и последовательная реализация технологического тренда в образовательной политике Европейской Комиссии, что образовательные системы должны быть реформированы так, чтобы готовить людей для рабочих мест, которые еще не существуют, использовать технологии, которые еще не изобретены, научить решать проблемы, которые еще даже не возникли. В этой связи весьма актуальным является тезис из работы [4]: «Боги образовательной теории всемогущи, но черти технологии – расторопней». Однако не менее важной представляется и воспитательная компонента образовательной системы, которая по мнению профессора У. Умурзакова должна позволить «избавиться от нищеты духа, обеспечить свое существование, здоровье, иметь постоянную работу, брать на себя ответственность, освободиться от всякого гнета, сделать невозможным унижение человеческого достоинства, быть более образованным, словом, делать, знать и иметь больше, чтобы стать лучше».

Университет 3.0 для экономики знаний – «фабрика инжиниринга инновационных предприятий».

Профессор У. Умурзаков подчеркивал, что «для осуществления требуемых инноваций сама научно-образовательная сфера обязана применять в своей деятельности самые современные инновационные технологии». Принципиально важной становится необходимость сформировать у выпускников технических вузов новые технологические и бизнес-компетенции, предпринимательскую культуру. Этот процесс в докладе мы назвали преодолением «эффекта колеи» традиционного классического образования. Формированию Университета 3.0 профессор У. Умурзаков придавал особое значение, посвятив свою деятельность последовательному и целенаправленному формированию Национального исследовательского университета «ТИИМСХ»: «Мировой опыт свидетельствует, что важным фактором формирования исследовательских университетов является их многофункциональность и поддержка инновационных процессов в образовании и науке, характеризуемых устойчивой взаимосвязанностью: образование — наука — производство». Важен и коммерческий результат деятельности высших учебных заведений, их вклад в эволюцию современного государства как сложной системы, которая в синергетических координатах представлена на Рис. 1 с выделением «новой оси» профессора У. Умурзакова, определяющей направление развития.

Рис. 1. Синергетический формализм развития государства как сложной системы

Особую значимость развития Университета 3.0 приобретает в период 4-ой промышленной революции с массовым внедрением киберфизических систем в экономику, жизнедеятельность человека, развитием цифровой экономики, аддитивных и квантовых технологий. По этому поводу профессор У. Умурзаков писал: «Мы хорошо понимаем, что создание и продуктивное функционирование исследовательского университета должно опираться на современную высокоорганизованную инновационную цифровую образовательную базу».

Безусловно, что ректор У. Умурзаков строил новую модель высшего учебного заведения, характерными чертами которого представляются:

- Высокая степень интернационализации;
- Сетевая организация образовательной, научной и инновационной деятельности (ТИИМСХ как национальный хаб);
- Развитая инновационная восприимчивость;
- Интеллектуальное лидерство (на наш вгляд, профессор У. Умурзаков - яркий представитель национальной педагогики лидерства).

Принципы подготовки кадров высшей научной квалификации-«Не отставать, а лидировать».

Подготовка научных и научно-педагогических кадров в аспирантуре является безусловным драйвером экономического роста в условиях глобальной конкуренции. При этом следует обратить внимание и на то, что именно подготовка работников высшей научной квалификации является в настоящее наименее стандартизированной и регламентированной в Европе несмотря на попытку развития некой характеристической модели (“a characteristic model of doctoral education”) [5]. Более того, в отличии от первых двух циклов высшего образования, исследовательская работа в аспирантуре имеет значимую практико-экспериментальную направленность. Отметим и роль послевузовского

образования для наращивания компетентностного потенциала системы переподготовки и повышения квалификации руководителей и специалистов системы образования.

С учетом значимой актуальности эти вопросы составляют повестку научно-исследовательской и инновационной политики ведущих государств мира – лидеров экономического развития [1]. Австрийское министерство образования, науки и культуры, Германское федеральное министерство образования и науки, Европейская ассоциация университетов еще в феврале 2005 г. организовали в Зальцбурге (Австрия) семинар по докторским (аспирантским) программам с целью выработки практических рекомендаций по развитию системы подготовки кадров высшей научной квалификации.

Поскольку и Беларусь, и Республику Узбекистан затронул серьезный процесс модернизации как системы высшей школы, так и послевузовского образования [6], нам представляется целесообразным представить выработанные в Зальцбурге подходы, редуцированные в «систему 10 принципов», тем более, что в недавнем исследовании [5], включающем 250 университетов из 36 стран, декларирована их неизменность, а представленные в работе [1] пути выхода из кризисного состояния российской аспирантуры во многом им созвучны.

Первый принцип — получение нового знания через проведение оригинальных исследований в аспирантуре. В то же время признается, что подготовка кадров должна значимым образом отвечать требованиям рынка труда, который не следует ограничивать только научно-педагогической деятельностью в вузах и научных организациях, но и на предприятиях-партнерах реального сектора экономики. Причем эта тенденция должна иметь прогрессирующий характер.

Второй принцип — ответственность специализированных учреждений за актуальность разрабатываемой аспирантами (докторантами) тематики, которая впоследствии будет способствовать карьерному продвижению и развитию выпускников.

Третий принцип — разнообразие, включая совместные, предлагаемые, например, двумя университетами из разных стран, — положительный стимулирующий фактор.

Четвертый принцип — аспиранты должны восприниматься в академическом сообществе как начинающие исследователи, способные внести ключевой вклад в генерацию нового знания и получить соответствующую поддержку(гранты, участие в международных проектах и др.).

Пятый принцип — определяющая роль научного руководства и аттестации. Необходимо создать прозрачную контрактную основу, обеспечивающую взаимную ответственность соискателей ученой степени, руководителей, учреждений образования и, возможно, других партнеров. Речь в данном случае идет об эффективном управлении подготовкой кадров высшей квалификации, которое мы предлагаем осуществлять в рамках так называемой лазерной модели, предложенной нами еще в 1996 г. [7] (Рис. 2).

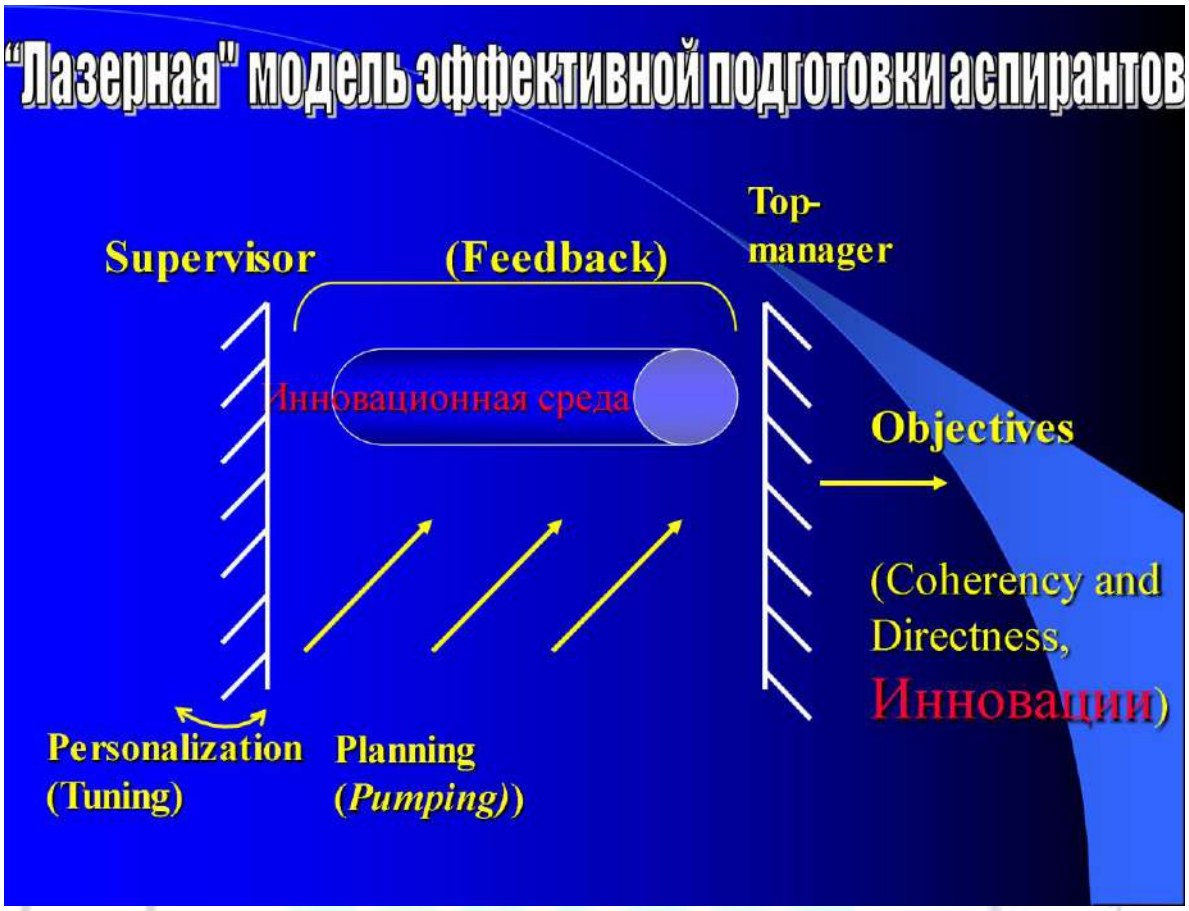

Рис. 2.

Эта модель может служить достаточно хорошим инструментом преодоления негативных последствий массовизации современной аспирантуры [8] и имеет следующие элементы:

цели — направленность и когерентность;

приоритеты — научные школы (*выбор активной среды*);

план-прогноз (*накачка*);

мониторинг и контроль (*обратная связь «ректорат — научный руководитель»*);

персонализация — индивидуальный план подготовки аспиранта (*юстировка или популярный сегодня тюнинг*).

Таким образом, именно «лазерный принцип», на наш взгляд, может стать вполне плодотворным для обеспечения эффективности подготовки научных кадров высшей квалификации.

Шестой принцип — достижение «критической массы» для обеспечения инновационности в университетах. При этом подчеркивается вариативность принятия решений в различных контекстах, учитывая особенности и различия стран европейского региона. Данное обстоятельство будет способствовать развитию международного, национального и регионального сотрудничества между высшими учебными заведениями.

Седьмой принцип — срок обучения. Докторские программы должны иметь адекватную длительность (как правило, 3—4 года).

Восьмой принцип— развитие инновационных структур. Данный принцип направлен на необходимость обеспечения междисциплинарной подготовки и совершенствование соответствующих умений и навыков. В данном контексте уместно привести и такое

определение инновации, практикуемое в Сингапурском колледже государственной службы, которое в англоязычном варианте звучит как «thinking new things + doing new things» или «творить и действовать».

Девятый принцип — мобильность. Докторские программы призваны содействовать как географическим, так междисциплинарным взаимосвязям и международному сотрудничеству в рамках межуниверситетской кооперации и взаимодействия с другими партнерами. Интересно отметить, что в соответствии с программой ЕС Erasmus Mundus («Окно международного сотрудничества») пропорции между мобильностью на первом, втором и третьем цикле распределены как 35, 25 и 20%.

Принцип десятый — обеспечение адекватного и устойчивого финансирования для качественной подготовки работников и обеспечение успешной защиты диссертаций в срок. Следует отметить, что исследование [5] в качестве наиболее важного стратегического приоритета определяет финансирование докторских программ (74% опрошенных университетов).

Выводы.

В качестве вывода нам представляется необходимым привести высказывание ректора У. Умурзакова, которое в полной степени можно считать его педагогическим завещанием: «Нужно оценить бесценный опыт и свои эволюционные накопления — кадровые, научно-образовательные, методологические, материальные, структурные, исследовательские, инновационные, чтобы сделать несколько шагов к обновлению. Сделать это необходимо! И этот путь — путь преобразований и открытий, путь трансформации ТИИИМСХ в современный исследовательский университет».

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THE INVESTIGATION OF STRENGTH PROPERTIES OF MODIFIED CONCRETE IN TENSION

B B Khasanov[1], N I Vatin[2], R K Choriev[1], Z K Ismailova[1], G E Eshchanova[1], U A Nullaev , T A Mirzaev[3]

[1] Department "Technology and organization of hydromeliorative works", National Research University "Tashkent Institute of Irrigation and Agricultural Mechanization Engineers", Tashkent, Uzbekistan

[2] Higher School of Industrial, Civil and Road Construction, Institute of Civil Engineering, St. Petersburg Polytechnic,Peter the Great University, Saint Petersburg, Russia

[3]YEOJU Technical Institute in Tashkent, Tashkent, Uzbekistan

e-mail: mr.bakhridin@mail.ru

Abstract

The resistance of concrete to axial tension is much less than the resistance to the compression and is largely determined by the adhesion of its components. The low tensile strength of ordinary concrete is explained by the heterogeneity of its structure and the discontinuity of concrete, which contributes to the development of stress concentration, especially under the action of tensile forces [1, 2, 3, 4, 5, 6].

In order to increase the tensile strength of concrete, it is necessary to eliminate, first of all, the heterogeneity of the structure of concrete - one of the main reasons for the large dispersion of the results of mechanical tests of this material, which affects the experimental determination of compressive strength.

A significant difference between the compressive strength for ordinary concrete indicates a rather large spread of such values [7, 8, 9]. This scatter is explained by the different influence of factors on tension and compression. For example, for ordinary concretes it has been established [10, 11, 12, 13] that with an increase in W / C, the tensile strength decreases, but to a lesser extent than the compressive strength.

With an increase in the grade of concrete, the tensile strength increases. High-strength concretes, as a rule, prepared on concrete mixes with low W / C and on clean conditioned aggregates in the form of crushed stone and sand, have an increased density, therefore, they have less variation in strength readings both in compression and at stretching [14, 15].

Keywords: resistance, tension, strength, heterogeneity, structure, continuity, concentration, stress, effort, mechanical test, compression, rupture, concrete grade, aggregate, crushed stone, sand, density, dispersion, vibration impact pressing, deformation, sample, compaction, conditions, process, concrete mixture, cement paste layer, homogeneity of the cementing matrix, vibration impact

1. Introduction. To determine the value of the temporary resistance to stretching Rp, at one time Feret proposed a dependence in the form

$$Rp=0,50\cdot R2/3, \qquad (1)$$

which was obtained for concrete of low grades. At present, this dependence also applies to concrete of grade 600 and more.

Under the influence of vibration-impact pressing, the concrete is compacted, which is characterized by a decrease in the thickness (height) of the sample. In all experimental observations, small discrepancies in the relative deformation were noted at different heights of the samples, i.e. the dimensions of the samples were taken as 80 x 80, 100 x 100, 150 x 150, and the concrete composition was 1 : 1,1 : 2,84 at (W/C)beginning=0.35.

Thus, during vibration-impact pressing of a concrete mixture, preliminary vibration -impact compaction creates favorable conditions for uniform deformation of the mixture. In the process of vibration-impact compaction of the concrete mixture, the aggregate grains begin to move, meeting, repel each other and from the mold walls. As a result, a layer of cement paste appears between them, increasing the homogeneity of the cementing matrix, which contributes to a more compact arrangement of aggregate grains in the concrete mixture. The foregoing is confirmed by the fact that on the surface of samples prepared by vibration impact pressing without preliminary vibration impact compaction, individual grains of coarse aggregate were observed that were not covered with cement mortar [15, 16, 17, 18].

For samples made by vibration-impact pressing, after preliminary vibration of the mixture, the outer surface consisted mainly of cement stone with a thickness of 0,5...1,0 мм.

2. Methods. As a result of the analysis of modern technologies, it has been established that physical modification is possible by removing excess mixing water added to the concrete mixture to give it the necessary fluidity and workability.

In the process of removing excess water and entrained air, the cement particles will begin to approach each other, which, in turn, will lead to the convergence of grains of coarse and fine aggregates. The normal pressure that is transferred to the water and causes its removal will contribute to the approach of the particles until the external pressure is completely perceived by the dispersed phase.

The removal of free water during the compaction process maximizes the use of the potential properties of cement to increase the density, water resistance and strength of concrete. Currently, in the technology of complex elements, there are several methods for dehydrating a concrete mixture: centrifugation, pressing, vacuuming, vibration compression and others. One of the most effective methods should be considered a vibration-peristaltic pressing method, since this can create the necessary conditions for maximum dehydration of a concrete mixture and concrete.

3. Results and discussion. The mode of vibration compression of the concrete mix with dehydration (Table 1) provides the possibility of reducing the water-cement ratio from 0,31...0,40 до 0,263...0,290, i.e. by 14...29,5% the initial A/C . As a result, the compressive strength of concrete at the age of 28 days increased to 110,7 MPa, the tensile strength reached 16 MPa, and the water resistance increased to 3 MPa. The values of R_b and R_p for GUME and conventional concrete are shown in Fig.1. At the same time, the value of Rp for ordinary concretes was taken according to the experimental data of O.Ya.Berg [11]. It is characteristic that the area of hypercompacted concrete lies above the area of ordinary and even high-strength concretes [19, 20]. A particularly significant difference in the values of Rp was observed in extra-strong hypercompacted concretes. [21]

Table 1

The influence of molding methods on the strength of concrete (Zh-10s)

n.n.	Primary W / C	Consumption of materials per 1 m3 of concrete, kg				Vibration pressing mode	Quantity of squeezed water, % воды, %	Residual W / C	Compressive strength limit, MPa, 28 days.	$\Delta = \frac{R_b^{вп}}{R_b^{v}}$
		C	P	S	V					
	2	3	4	5	6	7	8	9	10	11
	0,31	530	495	1272	165	1	14,0 / -	0,268 / 0,31	101,3 / 46,7	2,17
						2	14,5 / -	0,267 / 0,31	104,6 / 46,7	2,24
						3	15,7 / -	0,263 / 0,31	110,7 / 46,7	2,37
	0,33	490	506	1300	162	1	16,7 / -	0,276 / 0,33	93,6 / 45	2,08
						2	17,9 / -	0,271 / 0,33	96,3 / 45	2,14
						3	19,1 / -	0,268 / 0,33	100,4 / 45	2,23
	0,35	460	508	1308	161	1	19,9 / -	0,280 / 0,35	85,5 / 42,1	2,03
						2	20,5 / -	0,278 / 0,35	88,4 / 42,1	2,10
						3	21,7 / -	0,275 / 0,35	90,5 / 42,1	2,15
	0,37	430	512	1316	159	1	22,6 / -	0,287 / 0,37	79,4 / 40,3	1,97
						2	24,5 / -	0,280 / 0,37	85,4 / 40,3	2,02
						3	24,5 / -	0,280 / 0,37	85,4 / 40,3	2,12

	0,40	397	516	1326	159	1 2 3	27,7 — - 28,3 — - 29,5 — -	0,290 — 0.40 0.288 — 0.40 0.283 — 0.40	67.1 — 34.6 69.5 — 34.6 72.7 — 34.6	1.94 2.01 2.10

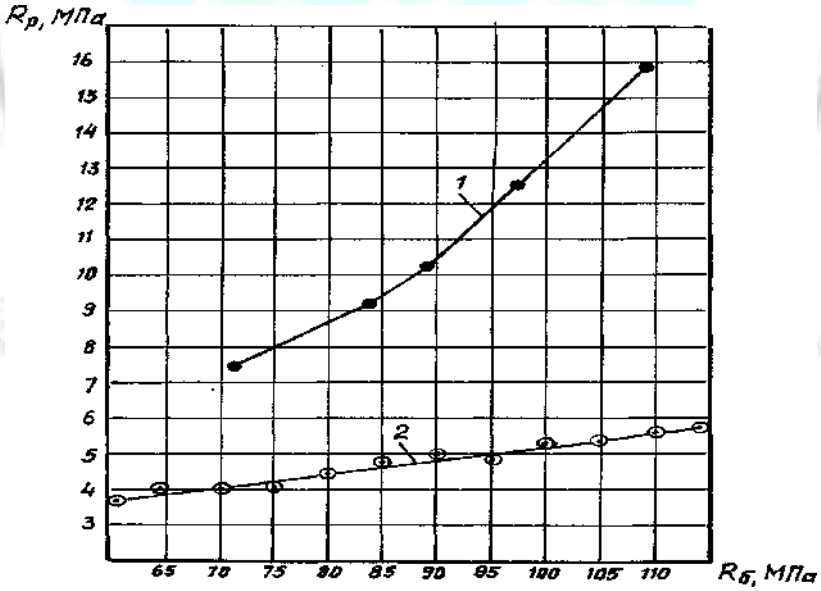
Note: Above the line - test results of concrete samples, compacted; vibro-impact pressing, under the line - the same, compacted by vibration, where:

Rbvp - strength of vibro-impact-peristaltically pressed concrete;

Rbv is the strength of vibrocompacted concrete.

A significant change in the strength of concrete in compression and tension (Rb / Rp) is characterized by the fact that this ratio decreases with a decrease in (W / C) beg. It can be concluded that with a decrease in the initial W/C, the efficiency of hyper densification increases [22, 23, 24]. The greatest hyper compaction effect was observed at (W/C)beginning=0.31, when the Rb/Rp ratio decreased to 7...8. Consequently, the average tensile strength of hyper compacted concrete was 109.7/6.9=15.9 MPa. Such tensile strength corresponds to the M150 grade of ordinary concrete in compression. This material is able to withstand significant tensile stresses. For example, it can be reliably used without reinforcement for non-pressure and low-pressure tubular elements. A production review of these provisions confirmed the legitimacy and reliability of these provisions.

The dependence of the strength of concrete in axial tension Rr on its cylindrical strength Rb



1 – vibration -peristaltic hyper compacted concrete (Rp);
2 - data of O.Ya. Berg [11].

The ratio of the strength of concrete in tension and compression, given in table. 2 are also reflected in the graph, fig. 2.

An analysis of the experimental data for determining the tensile strength of hyper compacted concrete leads to the conclusion that the use of the Feret formula is impossible. As follows from dependence (1), the coefficient 0.5 is a constant value. This may be true for vibration compacted concrete. During hyper consolidation and modification of concrete, the coefficient in the Fere formula becomes variable and depends on the value of the compressive strength of concrete, Fig. 3. Experienced?; It follows from the data that when the strength of concrete changes from 70 to 110 MPa, the coefficient increases from 0.55 to 0.70. One can accept the linear dependence of Kp on Kb. In this case, the Feret formula for GUME takes the form:

$$Rp=K\cdot Rb\sqrt[3]{R_b^2}. \qquad (2)$$

The ratio of concrete tensile and compressive strength

Table 2

Strength characteristic of concrete, MPa, aged 28 days	Designation	(V/C)begin/(V/C)stop.avg.				
		0,31 / 0,265	0,33 / 0,270	0,35 / 0,276	0,37 / 0,281	0,40 / 0,285
Vibra compacted	$R_б$	46,3	45,1	42,0	41,2	34,9
	R_p	5,1	4,9	4,5	4,0	3,4
	R_b/ R_p	9,1	9,2	9,3	10,3	10,1
Vibro-impact pressed	R_b	109,7	97,4	89,1	84,9	71,3
	R_p	15,9	12,5	10,2	9,1	7,4
	R_b R_p	6,9	7,8	8,7	9,3	9,6

The ratio of concrete tensile and compressive strength

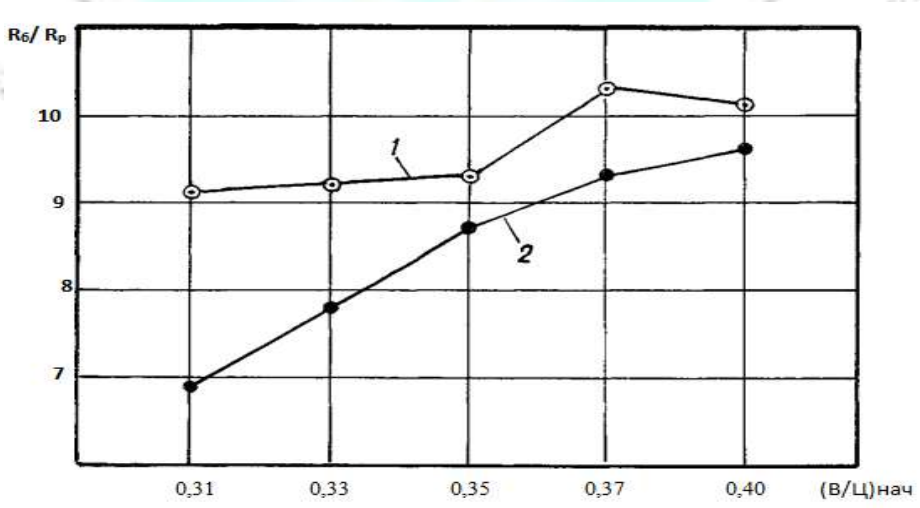


Figure. 2.
1 - concrete compacted by vibration;
2 - concrete compacted by vibroimpact pressing.

The dependence of the stretching coefficient in the refined Feret formula for GUMB

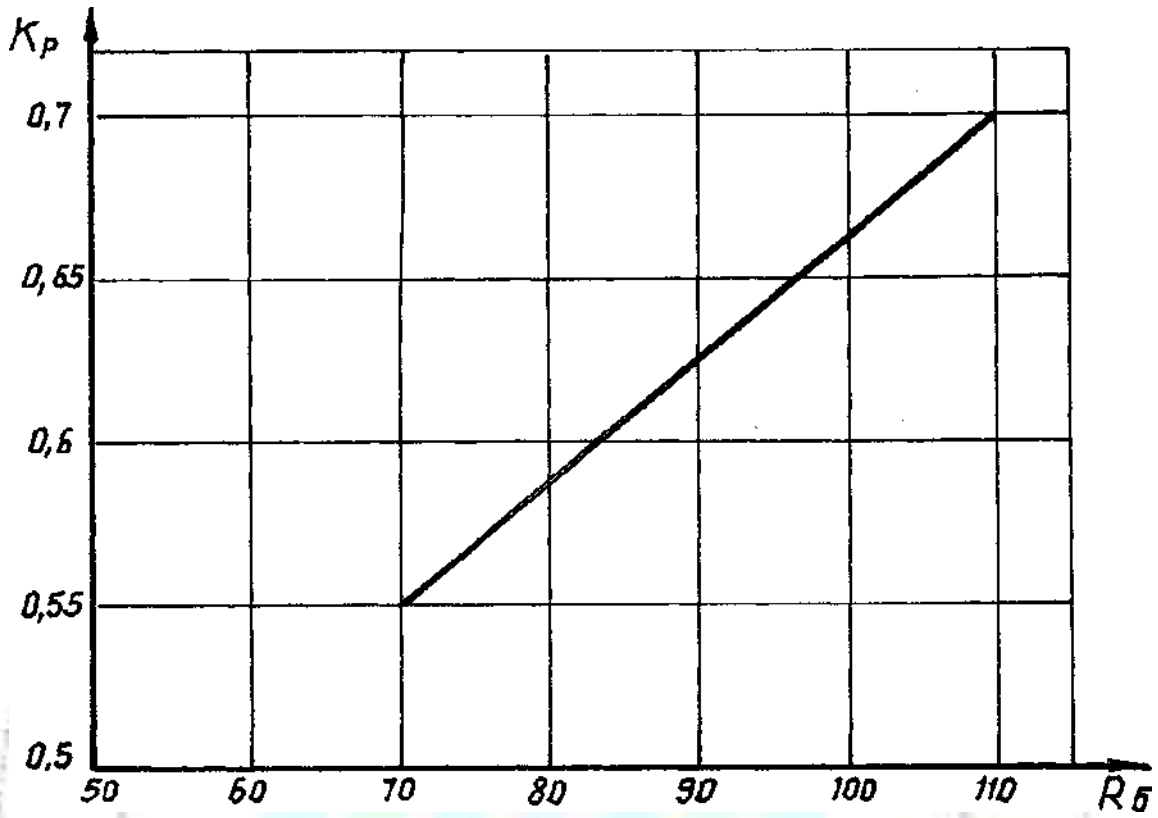


Figure 3.

It is more rational to bring this formula to the form

$$R_p=\frac{K\cdot\sqrt[3]{R_6^5}}{100}. \quad (3)$$

As shown by the experiments, this dependence makes it possible to reliably predict the tensile strength of hypercompacted concrete. It should be noted that for GUMB with a strength above 90 MPa, the R_b/R_p ratio decreases to 7...8. Consequently, high-intensity compaction and modification of concrete also leads to an increase in the homogeneity of the material, and, consequently, an additional increase in tensile strength.

Conclusions

1. The developed complex method of hypercompacting and modifying the concrete mix allows to increase the strength of the test concrete by 2...2.2 times compared to the strength of vibrocompacted concrete with the same initial W/C value.

2. The relationship between the strength of hyper compacted concrete and (W/C)res is linear, however, the tangent of the slope of the dependence Rb=(W/C)res is 2 times greater than the analogous parameter of vibration compacted concrete.

3. The functional dependence of the strength of hypercompacted concrete on its structural components, strength, elasticity and deformability of the corresponding cement stone and mortar part of concrete has been established, while the dependence of Rb on Rc and Krast is approximately linear.

4. Experiments have shown that hypercompacting, together with the modification of the

concrete mixture, to a greater extent affects the tensile strength of concrete, while the ratio Rb / Rr decreases to 7 ... 8 compared to the same indicator for high-strength concretes, equal to 9...10. A refined dependence is proposed for determining Rr by grade strength Rb obtained from the Feret formula.

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CHANGE IN THE STRENGTH PROPERTIES OF MODIFIED CONCRETE OVER TIME

B B Khasanov [1], N I Vatin [2], R K Choriev [1], S.N. Akhmedov [1] Sh.M. Nazarova[1], T A Mirzaev [3]

[1] Department "Technology and organization of hydromeliorative works", National Research University "Tashkent Institute of Irrigation and Agricultural Mechanization Engineers", Tashkent, Uzbekistan

[2] Higher School of Industrial, Civil and Road Construction,Institute of Civil Engineering, St. Petersburg Polytechnic Peter the Great University, Saint Petersburg, Russia

[3] YEOJU Technical Institute in Tashkent, Tashkent, Uzbekistan

e-mail: mr.bakhridin@mail.ru

Abstract.

Till present, there is no data on the change in the strength of hyper compacted concrete. The conducted field observations generalize the data of the long-term period and make it possible to draw a number of conclusions.

As shown by numerous studies [1, 2, 3], the nature of the development of concrete strength over time depends mainly on the type of cement, the composition of the concrete mixture, the temperature and humidity conditions of hardening, and also on many other factors.

Obtaining highly efficient building materials is possible by modifying the structure of cement stone and concrete. Consequently, the modification of the concrete structure in this direction is intended to improve the technological properties of the material. By modifying it is possible to change the kinetics of the growth of physical properties and the final values of the strength of concrete.

Without considering the physical-analytical mechanism of modifying the structure-formation of concrete, we note that it is primarily aimed at reducing the amount of water-mixer per unit volume of the material. However, various studies have shown that in the initial period, the structure formation of cement stone develops in the optimal direction only at a certain volumetric water content. The limiting reduction in water content complicates the process of hydration of the binder, limiting the final strength properties of the material. At the same time, the final strength properties of the material are improved by reducing the volumetric water content of the mixture in every possible way. In all cases, the modification of concrete assumes its composition to be unchanged from the mixing of the mixture to the final stage of the formation of the concrete structure.

Key words: strength, cement, concrete mix composition, hydration process, high-strength, hyper compaction, total effect, given strength, technological parameters, water extraction, grade strength, material quality, dependence, speed, limit level, optimal conditions, mixture modification , technological parameters.

1. Introduction. The dependence of the strength and water resistance of concrete on W / C follows from the physical essence of the formation of the concrete structure. The study of the process of cement hydration showed that cement, depending on the quality and hardening time, binds only 15...25% of water from its mass [4, 5]. During the first month, at least 20% of water by weight of cement binds. At the same time, to impart plasticity to the concrete mixture, to improve the conditions for hydration of the binder, a significantly larger amount of water is introduced, since at (W/C)beginning = 0.20 the concrete mixture remains practically dry and it is impossible to lay, mold and compact it with high quality. Excess water, without entering into chemical reactions with cement, remains in the concrete in the form of water pores and capillaries or evaporates, leaving air

pores. Undoubtedly, this is the main reason for the decrease in the strength and water resistance of concrete.

To optimize the properties of concrete, to obtain ultimate strength, it is necessary to remove excess mixing water. The physical and mechanical properties of concrete in this case will be directly dependent on the amount of residual mixing water [6]. If the concrete mixture is compacted by squeezing out a certain amount of free water, then the concrete strength will be inversely functionally dependent on the residual W / C, since it determines the porosity of the cement stone and concrete. Therefore, in order to obtain concrete of extremely high strength and density, the pre-laid mixture must be additionally compacted under conditions of maximum concrete dehydration.

For a preliminary identification of the factors affecting dehydration, let us consider the process of compaction of a concrete mixture placed in a mold representing a cylinder with a solid wall. Let us assume that the mixture is subjected to compression by normal pressure applied to the piston. If the volume of cement mortar (V_(c.r.)) present in the concrete mixture is less than the volume of pores (V_pore) between the grains of a coarse aggregate, then the normal pressure will be perceived only by the coarse aggregate, and the cement mortar will not perceive any pressure in this case . The influence of vibration-impact-peristaltic pressing in these cases is likely to be negative, since under the action of normal force there may be cases of fragmentation of individual grains of a large fraction, which leads to a decrease in the strength of concrete.

If V_(c.r.) = Vpore between the grains of coarse aggregate, then the normal pressure will be perceived by the grains of all components of the concrete mix. Under these conditions, the effect of vibration-peristaltic pressing will be unstable.

If V_(c.r.) is greater than Vpor by a certain value, then the normal pressure will be perceived only by the cement mortar, and the effect of vibration -peristaltic pressing will depend on the ability of the cement-sand mortar to deform. The mortar will deform if the amount of cement paste is greater than the pore volume of the fine aggregate. Under these conditions, the entire load must be taken up by the cement paste. With an excess amount of water in the cement paste, the entire load will be taken up by water.

2. Methods. The process of squeezing the liquid and gaseous phases from the molded material is the main process of structure formation and modification of concrete properties. The reason for the removal of liquid and gas from concrete is the pressure drop across the wall thickness of the molded product towards the perforated surface of the formwork. The removal of liquid and gaseous media from the concrete mixture is an ex filtration process, i.e. removal of liquid and gaseous fluids from the material into the environment [7].

The main role in the formation of a particularly dense structure of concrete is played by the process of concrete dehydration. The extraction of excess mixing water from the concrete mixture under the action of the applied normal pressure is a filtration process [1]. An important role in it is played by the difference in the chemical potentials of the interacting phases and various gradients that arise in the system depending on the type of energy source, under the influence of which free water moves. The movement of free water under the action of a moisture gradient occurs in the direction of less moistened pores until the moisture is completely equalized.

Therefore, in order to remove free mixing water from the concrete mixture under pressure, it is necessary to perform work (energy consumption) to overcome the forces of water bonding with cement particles and to move it in the system. Naturally, the main task of studying the transfer of excess mixing water from a concrete mixture is to determine the dependence of the parameters of vibration-peristaltic action and filtration rate on various technological parameters and normal pressure.

3. Results and discussion. Let us consider the general patterns of increase in the strength of concrete under normal temperature and humidity conditions of the environment (Ѳ=90...100%, t=20°C). Having thus eliminated the influence of external factors on the hydration process, we compare the potential possibilities for increasing the strength of ordinary, high-strength and hyper-compacted concretes depending on their individual qualities. High-strength, hyper-compacted concretes are characterized by the fact that they are produced on highly active cements and have low W/C values [1, 5, 8]. However, it is rather difficult to

quantify their total effect in most cases, especially since concrete of a given strength can be obtained with a wide variety of combinations of these technological parameters.

With an increase in the activity of Portland cement or a decrease in W / C, in particular, as a result of water extraction, the increase in the strength of concrete, other things being equal, as a rule, accelerates. Therefore, the influence of both factors on the increase in the strength of concrete (for a given brand) should at least compensate for each other. Taking into account these considerations, one can try to estimate the joint influence of these factors on the growth rate of concrete strength through its nominal grade strength R_b. Although this kind of assessment is rather tentative, it is convenient because it allows us to proceed from the generally accepted characteristics of the quality of the material. Yu.N. Khromets and E.N. Shcherbakov [2] proposed the following empirical expression for assessing the growth of concrete strength over time:

$$\frac{R_\tau}{R_b} = 1 - \frac{100-\tau}{5\cdot(100+R_b)} \cdot lg\frac{28}{\tau} \ , \qquad (1$$

where R_τ - cubic strength of concrete when loaded at an arbitrary age $3 < \tau < 180$ days;

$R_{b\_}$ - cubic strength of concrete at 28 days of age.

Further studies conducted by E.N. Shcherbakov [10] have shown that high-strength concretes (grades up to 1000) also obey regularity (1) quite well. This can be seen from the analysis of the data of numerous researchers cited in [1, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21].

This also applies to experimental data on hyper compacted concretes, although they lie in a separate area, but they are subject to general laws. Therefore, dependence (1) can be accepted as valid for hyper compacted modified concrete. Figure 1, on which the values of the ratios R_τ / R_b (τ= 3.7 and 90 days) for ordinary and high-strength concretes are entered as a function of grade strength R_b at 28 days of age.

The hyper compacted concretes used in the experiments hardened under normal temperature and humidity conditions. The composition of mixtures and the individual properties of alite Portland cements varied over a wide range. Nevertheless, the location of the experimental points in the entire considered range of R_b satisfactorily obeys the laws (1).

In early age concretes (τ = 3 days), a slightly increased scatter is noticeable experimentally?; points, but the general nature of dependence (1) is preserved. For concretes of mature age ($\tau \geq 180$ days), it is more difficult to check the nature of this dependence, since there is not enough experimental data. However, the increase in the strength of concrete on alite Portland cements at $\tau \geq 180$ days, as a rule, is small, therefore, expression (1) actually describes the region of the highest values of strength $R_\tau\tau$ in time.

High-strength hyper compacted concretes, as compared to concretes of conventional grades, are characterized by a more intensive increase in strength at an early age ($\tau < 28$ days) and a less significant increase in strength beyond the 28-day age (Fig. 1). This was also noted in [2, 8, 16, 22] for high-strength concretes.

The development of the strength of concrete over time, depending on their graded strength. Alite Portland cements 40 different batches

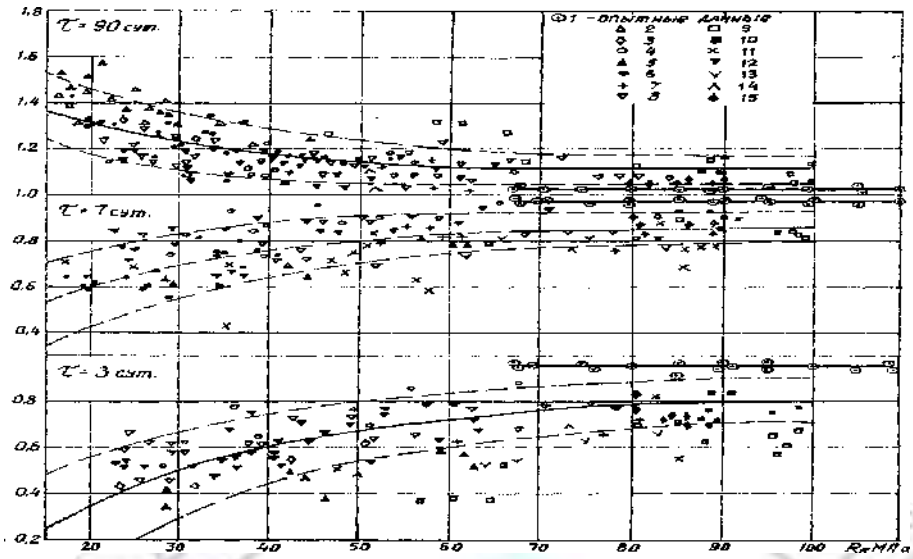

Figure 1.

The nature of the development in time of the strength of various heavy concretes on alite Portland cements

1-experimental data; 2-Dutron [18]; 3-Hummel [17]; 4-Kiselev [1]; 5-Meyer [19]; 6-Vishers [21]; 7-Ceylon [2]; 8-Kwao [20]; 9-Sytnikov and Ivanov [16]; 10-Pisanko and Golikov [14]; 11-Berg, Pisanko and Hromts [12]; 12-Bonzel and Dams [23]; 13-Pinus [8]; 14-Rokach and Kochetkov [15]; 15-Berg and Rozhkov [13]; (-) according to O.Ya. Berg [11].

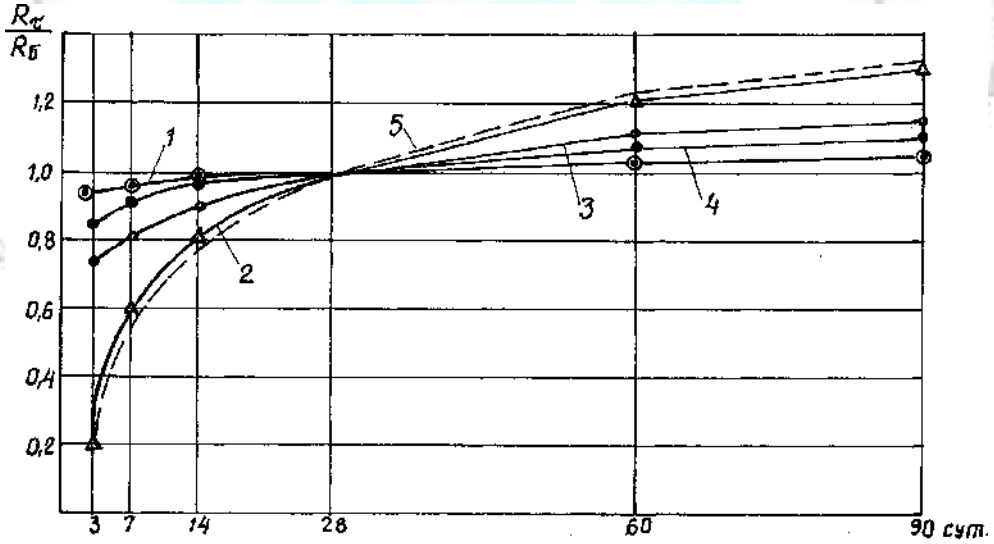

Figure 2

1 - hypercompacted concrete; 2 - concrete grade 200; 3 - the same, 600;

4 - the same, 1000; 5 - according to the logarithmic dependence, (curves 2, 3, 4, 5 - data of O.Ya. Berg) [11...13].

Expression (1) is more general in comparison with other well-known formulas of this type. In particular, for concrete of low grades, it is close to the known logarithmic dependence [24], and with increasing grade, it deviates more and more from this dependence [1, 2, 8, 25]. As can be seen

from Fig. 2, as a result, the rate of growth in the strength of ordinary and high-strength concretes can differ quite significantly. This feature of hyper-compacted, high-strength concrete is one of the important advantages that makes it possible to reduce the time for manufacturing structures, and in some cases, for example, in the climatic conditions of Uzbekistan, to abandon the use of heat and moisture treatment.

At the same time, one should be more careful when considering the possible increase in the strength of this concrete beyond the 28-day age. For the experimental type of concrete, R28 should be taken as the ultimate strength level. At the same time, no strength drops were observed during the observation period.

Conclusions:

1. Experimental data confirmed that the greatest strength of concrete is provided with (W / C) rest close to the normal density of the cement paste and the use of concrete mix compositions with cement consumption by 10 ... 12% exceeding the minimum binder consumption, which provides optimal conditions of deformation, hyper consolidation and modification of the mixture.

2. According to the testing of experimental cylinders and drilled cores with a diameter of 150 mm, the strength level reaches 80 ... 110 MPa on ordinary cements (Rc - 42 ... 44 MPa) and carbonate aggregates, when using a vibration-peristaltic wave of hyper compaction up to 20 MPa.

3. The level of modification of the concrete mix, determined by the ratio (W / C) rest / (W / C) beginning, depends on the value of the initial W / C and the mode of vibration-impact pressing.

4. An extensive analysis of various experimental data on the change in the strength of various concretes over time was carried out, which made it possible to establish the area of placement of experimental data for hyper compacted concrete in the range from 3 to 90 days.

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Obtaining extra-strong concrete of class B100 and above

1. The above is possible on the basis of controlling the composition of the concrete mixture and concrete, using the developed physics-analytical method for designing concrete compositions, as well as using the peristaltic method of hypercompacting and modifying the concrete mixture.
2. The choice of the optimal concrete compositions to be hyper-compacted and modified is made from a table of equivalent concrete compositions, while the technological parameters of the compositions are obtained in the course of preliminary laboratory experiments.
3. The developed complex method of hyperconsolidation and modification of the concrete mixture makes it possible to increase the strength of experimental concrete by 2...2.2 times compared to the strength of vibrocompacted concrete with the same initial W/C value.
4. The ratio between the strength of hyper-compacted concrete and (W / C) rest is linear, however, the tangent of the slope of the dependence Rb \u003d (W / C) rest is 2 times larger than the similar parameters of vibration compacted

concrete.

5. The functional dependence of the strength of hyper compacted concrete on its structural components, strength, elasticity and deformability of the corresponding cement stone and mortar part of concrete has been established, while the dependence of Rb on Rc and Crust is approximately linear.

Experiments have shown that hyper consolidation, together with the modification of the concrete mixture, has a greater effect on the tensile strength of concrete, while the ratio Rb / Rr decreases to 7 ... 8 compared to the same indicator of high-strength concrete, equal to 9 ...ten. A refined dependence is proposed for determining Rr by grade strength Rb obtained from the Feret formula.

UDK: 004.82

RESEARCHING THE OUTPUT PARAMETERS OF THE ENERGY SYSTEM BASED RENEWABLE ENERGY SOURCES

Siddikov I.Kh. (TIIAME)

Abstract

This paper discusses the issues of digitalization of electrical networks, the organization of remote monitoring of the values and parameters of electrical energy, as well as the creation of digital elements, devices for monitoring and managing energy quality indicators of power supply systems with renewable energy sources based on Cloud Computing technology.

Keywords. Cloud Computing, renewable energy sources, current, voltage, simulation, remote monitoring, control, converter.

Introduction. In the world in context of globalization of economy, an important attention is given to digitalization and automation of monitoring of indicators and values of production processes, including in the field of electric energy consumption. Ensuring high accuracy and efficiency of monitoring the values and parameters of power supply with renewable energy sources, contactless signal conversion about the values and parameters of the electrical nets based on modern elements and devices of Cloud Computing technologies are relevant and the main tasks of ensuring reliable operation of electrical equipment. Currently, the use of digital monitoring technology based on Cloud Computing is limited due to insufficient formation of the principles of building elements, devices, control and management, calculation and design methods. In addition, the classical devices, methods and models used for measure and control electrical quantities and parameters do not provide the necessary accuracy of monitoring processes.

Models and methods. Output values and parameters of power supply systems with renewable energy sources, especially current and voltage, and their curve accordance with the standard (GOST 13109-97. Electrical energy. Electromagnetic compatibility of technical means. Standards of quality of electric energy in general-purpose power supply systems) characterizing by following mainly indicators [1-5]: - frequency deviation; - steady-state voltage deviation; - voltage fluctuations characterized by the magnitude of the voltage change and the dose of the flicker ; - coefficient of the nth harmonic component of the voltage ; - coefficient of distortion of the sinusoidal voltage curve ; - coefficient of stress asymmetry in the reverse sequence ; - coefficient of stress asymmetry in the zero sequence ; - duration of voltage failure; - voltage pulse; - coefficient of temporary overvoltage.

An analysis of the operating modes of power supply systems with renewable sources shows that the most general law of change of primary currents is electric current. The model of the three-

phase current conversion circuit of the power supply system with renewable sources, built on the basis of accepted symbols and assumptions, is shown in Fig. 1.

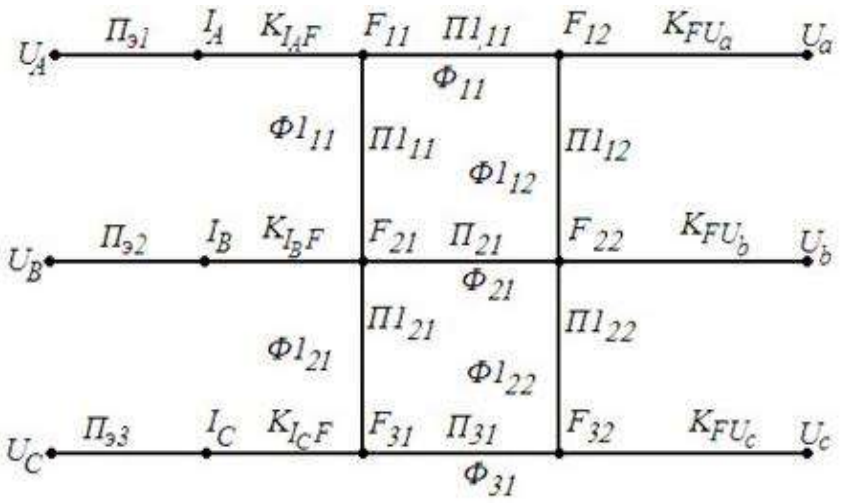

Fig. 1. The model of the three-phase current conversion circuit of the power supply system with renewable power sources

Based on the configuration of the model, analytical equations are formed to determine the output voltages of the primary three-phase current converter of power supply systems with renewable sources [6]:

$$\begin{aligned} U_a &= K_{F_aU_a} \cdot W_a(x,y,z,t)(K_{I_AF} \cdot П_{эA}\dot{U}_A + K_{I_BF} \cdot П_{эB}\dot{U}_B + K_{I_CF} \cdot П_{эC}\dot{U}_C); \\ U_b &= K_{F_bU_b} \cdot W_b(x,y,z,t)(K_{I_AF} \cdot П_{эA}\dot{U}_A + K_{I_BF} \cdot П_{эB}\dot{U}_B + K_{I_CF} \cdot П_{эC}\dot{U}_C); \\ U_c &= K_{F_cU_c} \cdot W_c(x,y,z,t)(K_{I_AF} \cdot П_{эA}\dot{U}_A + K_{I_BF} \cdot П_{эB}\dot{U}_B + K_{I_CF} \cdot П_{эC}\dot{U}_C); \end{aligned} \quad (1)$$

Where $K_{F_aU_a} = 4{,}44 \cdot f \cdot W_2; K_{F_bU_b} = 4{,}44 \cdot f \cdot W_2; K_{F_cU_c} = 4{,}44 \cdot f \cdot W_2$ -the coefficient of inter-chain coupling between magnetic and electrical quantities, depending on the frequency and number of turns of sensing element, installed in magnetic conversion circuit; $\dot{I}_A = П_A \cdot \dot{U}_A; \dot{I}_B = П_B \cdot \dot{U}_B$ and $\dot{I}_C = П_C \cdot \dot{U}_C$ – phases currents, flowing through the electrical nets of the three-phase electrical network of power supply system with renewable energy sources; $П_A; П_B$ and $П_C$ – phases currents flowing through the electrical nets of the three-phase electrical nets of power supply system with renewable energy sources.

Graphs of the static characteristics of a three-phase current converter of a power supply system with renewable sources can be determined by next equations [7-8]:

$$\dot{U}_a = 4{,}44 \cdot f \cdot w_1 \left(Ф_{\mu A} e^{\frac{R_1}{L_1}} + Ф_{\mu B} e^{\frac{R_2}{L_2}} + Ф_{\mu} e^{\frac{R_3}{L_3}} \right),$$

$$\dot{U}_b = 4{,}44 \cdot f \cdot w_2 \left(\Phi_{\mu A} e^{\frac{R_1}{L_1}} + \Phi_{\mu B} e^{\frac{R_2}{L_2}} + \Phi_{\mu} e^{\frac{R_3}{L_3}} \right), \quad (2)$$

$$\dot{U}_c = 4{,}44 \cdot f \cdot w_, \left(\Phi_{\mu A} e^{\frac{R_1}{L_1}} + \Phi_{\mu B} e^{\frac{R_2}{L_2}} + \Phi_{\mu} e^{\frac{R_3}{L_3}} \right),$$

where f – frequence; w_1, w_2, w_3 – he number of turns of the secondary windings of the three-phase current converter; $\Phi_{\mu A}, \Phi_{\mu B}, \Phi_{\mu C}$ – magnetic fluxes of phases, created by primary currents A, B, C; $R_1, L_1, R_2, L_2, R_3, L_3$ – active and inductive resistances of secondary windings.

RESULTS AND DISCUSSION. Graphs of static characteristics of electromagnetic converters of three-phase current of the power supply system with renewable sources obtained on the basis of Cloud Computing technology and experiments are presented in Fig. 2-4.

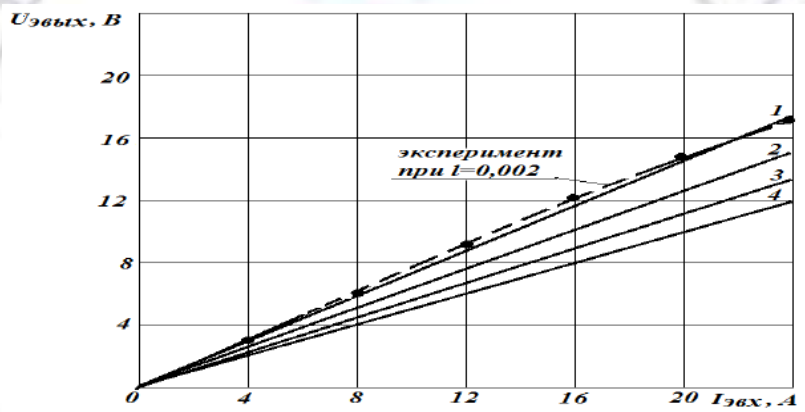

Fig.2.

Static characteristics of electromagnetic converters of three-phase current of the power supply system with renewable sources
1–*l*=0,002; 2–*l*=0,0022; 3–*l*=0,0024; 4–*l*=0,0026.

From the graphs shown in Fig. 2, it can be seen that with an increase in the length of the path of the magnetic flux through the magnetic circuit, the voltage at the output of the converter decreases, by the dependence itself $U_{e\ out}$=f($I_{e\ in}$) it is linear.

Figure 3 shows a graph of the dependence of the output voltage - $U_{e\ out}$ from the cross-sectional area of the winding - *F*. It can be seen from the graph that this dependence is linear in nature and with an increase in the cross-sectional area of the winding, the output voltage increases.

Figure 4 shows a graph of dependence of output voltage – $U_{e\ out}$ of converter is depends on the size of air gap δ.

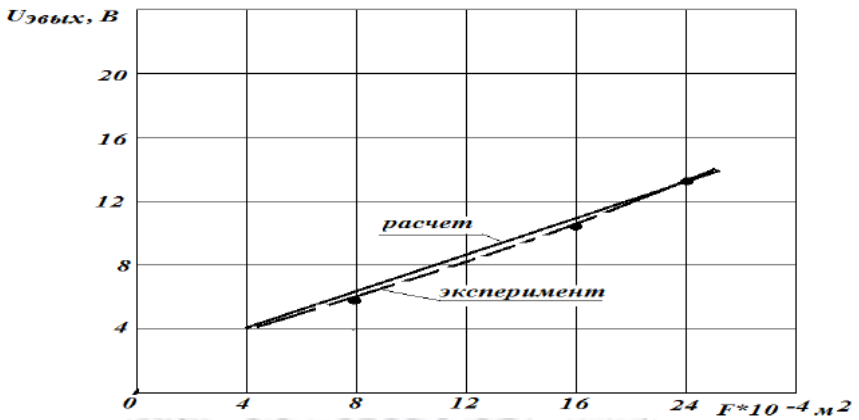

Fig.3. A graph of the dependence of the output voltage - $U_{e\ out}$ from the cross-sectional area of the winding - F.

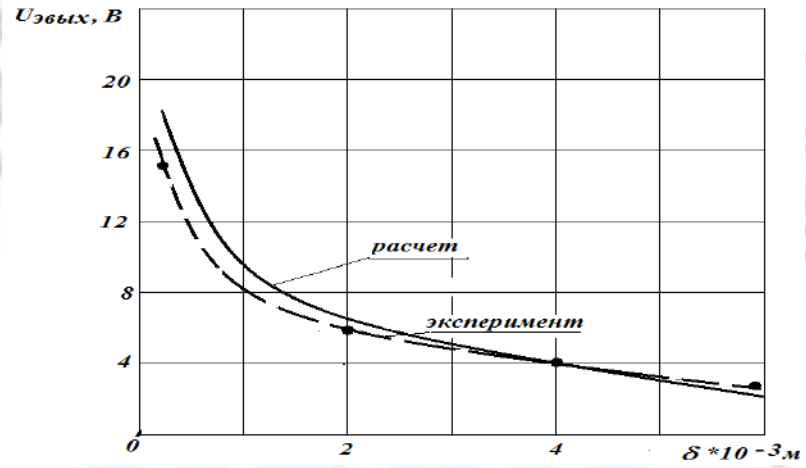

Fig.4. A graph of dependence of output voltage – $U_{e\ out}$ of converter is depends on the size of air gap δ.

From the graphs presented in Fig. 4. it can be seen that with an increase in the air gap - δ the value of the output voltage decreases $U_{e\ out,}$ moreover, according to a nonlinear rule.

Conclusions

1. Mathematical models and an algorithm have been developed that allows calculating the characteristics of the current-to-voltage converter and monitoring the values and parameters of the conversion of the primary three-phase current of the electrical network of the power supply system with renewable energy sources with a wide change in circuit and operating parameters.

2. A graph model and algorithm have been developed that allow monitoring the characteristics of a three-phase current converter of a power supply system with renewable sources, and the results of the study showed that the duration of the transition process does not exceed two periods of the fundamental frequency**.**

The effects of secondary converter currents and ambient temperature on the conversion accuracy have been theoretically and experimentally investigated, and it has been revealed that secondary currents practically do not affect the accuracy of a three-phase current converter, and the effect of ambient temperature leads to an increase in the error to 0,11%.

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INTELLIGENT DECISION SUPPORT IN THE OPTIMIZATION OF IRRIGATION SYSTEMS IN AGRICULTURE

Kabildjanov Alexander Sabitovich[1, a)], Okhunboboyeva Charos Zukhriddin kizi[1, b)], Ismailov Sarvarbek Yodgor ugli[1, c)]

[1]Department of Automation and Control of Technology Process, Tashkent Institute of Irrigation and Agricultural Mechanization Engineers National Research University, 39 Koriy-Niyoziy, 100000, Tashkent, Uzbekistan [a)] kabildjanov@yandex.ru [b)] ch.ohunboboeva@tiiame.uz

[c)] Corresponding author: sarvarismailov.y@gmail.com

Abstract

The issues of determining the optimal values of the regulatory parameters of irrigation systems engaged in the cultivation of agricultural crops are considered. In accordance with the requirements of a market economy, the main emphasis is placed on taking into account two types of criteria: maximizing the yield of agricultural crops and minimizing monetary costs. The proposed method for solving the multi-criteria optimization problem is based on the combination of the minimax criterion and the medium-step convolution, which makes it possible to scalarize the vector optimality criterion with access to smooth optimization methods. In relation to the case of priority uncertainty according to particular optimality criteria, an intelligent algorithm is proposed based on the approximation of the preference function of the decision-maker by the fuzzy Mamdani model. The results of the multi-criteria optimization of the irrigation system used for the process of growing cotton differ favorably from the average values.

Taken in terms of one hectare yield in the republic- increased by 2%, monetary costs - reduced by 4.5%. It could be concluded that the developed methodology makes it possible to bypass the computational difficulties that arise when solving problems of multi-criteria optimization of irrigation systems engaged in the cultivation of agricultural crops, and to obtain real results in conditions of certainty and uncertainty goals.

Keywords: optimization, optimization model, multicriteriality, minimax convolution, scalarization, smoothing, uncertainty of priorities, preference function, approximation, fuzzy model, irrigation systems, agriculture.

1. Introduction

One of the effective ways to solve the problems of rational use of water and land resources in water and agriculture, increasing crop yields is the use of system analysis, mathematical modeling and optimization in planning, preparing and managing the technological processes of irrigation systems.

A feature of setting the optimization problem in a market economy in relation to irrigation systems of agriculture is multi-criteria, since along with technological (yield), it involves the use of economic optimality criteria (cash costs for irrigation, mineral fertilizers, etc.). The vector optimality criterion gives rise to two problems in practice [1-5].

First, the existing methods of scalarization of vector optimality criteria often lead to non-smooth functions. Conventional numerical optimization methods under these conditions turn out to be ineffective due to the emerging «jamming» effect. Overcoming this problem is possible on the basis of smoothing the scalar optimality criterion and is in the plane of solving ill-posed problems by regularization methods [6- 8]. The practical implementation of these methods encounters a number of difficulties due to the need for additional functional analysis, as well as relatively high computational costs.

Secondly, most methods of scalarization of vector optimality criteria require setting priorities (weight coefficients) for each of the particular optimality criteria. In practice, setting priorities is not a trivial task and leads to a situation of uncertainty. The solution to the problem of «uncertainty of priorities» is possible based on the introduction of a preference function (PF) of a decision maker (DM), followed by its approximation by fuzzy or neural network approximation methods [9-12].

Thus, further progress in the field of solving problems of multicriteria optimization in the preparation and control of technological processes of irrigation systems of agriculture provides for the creation of effective methods and algorithms that combine traditional numerical optimization methods, regularization methods for ill-posed problems, and intelligent decision support.

2. Methods

Multicriteria optimization of irrigation systems used for cultivation of agricultural crops under conditions of certainty. The problem statement for optimizing the irrigation system has the form

$$y_1 \to \max_{x\in\Omega_v};\ y_2 \to \min_{x\in\Omega_v},\ (1)$$

In (1) y_1 - is the yield; $y_2 = c_1x_1 + c_2x_3 + c_3x_4 + c_4x_5 + c_5x_6 + c_6 + c_7 + c_8 + c_9 + c_{10} + c_{11}$ - money spendings; x_1 - irrigation rate per integrated hectare (thousand m^3/hectare); x_3 - costs of nitrogen fertilizers (Ton/hectare); x_4- costs of phosphate fertilizers (Ton/hectare); x_5- labor costs (man-days/hectare); x_6 - average consumption of seeds (kg/hectare); c_1 - cost of irrigation (sum/thousand m^3); c_2 - cost of nitrogen fertilizers (sum/t); c_3 - cost of phosphate fertilizers (sum/Ton); c_4 - the average wage rate (sum/person-day); c_5 - average cost of seeds (sum/kg); c_6 - average cost of land reclamation works (sum/hectare); c_7 - the average cost of sowing (sum/hectare); c_8 - average cost of crop protection from pests and diseases (sum/hectare); c_9 - costs for services (sum/hectare); c_{10} - expenses for the needs of management (sum/hectare); c_{11} - other expenses for social contributions (sum/hectare); Ω_v - is the set of feasible solutions.

The set of feasible solutions is defined as:

$$\Omega_v = Y \cap X = \{Y \in R^k \,|\, y_1 \ge t_{1task};\ y_2 \le t_{2task};\ X \in R^n \,|\, x_{j\min} \le x_j \le x_{j\max};\ j = \overline{1,n}\} \quad (2)$$

Applying the combined convolution method, we transform problem (1) as follows [2, 15].

Multiplying both parts of the criterion constraint $y_1 \ge t_{1task}$ in expression (2) by -1, we obtain constraints of the form $-y_1 \le t1_{task}$ and a particular criterion $-y_1 \to \min_{x\in\Omega_v}$. Let us introduce estimates of the degree of fulfillment of constraints for each of the output parameters of the form

$$z_i(x) = \alpha_i[(t_i - y_i)/\delta_i - 1] \ge 0;\ i = \overline{1,2};\ \alpha_i \ge 0;\ \sum_{i=1}^{2}\alpha_i = 1,\ (3)$$

where δ_i - is the estimate of the scattering of the *i*- th output parameter, which is set on the basis of practical considerations, or is determined using the method of statistical tests; α_i - weight coefficients that determine the relative importance of particular criteria y_i; $i = \overline{1,2}$.

Applying the maximin convolution, we obtain a scalar optimality criterion

$$F(x) = \min_{i=\overline{1,2}} z_i(x) \to \max_{x\in D},\ (4)$$

where *D* - is a set in which direct restrictions on the variable parameters with the help of an appropriate substitution, for example $x_j = x_{jmax} + (x_{jmin} - x_{jmax}) * sin^2(x'_j)$, converted to functional; $x'_j;\ j = \overline{1,n}$ - new independent variables.

Let's smooth the criterion (4) using the exponential function and the power-mean convo-lution

$$F(x) = \sum_{i=1}^{2}\phi_i^{\gamma}(x) \to \min_{x\in D};\quad \gamma = 1, 2, \ldots,\ (5)$$

In (5) $\phi_i(x) \equiv exp\ [-z_i(x)]$, γ - parameter, introduced to control convergence in the vicinity of the optimum point.

The final optimization problem (1) will take the following form

$$F(x) = \sum_{i=1}^{2} \exp[-\gamma \cdot z_i(x)] \to \min_{x \in D};\ \gamma = 1, 2, \ldots , (6)$$

In (6) F(x)- is the modified optimality criterion.

As applied to additive regression, for the smoothness of the modified criterion, it is necessary that the partial derivatives be continuous [15]. When the condition of smoothness of the modified criterion is satisfied, as applied to problem (6), the simplest $f_i(x_i, a)'_{x_i};\ i = \overline{1,n}$ smooth optimization algorithms can be applied in practice.

Intelligent Decision Support in the Problem of Multicriteria Optimization of Irrigation Systems under Uncertainty of Priorities. When solving problem (6), the values may not be known in advance, which leads to the $\alpha_i,\ i = \overline{1,2}$ *uncertainty of priorities*. The general statement of the problem of multicriteria optimization of irrigation systems in this case is formulated as follows. A vector function is given, whose components are particular optimality criteria and, defined on the set of alternatives of the vector of variable parameters $\Psi(x, a) = (y_1(x, a), y_2(x, a))$ $y_1(x, a)$ $y_2(x, a)$ Ω_X X. It is necessary to find such a solution on the set, Ω_X would minimize all components of the vector function $\Psi(x, a)$.

For each fixed vector, the combined convolution method reduces the solution of problem (6) to the solution of a single criterion optimization problem of the form: $\mathrm{A} = (\alpha_1, \alpha_2)$

$$\min_{x \in D} F(x, A) = F(x^*, A)\ (7)$$

If the solution of problem (7) is unique for each $\mathrm{A} \in D_{\mathrm{A}} = \{\mathrm{A} \big| \alpha_i \le 0, \sum_{i=1}^{2} \alpha_i = 1\}$, then this means that each of the admissible vectors A corresponds to a single vector x^* and corresponding values of partial optimality criteria $y_1(x^*, a),\ y_2(x^*, a)$. Based on this, you can build some PF DM $\zeta(\mathrm{A})$, defined on the set $D_{\mathrm{A}} : \zeta : \mathrm{A} \to R$.

Then the problem of multicriteriative optimization is reduced to the choice of $\mathrm{A}^* \in D_{\mathrm{A}}$, such that $\max_{\mathrm{A} \in D_{\mathrm{A}}} \zeta(\mathrm{A}) = \zeta(\mathrm{A}^*)$.

We will assume, that ζ it is a linguistic variable, that takes a certain number of finite values, for example, e=5: «Very bad», «Bad», ..., «Very Well». Let us ζ^0 denote the kernel of the fuzzy variable ζ and introduce the following correspondence: the value ζ «Very bad» corresponds to $\zeta^0 = 1$, the value ζ «Bad» corresponds to $\zeta^0 = 2$, the value ζ «Average» corresponds to $z^0 = 3$, the value ζ «Well» corresponds to $z^0 = 4$ and the value ζ «Very Well» corresponds to $z^0 = 5$.

This, the problem of multicriteria optimization is reduced to finding a vector $\mathrm{A}^* \in D_{\mathrm{A}}$, that provides the maximum of the discrete function $\zeta(\mathrm{A})$:

$$\zeta(\mathrm{A}^*) = \max_{\mathrm{A} \in D_{\mathrm{A}}} \zeta(\mathrm{A}), (8)$$

those, to the approximation of the PF DM.

The general scheme for solving such a problem is iterative and has several stages [1, 13].

At *the first stage* n vectors A_1, A_2,..., A_m are randomly generated. The order of the following actions is as follows.

A one-criteria problem is solved:

$$F(x^*, A) = \min_{x \in D} F(x, A_l), l = \overline{1,m} \quad (9)$$

The obtained values are $x_l^*; l = \overline{1,m}; y_i(x_l^*); \ i = \overline{1,2}$.

The obtained values are evaluated $y_i(x_l^*); \ i = \overline{1,2}; \ l = \overline{1,m}$ evaluated and the values of the preference function $z(A_l); \ l = \overline{1,m}$ are introduced.

In the *second step*, based on the values A_1, A_2, ..., A_m and estimates $z(A_l); \ l = \overline{1,m}$, the following actions are performed.

1) A function $\tilde{\zeta}_1(A)$ is constructed, approximating $\zeta(A)$ in the vicinity of points A_1, A_2,..., A_m;

2) A single-criteria problem is solved

$$\max_{A \in D_A} \tilde{\zeta}_1(A) = \tilde{\zeta}(A_1^*); \quad (10)$$

3) A single-criteria problem $\min_{X OD} F(z, A_1^*) = F(x^*, A_1^*)$ is solved;

4) The found values $x^*; y_i(x^*); \ i = \overline{1,2}$ are displayed;

5) The obtained values $y_i(x^*); \ i = \overline{1,2}$ are evaluated and the value of the preference function $\zeta(A_1^*)$ is entered.

In the *third step*, based on the available values of A_1, A_2,..., A_m, A_1^* and the corresponding estimates of the preference function $\zeta(A_1)$, $\zeta(A_2)$,...,$\zeta(A_k)$, $\zeta(A_1^*)$, an approximation of the function $\zeta(A)$ in the vicinity of points A_1, A_2, ..., A_m, A_1^* is performed, as a result of which the function $\tilde{\zeta}_2(A)$ is constructed. Further, the procedure continues according to the scheme of the second stage until the DM decides to stop the calculations. At each iteration, a «rollback» is allowed in order to change the previously introduced estimates of its PF DM.

The approximation of PF DM $\zeta(A)$, given indistinctly as a linguistic variable, can be carried out by fuzzy models, neural and neuro-fuzzy networks [9-12].

3. Results of practical application. The above optimization technique has been applied to the irrigation system used for cotton cultivation.

The software implementation of optimization algorithms was carried out in the MATLAB 2015 environment on a computer with an Intel(R) Core (TM) i5-9400 CPU @ 2.90 GHz and 8.00 GB of RAM.

The vector of input parameters of the technological process included: irrigation rates per complex hectare x_1 (thousand m^3/hectare), cash costs x_2 (thousand sum/hectare), costs of nitrogen fertilizers x_3 (Ton/hectare), costs of phosphate fertilizers x_4 (Ton/hectare), labor costs x_5 (person-days/hectare).

On the output parameters y_1 (yield) and y_2 (monetary costs), the input parameters $x_1 \div x_5$ of the technological process of cotton irrigation, restrictions were imposed, constituting a set of permissible solutions

$W_v = Y \text{ I } X = \{Y \text{ O } R^2 \mid y_1 \text{ i } 37$ *Centner / hectare*;
y_2 J 86000 *thousand sum / hectare*;
X O $R^5 \mid 6$ *thousand* $м^3$ */ hectare* J x_1 J 10 *thousand* $м^3$ */ hectare*;
80000 *thousand sum / hectare* J x_2 J 86000 *thousand sum / hectare*;
0,2 T/ *hectare* J x_3 J 0,25 T / *hectare*; 0,15 T / *Ha* J x_4 J 0,175 T / *hectare*;
x_5 = 720 *person - days / hectare*}.

The equalization of mathematical modeland yield has the form of an additive regression equation

$$y_1 = \frac{a_1 x_1}{(a_2 + x_1)^2} + a_3 x_2 + a_4 x_3 + a_5 x_4 + a_6 x_5, \quad (11)$$

where a_1 = 420.06; a_2 = 6.49; a_3=0.00000002; a_4 =0.075; a_5=0.075; a_6=0.01505.

The optimization problem under conditions of certainty was to maximize parameter y_1 and minimize parameter y_2. A set of variable parameters make up parameters x_1, x_3 and x_4.

The scattering estimates of the output parameter values were selected as follows: $d_1 = 5$, $d_2 = 150000$. The static optimization problem in proposition (6) was solved by the method of coordinate descent for different sets of values a_i; $i = \overline{1,2}$. The results of the optimization are summarized in Table 1. Bold indicatesa situation in which the functional limits on the output parameters are violated.

Table 1.

Results of software implementation of the optimization model.

№	α_1	α_2	y_i; $i = \overline{1,2}$	F	x_1	x_3	x_4	It's time decisions, sec.
1	0	1	y(1)= 38.5605502 y(2)= 79023222.5	1.7964	6.0000	0.2000	0.1500	19,22
2	0.1	0.9	y(1)= 38.5605502 y(2)= 79023222.5	1.8151	6.0000	0.2000	0.1500	19,16
3	0.2	0.8	y(1)= 38.5605502 y(2)= 79023222.5	1.8342	6.0000	0.2000	0.1500	19,22
4	0.3	0.7	y(1)= 38.5605502 y(2)= 79023222.5	1.8537	6.0000	0.2000	0.1500	19,22
5	0.4	0.6	y(1)= 38.5605502 y(2)= 79023222.5	1.8737	6.0000	0.2000	0.1500	19,16
6	0.5	0.5	y(1)= 38.5605502 y(2)= 79023222.5	1.8941	6.0000	0.2000	0.1500	19,22
7	0.6	0.4	y(1)= 38. 5605502 y(2)= 79023222. 5	1.9150	6.0000	0.2000	0.1500	19,22
8	0.7	0.3	y(1)= 38. 5605502 y(2)= 79023222. 5	1.9364	6.0000	0.2000	0.1500	19,22
9	0.8	0.2	y(1)= 38. 5605502 y(2)= 79023222. 5	1.9582	6.0000	0.2000	0.1500	19,16
10	0.9	0.1	y(1)= 38. 5744754 y(2)= 79026271. 1	1.9805	6.1596	0.2000	0.1500	19,22
11	1	0	y(1)= 38.7631635 y(2)= 87627619.4	2.0032	6.4920	0.2500	0.1750	19,11

Optimization in the face of uncertainty of priorities was carried out as follows.

The formation of function values ζ was carried out on the basis of the rules given in Table 2.

Table 2.

VALUE GENERATION RULES.

№	F	ζ
1	F≤1.8	*Very Well*
2	1.8<F≤1.86	*Well*
3	1.8<F≤1.92	*Average*
4	1.92<F≤2	*Bad*
5	$F > 2$	*Very bad*

When solving the problem (6), the method of coordinate descent was used, the method of the golden ratio was used to solve the problem (10). The intermediate points of the function $z(\mathrm{A}) = z(a_1, a_2)$ were determined using a cubic spline. The approximation of the function ζ was carried out using a fuzzy Mamdani model, which was implemented using the **Fuzzy Logic Toolbox** MATLAB 2015 extension [16, 17].

Thesemi complete fuzzy output system (see Fig. 1) has two inputs (weigh1t1, weigh1t2), a Mamdani fuzzy output mechanism, one output (function). The input variables are a_1, a_2 the weighting coefficients of the particular criteria of optimality y_1 and y_2, the output variable corresponds to the function ζ .

The input and output variables correspond to the coziness of the membership function, which were given as a symmetrical Gaussian function.

The input variables correspond to three types of membership functions: small, middle, big, which correspond to a small, medium and large value of the weighting coefficients α_1 and α_2. The output variable corresponds to five types of accessory functions, which have been assigned names - VB (*Very bad*), B (*Bad*), A (*Average*), W (*Well*), VW (*Very Well*).

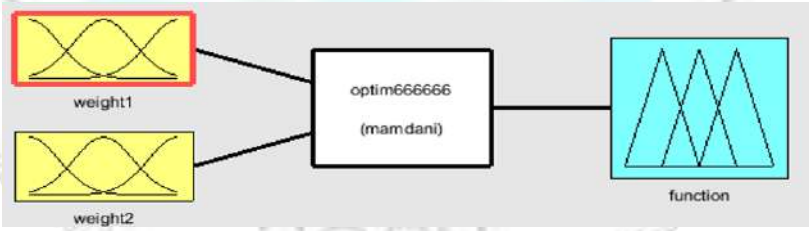


Figure 1. Fuzzy Output System

The set of rules that specify the relationship between the input and output variable is of the form

*IF weight*1 = *small AND weight*2 = *big THEN function* = *Very Well*;

*IF weight*1 = *small AND weight*2 = *middle THEN function* = *Well*;

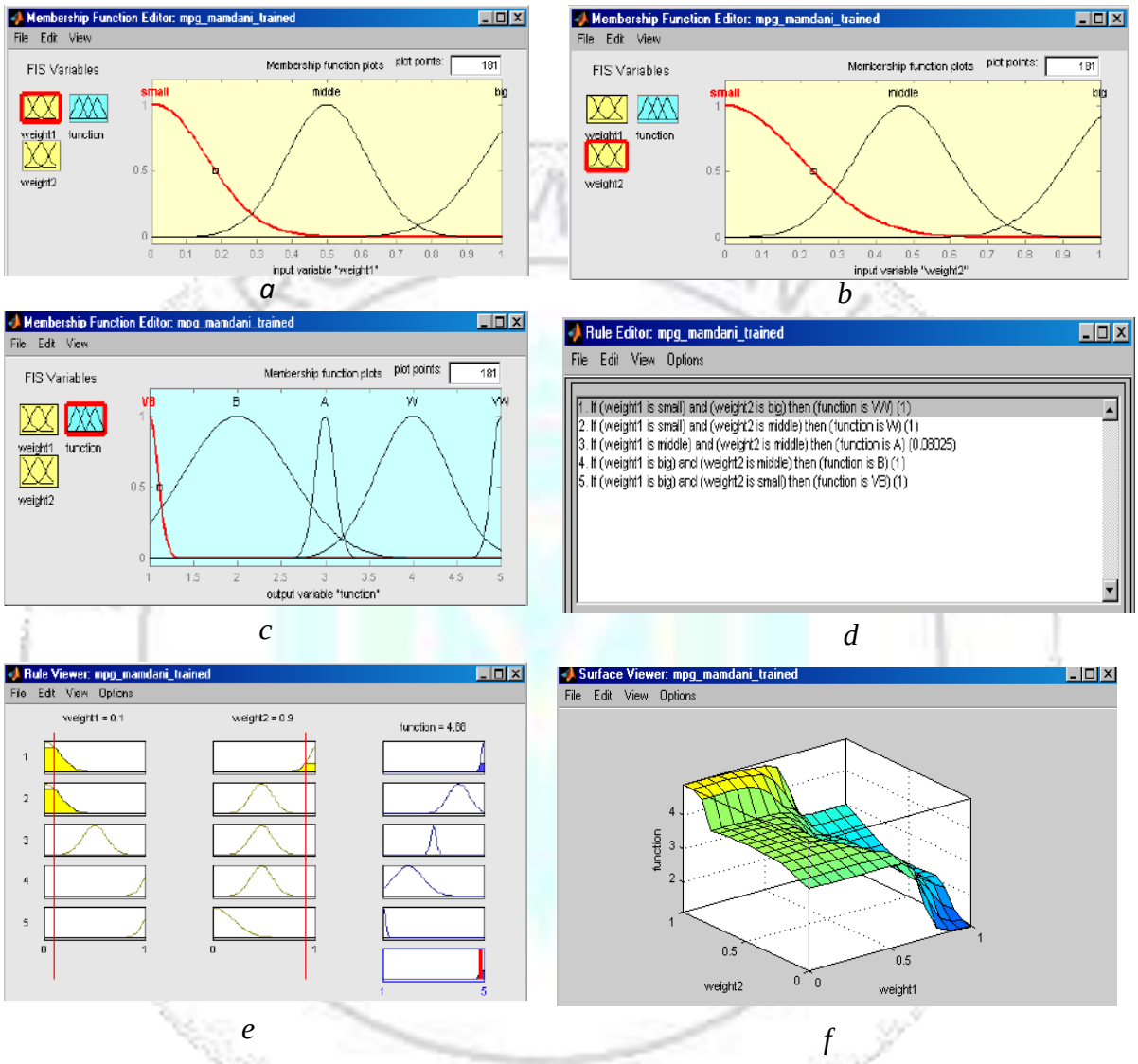
*IF weight*1 = *middle AND weight*2 = *middle THEN function* = *Average*;

*IF weight*1 = *big AND weight*2 = *middle THEN function* = *Bad*;

*IF weight*1 = *big AND weight*2 = *small THEN function* = *Very bad*.

Fine-tuning of the fuzzy output model at each step of the problem solution (10) was implemented using *the fmincon* function of the extension **Optimization Toolbox MATLAB** 2015 [18-20].

In Fig. 2 an illustration of a fuzzy model is given Mamdani, obtained after tuning in the next step of solving the problem (10).



a *b* *c* *d* *e* *f*

Figure 2. Fuzzy Mamdani model after fine tuning

a- editor window of the functions of belonging to the variable weight1; b- window of the editor of the functions of belonging to the variable weight2; c- the function editor window of the function membership variable; d- output Rule Editor window; e - output rule viewer window; f- solution Viewer window

When solving problem (10), the number of "overclocking" solutions n was chosen equal to six: A_1, A_2, ..., A_6. Moreover, the extreme values A_1, A_6 were chosen at the boundaries of the area of change in the weighting coefficients α_1 and α_2, and the average values A_2, A_3, ..., A_5 were randomly generated. The results of solving the problem of multi-criteria optimization are shown in Table 3 and illustrated in Fig. 3.

In Table 3, the «overclocking» iterations are highlighted in gray. The optimal value $a_1 = 0.059$ and, respectively $a_2 = 0.941$. At the same time, the values of the partial optimality criteria were: f_1=38.560 *centner/hectare* and f_2 = 79023.222 thousand *sum/hectare*. The optimal values of the variable parameters obtained during optimization are distributed as follows: x_1=6.0000 *thousand* m^3*/hectare*; x^3=0.2000 *Ton/hectare*; x^4=0.1500 *Ton/hectare*.

The maximum time for one iteration when solving the problem (10) was 4.6 s. The total time for solving the problem (9) was 30 seconds.

Table 3.

Problem solution results optimization.

Iteration No.	α_1	α_2	F	ζ
1	0	1	1.99661	VW
2	0.31	0.69	1.99888	W
3	0.861	0.139	2.00295	B
4	0.599	0.401	2.00101	A
5	0.202	0.798	1.99809	W
6	1	0	2.00699	VB
7	0.08	0.92	1.99719	VW
8	0.04	0.96	1.99689	VW
9	0.059	0.941	1.99703	VW

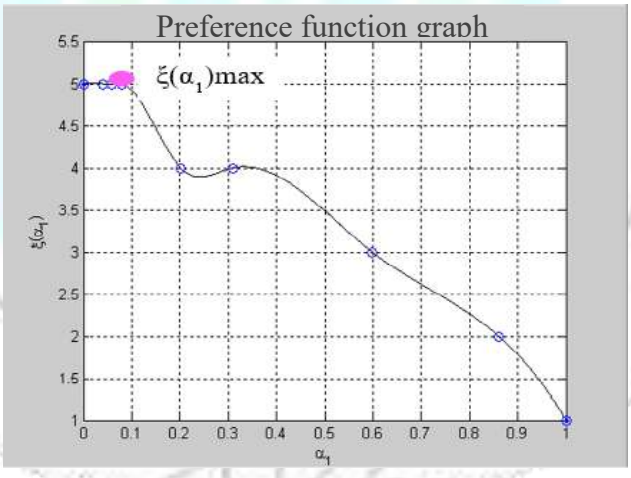


Figure 3.

Graph of the face preference function, the decision maker

Conclusion

1. The proposed method of solving the problem of optimizing the values of parameters of irrigation systems makes it possible to bypass the computational difficulties associated with the complexity and incorrectness of the problem.

2. The described algorithm of intellectual decision support makes it possible to solve the problem of multicriteria optimization of irrigation system parameters in conditions of uncertainty of priorities according to particular criteria of optimality.

3. The software implementation of the developed methodology and algorithm for optimizing the parameters of irrigation systems is very effective and can be widely used in practice to solve the problems of multicriteria optimization of various irrigation systems in agriculture.

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THE EVALUATION OF PVD COATED HSS END MILL

***Professor Sangseog Lee**, (Department " Mechanical Engineering", KMCU)*

Professor Bakhadir Mirzaev *(Rector of "TIIAME" National Research University)*
Associate professor Guzal Eshchanova (Faculty "Organization and Management of Water Resources", "TIIAME" National Research University)
Dr Ismoil Ergashev, *Director of Samarkand Vocational Centre*

Abstract

To enhance the cutting performance of high speed steel(HSS) end mill, single and multilayer coating is applied on the substrated of the HSS end mill. Coating material reduces cutting force and enhances resistance against abrasive wear. This paper presents the physical vapour deposition(PVD) coating technology and the machinability of PVD coated HSS end mill. The performance of coated HSS end mills are fifteen times better than uncoated HSS end mill on proposed cutting conditions. The TiAlN monolayer coated end mills(futura nano coating) are better than those of multilayer coated end mills(futura coating) on machined surface and tool wear.

Key Words : PVD coating, HSS end mill, Coating Tool

1. Introduction

The current metal processing process is progressing with high precision and high efficiency, and in order to improve the productivity of this metal cutting process, metal processing using high-speed steel (HSS) end mills with good toughness is the mainstream in the field. This end mill is an elongated, slender rotary tool that is widely used for free machining of outlines and small spaces within parts with the development of machining centers

With the development of tool grades, starting from HSS tools, hard grade tools such as cemented carbide and cermet tools are becoming common. This good HSS end mill has a lot of market share. Although the HSS end mill has good toughness, it has poor wear resistance compared to cutting tools of other grades, so it is generally used by coating the end mill.

Coating methods for cutting tools are generally divided into chemical vapor deposition (CVD) and physical vapor deposition (PVD). Although the CVD method has a high adhesion between the coating and the base material, due to the disadvantages of high working temperature and environmental pollution, so it is being replaced by PVD coating which is economical and the process temperature is relatively low,

TiN coating obtained by PVD coating improves the wear resistance of cutting tools. In the case of TiCN coating, it improves the tool life by having excellent hardness as well as wear resistance. In addition, in the case of TiAlN coating, the friction coefficient between the workpiece and the cutting tool generated during machining is lowered so that the tool can be operated without using coolant. It improves performance. In addition, it has low thermal conductivity, thermal stability, and excellent high-temperature corrosion resistance by removing the heat generated during processing together with the processing chip.

Recently, there is a trend to improve the tool life and performance by treating the TiAlN coating as a multi-layer coating instead of a single-layer coating to greatly improve the resistance to crack growth on the surface of the coating layer generated during operation.

Therefore, in this study, TiAlN single-layer coating(futura nano) and multi-layer coating (futura) coating by PVD coating method of HSS end mill were tested to evaluate the cutting

performance according to the change of cutting speed and machining conditions of this coating tool.

2. Main Contents

2.1 PVD coating technology

For alloy coating such as TiAlN, it is preferable to apply the coating using Arc-type sputtering equipment. <Fig.1> is an arc-type sputtering type BAI1200 PVD coating equipment that can coat TiN and TiCN as well as alloy coatings such as TiAlN in a relatively low vacuum. The coating process is divided into four stages: Heating - Etching - Coating - Cooling, and the total coating process for TiAlN alloy coating takes about 9 to 10 hours.

Looking at the PVD coating mechanism, first, the target metal is vaporized and moved from the target material, and after the vapor is converted to an ion state by a coating auxiliary device such as plasma, it is deposited on the surface by the bias voltage applied to the object to be plated. As deposition proceeds in the form of ion plating, the adhesion between the base material and the coating layer is increased, and the porosity of the coating layer can be significantly reduced.

In general, the thickness of the PVD coating is determined by the coating time, and since the growth of the coating layer is different depending on the bias voltage or the temperature of the coating process during coating, the mechanical and physical properties of the coating layer can be controlled by these variables.

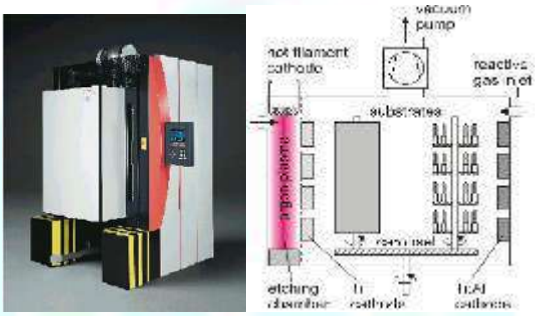


Fig.1

Balzers BAT1200 coating system and PVD coating mechanism

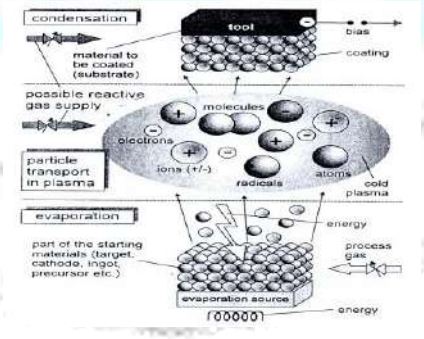
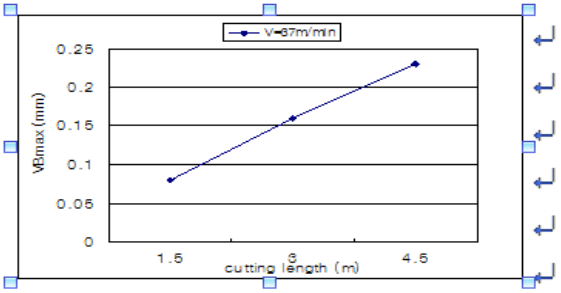


Fig.2

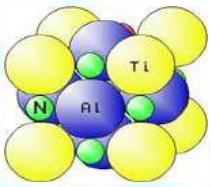
The three phases of coating formation

The vacuum-deposited thin film in the PVD coating process basically exists in three phases as shown in <Fig.2>. That is, 1) conversion of the coating material into gaseous state by the physical evaporation principle 2) vapor transfer through the gas atmosphere (plasma) state between the evaporation source and the substrate 3) It is condensed in the form of a thin film on the surface of the substrate.

2.2 Structure of TiAIN The TiAlN coating has the following FCC structure.



In the face-centered cubic structure of TiAlN, titanium atoms are located at the vertices of the cube and aluminum atoms are located at the center of the plane. And the reacted nitrogen is in a form that penetrates into the gap between the titanium



atom and the aluminum atom.

At this time, it can be seen that one crystal structure contains one titanium atom, three aluminum atoms, and two nitrogen atoms. When these ratios are correctly combined, the color of a complete TiAlN coating can be obtained.

3. cutting experiment

The machine tool used for the cutting performance test of the end mill was Daewoo Heavy Industries Co., Ltd. Machining Center (ACE-V400), and the workpiece material was alloy steel SCM4. The performance of the end mill was evaluated by applying TiAlN single-layer and multi-layer coating to an HSS end mill of φ10 mm with four cutting edges.

After fixing the workpiece in a vise, it was cut at regular intervals. Using a tool dynamometer (Kistler 9257BA), the change in cutting force according to the abrasion of the end mill was acquired and analyzed using an A/D converter (DT3001).

In order to minimize the error caused by tool setting during the cutting experiment, the cutting force was measured while continuously changing the radial depth of cut after setting a new cutting edge. When the end mill is mounted on the tool, the protrusion length significantly

affects the tool life and surface roughness. In this experiment, the protrusion length was fixed at 30 mm to minimize the error caused by the change in the end mill protrusion length. Tool wear was measured using a tool microscope (Mitutoyo TM). For flank wear, VBmax was constantly measured at 5 mm from the tip of the cutting edge, and the wear amount VC of the minor cutting edge was measured.

4. Results and Discussion

4.1 Performance evaluation according to changes in cutting speed

In the performance evaluation according to the cutting speed of the HSS end mill, based on the cutting conditions recommended by the manufacturer of the test end mill, the feed rate and depth of cut are constant and only the cutting speed is changed to investigate the wear and surface roughness of the coated tool at each cutting speed. In the cutting process, the wear phenomenon of

the cutting tool appears in various ways depending on various variables. In particular, compared to the turning process, the analysis of the characteristics of the milling process is difficult because the intermittent cutting process is performed. However, the wear of the cutting tool is most dominantly affected by the change in cutting speed.

Due to the high toughness of the uncoated HSS end mill, gradual wear is dominant on the flank surface of the cutting tool's main cutting edge according to the change of the machining length under the given machining conditions. Tool damage is predominant.

As shown in Fig. 3, up to the cutting speed of 37m/min, when the limit of flank wear is VB=0.2mm, it was possible to machine up to 4.5m in length, but as the cutting speed increased, HSS without coating End mills suffer from severe tool wear, so their performance is poor.

Fig.3 Rack face wear (uncoating) at V=37 m/min

In Fig. 4, when the cutting speed (V) is 53m/min, In the case of the non-coated HSS end mill, the abrasion of the free surface of the main cutting edge exceeds 0.2mm even when the machining length is only about 3m. However, the PVD-coated end mill can process more than 45 m, so it shows a performance difference of about 15 times compared to the PVD-coated and non-coated tool.

In terms of economy, the general HSS end mill (φ10) without coating is about 5,000 won, and when it is coated, it is about 11,000 won. It can be said that the economic effect of coating is large as it increases by about 15 times.

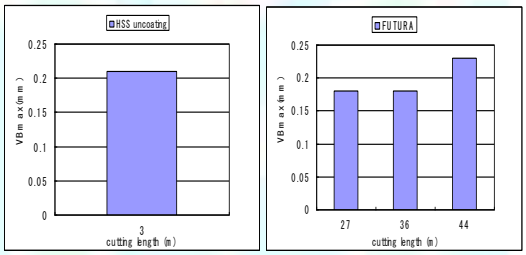


Fig.4

Wear of Race face on V=53m/min
(futura coating & uncoating)

Fig.5 and Fig.6 show the test results by changing the cutting speed of the PVD coated end mill to 100m/min.

As can be seen from the figure, in the futura nano coating, the tip wear (VC) of the end mill was about 0.4 mm at a machining length of 84 m, but in the futura coated end mill, the tip wear exceeds 0.4 mm at a machining length of 15 m.

The surface roughness of the futura nano-coated end mill shows Rmax 12.2㎛, but the futura-coated endmill shows 39.2㎛ when machining 12m at the same cutting length.

In conclusion, in the performance evaluation of end mills according to the change in cutting speed, PVD coated tools can improve productivity significantly compared to uncoated tools. It is also shown to be excellent in tool wear and surface roughness.

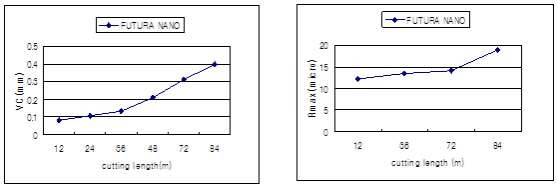


Fig.5

V = 100m/min, flank wear and surface roughness (futura nano coating)

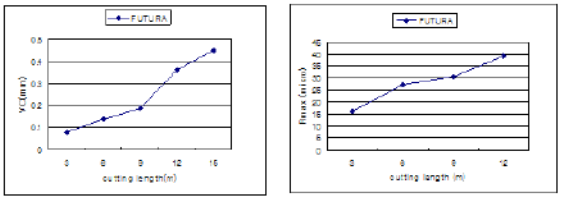


Fig.6 V=100m/min, flank wear and surface roughness (futura coating)

4.2 Performance evaluation according to change in radial depth of cut (Rd)

Fig. 7 shows the cutting length by changing the axial depth of cut (Ad) to 10mm and the radial depth of cut Rd to 0.5mm, 1mm, and 2mm at a cutting speed of 100m/min, a spindle speed of 3183rpm, and a feed rate of 636mm/min. Changes in tip wear (VC) and surface roughness of coated end mills after 3 m machining were shown. As can be seen from the figure, as the radial depth of cut increases under the same machining conditions, the tip wear (VC) of the coated tool increases, and the futura nano coated end mill shows less wear than the futura coated end mill.

In the case of surface roughness, there is no general tendency that the surface roughness increases or decreases as the cutting depth in the radial direction is gradually increased.

It can be seen that the surface roughness of the futura nano coating tool is relatively superior in the surface roughness of the workpiece according to the change of coating. As can be seen from the change in the length of the tip wear according to the change in the radial depth of cut, the futura nano-coated tool has less wear than the futura-coated tool, so the surface roughness is also improved.

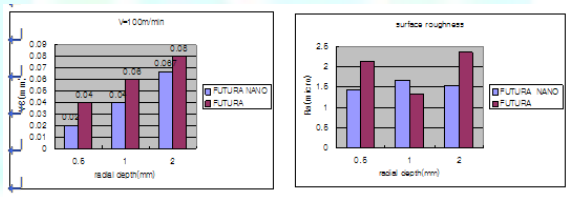


Fig.11 Changes in VC and Ra according to radial depth of cut change (cutting length=3m, V=100m/min)

According to the change of the radial depth of cut in high-speed machining using an end mill, the futura nano coating causes less wear at the tip than the futura coating and shows excellent properties in terms of surface roughness.

4.3 Changes in cutting force due to coating

Fig. 8 shows the average values of the cutting forces in the X, Y, and Z directions when the radial cutting force Rd is changed to 0.5mm, 1.0mm, and 2.0mm under dry cutting at a cutting speed of 100m/min and a feed rate of 626mm/min. was shown.

In fact, as the radial depth of cut increases, the cutting force increases. Under the conditions of this experiment, the cutting forces in the X and Y directions are generally similar, but the Z direction is smaller than the cutting forces in these two cutting directions.

The difference between the cutting forces of futura nano and futura coated end mills is not constant in the cutting forces in the X and Y directions.

It can be seen that the end mill with futura nano coating in the Z direction takes less cutting load according to the change in depth of cut than the case with futura coating.

Table 1

Performance of Z-direction cutting force according to coating

Rd / coating	0.5mm	1mm	2mm
futura nano	34N	53N	92N
futura	44N	66N	102N
performance(%)	22%	19%	9%

Table 1 quantitatively shows the change in cutting load according to the change of the radial depth of cut in futura nano coating and futura coating in the Z direction.

Here, it can be seen that the smaller the Rd value, the better the cutting load performance of the futura nano coating.

The Z direction is a component of the cutting force acting in the axial direction of the end mill and has a great influence on the surface roughness of the workpiece.

Therefore, it is suggested that the HSS end mill is coated with a single layer (futura nano) in high-speed machining at a cutting speed of 100 m/min to reduce the radial depth of cut, thereby improving the performance of the cutting load.

Fig.9 and Fig.10 show the cutting force signals of futura nano and futura coating.

Fig. 11 shows the change in cutting force in the X, Y, and Z directions as the machining length of the coated end mill changes at a cutting speed of 100 m/min.

As can be seen from the figure, the cutting force in the x-y direction increases as the machining length increases, but the change in the machining length in the z-direction changes slightly.

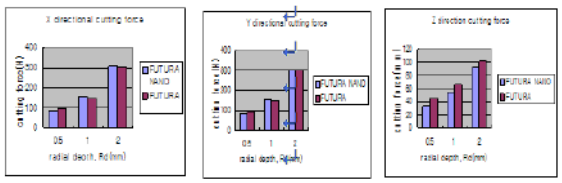


Fig.8 Effect of cutting force according to radial depth of cut

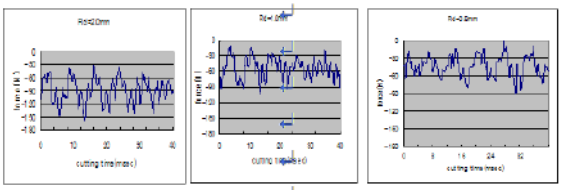
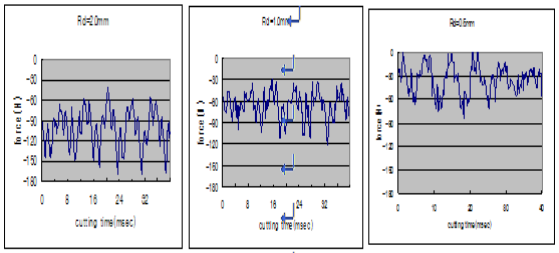
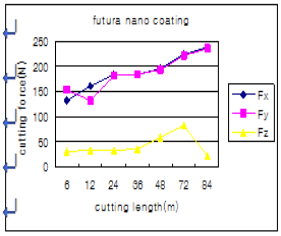
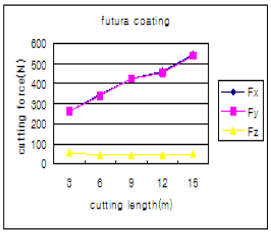


Fig.9 Cutting force signal according to radial depth of cut (futura coating)
Fig.10 Cutting force signal according to radial depth of cut (futura nano coating)
Fig.11 Cutting force in the 3-axis direction according to the machining length







5. Conclusions

In this study, PVD coating technique of HSS end mill with excellent toughness and low price was presented, and the performance of the PVD coating coated end mill was tested according to changes in cutting conditions.

Through this study, we would like to present the following conclusions.

1) By applying PVD coating to HSS tools, machining speed can be improved and tool performance is significantly increased. In this experimental condition, the PVD-coated end mill has about twice the unit price compared to the non-coated tool, but in terms of performance, it shows a performance difference of about 15 times.

2) In terms of surface roughness of the workpiece, futura nano coating shows better results than futura coating.

3) In the performance evaluation of the coated tool according to the change of machining conditions, the tip wear (VC) of the coated tool increases as the radial depth of cut increases under the same machining conditions.

In addition, futura nano coated end mills show less wear than futura coated end mills.

4) The cutting force applied to the coating tool increases as the radial depth of cut increases. According to the change in depth of cut, the end mill with futura nano coating takes less cutting force than the case with futura coating.

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WAYS OF DEVELOPING A SYSTEM FOR DELIVERING PRODUCTS TO CONSUMERS IN INTENSIVE HORTICULTURE

Sattorov Orifjon Boymuratovich *Associate professor of "Tashkent institute of irrigation and agricultural mechanization engineers" National research university*

Keywords. Gross revenue, intensive, farm, construction, productivity

Abstract

In this article trends and changes of development of a savdovodstvo and intensive gardening in the region and in the country in general are considered. Are submitted the analysis of the current state of the areas of gardening and their change. The recommendations of an irpedlozheniye about improvement of gardening in the Kashkadarya region and the republic are given.

In fact, currently the agricultural is not gotten well efficiently without new technologies. The intensive gardens are also the most effective than traditional method. The researchers are showed that the development of intensive gardening have to be based on agricultural production and efficient use of regional characteristics.Do not forget that the production of agricultural goods is directly dependent at the climate so all processes have been required a long time, for instance farms have to spend minimum six months to get their harvest. However, each fruits have several varieties and if farms can use intensive method they will produce over the during year.These features are important to organized of product marketing processes.Today, specific farms have been established and operate in replace of liquidated collective farms.

1 Introduction.

In our country in the conditions of liberalization of economy large-scale reforms in the field of intensive gardening and wine growing are undertaken. Even before creation of farms in the sector of fruit and vegetables the most part of fruit (78.1%) was grown up by Dehkan farms and farms. In particular, in 2016 60.6% of total area of gardens 33.9% - to Dehkan farms were transferred to farms, the others belonged to other agricultural enterprises. Besides, 45.7% of all fruit which are grown up in 2015 are grown up on farms and 52.2% on Dehkan farms. If to draw a close attention to these figures, that is for 33.9% of Dehkan farms with the land plots, 52.2% of a harvest of fruit show high efficiency of Dehkan farms. Development of intensive gardening demands use of features in the industry. Specific features which need to be taken into account, according to us, the following groups:

The first group is various products of intensive gardening which are directly connected with intensive gardening; appearance of products, difference in the nature of goods; process of intensive gardens and labor-consuming harvesting; differences in maturing of fruits; All types of fruit can be stored and be processed.

The second group - the specific features connected with activity of intensive gardening farms. That is agricultural grounds and small amount of production; Production of fruit demands from the farmer of sufficient knowledge, experience and skills; far away from the market; The Possibility of cultivation of fruit in water, magnificent, mountain and foothill areas; Fertility on the basis of various agrotechnical actions; access to the field; experiments generally from generation to generation; the beginning of investments into the industry in 5-6 years; Very intensive influence of climatic conditions should be considered at intensive gardening. [1]

Organizational aspects of activity of intensive gardening economy can be divided into two groups.

Establishing intensive gardening business - land lease, a solution of the problem of possession and use of gardens; Infrastructure, use of objects; Possession of fixed assets; management of a farm;

production creation; processing of the earth; care of a garden; protection against insects and diseases; harvesting and marketing.

Within economic aspects of economic activity of economy - landing and realization of fruit; contractual relations; price policy, mechanism of material benefit; financial and credit, tax, insurance relations; organization of processing and product sales; issues of professional development, retraining and use of scientific achievements of gardeners have to be resolved.

It is desirable to allocate to farmers the long-term credits for purchase of the mineral devices, mini-technologies connected with production, processing, storage and transportation of fruit.

Intensive gardening began in 2012. For example, the area of gardens in the territory of our country in 2013-2017 increased from 254.6 thousand. Hectare up to 279.6 thousand. Hectare, i.e. For 9%, and the quantity of gardens increased by territories of the country from 201.3 thousand. Up to 226.9 thousand. Hectare. for 12%. Productivity increased by 19%, and the gross product grew by 34%. In spite of the fact that these figures are low now, such growth rates in the short term indicate that development of the industry of gardening is positive development.

Fruit and berry fields, gross collecting and productivity in our country

	2013	**2014**	**2015**	**2016**
Fruit and berries (thousand pieces)	254.6	261.9	266.4	279.6
from which profitability (thousand pieces)	201.3	214.6	214.3	226.9
Gross revenue (one thousand tons)	2261.1	2490.6	2746.1	3042.8
productivity (one thousand tons)	112.3	116.0	128.1	134.1

In particular, taking into account a situation in the Kashkadarya region a share of gardens in the region in 2016-2017. Makes 17238.0 hectares. from 20755.6 to 20%. The area of younger gardens increased from 122,140 to 15,156.0 points and increased by 24%, and the share of intensive gardens increased from 1945.3 to 1954.5, or for 0.4%. The low share of intensive gardens in the region aggravates need of intensive gardening for the region now. However lack of necessary conditions for creation of intensive gardening in the region, lack of adequate knowledge and skills in the cost of new technologies for development of intensive gardening.

Information on the existing gardens in the Kashkadarya region

Available gardens, hectare	**Areas of gardens, hectare**	**Areas of younger gardens, hectare**	**Intensive gardens, hectare**
2016 year	17238	12214	1945.3
2017 year	20755.6	15156.0	1954.5

Today intensive gardening is based on the market principles and is not a method of administrative management for development of the industry, and it is rather an inadequacy of deliveries of high levels of mineral fertilizers, gardens and insecticides and also intensive methods of gardening. Quantity of the got profit low. In recent years increase in profit is observed. In

particular, the analysis of intensive gardening in the Kashkadarya region in 2012 allowed to receive a harvest of 1025 000 sum from hectare of crops, 1957 000 sum in 2015, 3251200 sum in 2016 and profitability of 5895600 sum in 2016, 75.6 percent. In view of the fact that the average gross area of an average farm in the region in 2017 is 10.8 hectares the annual net profit of a farm is 33694.0 thousand Sumov. Of course, taking into account the level of this income, and good results are achieved. In particular, on an intensive garden farm Orifzhon who grows on the area of 3.5 hectares in Yakkabagsky district in 2017 the net profit of one hectare of gardens was 1055 000 sum.

Apparently above, development of intensive gardening in our country differs from traditional gardening, with its high productivity for the short period of time, with its high efficiency, resistance to storage and transportation of the grown-up fruit. Thus, for development of intensive gardening in our country it is expedient to realize the following tasks:[2]

- increase in quantity of the farms specializing in intensive gardening;
- interest rates reduction on soft loans and extension of tax benefits for effective development of intensive gardening;
- allocation of the grain and cotton fields free from intensive gardening, not for objects of housing construction, and for intensive gardening;
- Creating favorable conditions for import of the leading foreign technologies (drop irrigation) for development of intensive gardening and increase in efficiency.

Development of intensive gardening and achievement of high efficiency will allow to ensure in the future food security in our country, to fill the national markets with fruit and vegetables, to satisfy demand of the population for fruit and also will contribute to the further development of the export potential of our country and increase in the standard of living.

At the same time the most modern products are based on a private property and can be used for free agrarian economy, but also provide extensive information for those who want to get economic support from the industry. The garden network is not an exception. Now in gardening network there is a set of problems, revealing ways of their overcoming, minimizing shortcomings and applying new effective methods of gardening.[3]

For example, by 2016 the population of our country which is engaged in fruit and berries had only 39.3 kg of real consumption (only fresh, raw) within one year, and this figure will make 65.31 kg according to medical standards. Because fruit and berries are generally grown up in Dehkan farms, consumption of fresh fruit is 40% less than medical norms that, in turn, creates the need for additional fruit and berries of the population of the country. The deficiency of fruit in the national markets is compensated by import fruit from our country, and their share makes 35-40% now. The product range of import fruit from abroad consists mainly of our fruit, but our fruit differ in the taste, ecological purity and the maintenance not of GMB. However this problem can be solved by further development of intensive gardening in our country, strengthenings of material and technical resources of the farmers and Dehkan farms specializing in intensive gardening, implementation of new technologies and further state support. In our country there are a lot of affairs, but with intensive gardens still there is a problem.

Therefore, in our opinion, importance and importance of organizational and economic development of intensive gardening differ. The purpose of this article is the analysis of a number of methodical and practical recommendations about the organizational and economic principles of intensive development of gardening, to organizational and economic mechanisms of development of intensive gardening.

The following difficult tasks are necessary for achievement of our purposes:

- theoretical studying of the current state of intensive gardening;
- assessment of the current state of fruit growing and intensive gardening;
- to define the factors influencing development of intensive gardening;

- to define ways of increase in efficiency of cultivation of fruit and berries;
- development of methodical recommendations about optimization of high-quality gardens;
- development of mechanisms of the state support of intensive development of gardening;
- justification of organizational forms of agro-industrial integration by production of fruit and vegetables, etc.

It is necessary to analyse carefully set of the economic relations developing in development of intensive gardening. Besides, close cooperation with research institutes, the centers and farmer councils in intensive gardening, carrying out theoretical and methodological researches, wide use of domestic and foreign experience, revision of the existing standard and legal documents, development of intensive gardening is planned. and production of high-quality fruit and berries.

According to us, the seasonality of operation of these products and use of human resources, operation duration, fast losses, harvesting, transportation and packing, non-standard grades of fruit and berries are the reasons of slow growth of intensive gardening.

It should be noted that in the region there are favorable conditions for mountainous and foothill areas and districts, with the aim of developing, developing and improving the efficiency of intensive gardening. Favorable climatic conditions, abundant rainfall, high land productivity and weak winds are most suitable for the future development of intensive orchards. In these regions, about 65% of intensive orchards will be used to increase production, increase the amount of fresh fruit and processed foods. to meet growing needs.

We are concerned that the lack of financial resources and the purchase of related equipment are a problem for many horticultural farms in the region. Therefore, in our opinion, it is desirable to introduce a system of specific measures for long-term leasing or concessional lending for farms engaged in intensive or intensive gardening in all regions of the country. To effectively implement these measures, government agencies, officials, or private entrepreneurs should rent companies and rent leasing operations.

In order to develop and increase the efficiency of intensive gardening in the region, it is extremely important to create stores, small and medium-sized enterprises, goods, trading and warehouse structures specializing in fruit processing, modern packaging and fruit cultivation, which correspond to the domestic and foreign markets of the country. Development and implementation of new investment projects to attract foreign and local investors. ahamiyatag view.

The aim of these projects is the development and implementation of comprehensive measures aimed at improving the productivity of intensive gardens through the optimal placement of highly productive seedlings. In addition, the correct placement of saplings in dekhkan and private farms and an increase in the area of highly productive competitive varieties. To achieve effective solutions to this problem is possible through the introduction of highly efficient and innovative technologies that are promising areas in intensive gardening.

The main disadvantage of previously unsupported layouts is that other types of agricultural production are present in the gardens at the same time and, in turn, little attention is paid to the composition of the coriander gardens. As a result of such allocation schemes, the volume of fruit crops grown in the region, as well as mountainous and mountainous. In the regions, there is a decrease in the efficiency of gardening.[4]

Based on the above, we propose to improve the efficiency of intensive gardening in the region as a prospective plan:

Economically:

- The increase in sales markets nigilnogo (bakery) products;
- stabilization of legislation and tax policy;
- reducing the share of imports in the domestic market;
- regulate the prices of products grown in gardening;

- increasing the level of material and technical base of the industry;

- Optimization of the wage system in horticulture;

- improving the quality of products grown for the purpose of increasing the demand for products in the domestic markets. agro-ecologically:

- Efficient layout schemes in gardening;

- an increase in acreage for the creation of intensive gardens;

- effective implementation of spring frost-resistant and high-yielding varieties;

- Increased use of cost-effective irrigation systems and harmless fertilizers;

- the transition from extensive low-income gardening to new, modern intensive gardening;

- Reducing the level of stress and instability in natural and climatic conditions due to environmental protection and so on.

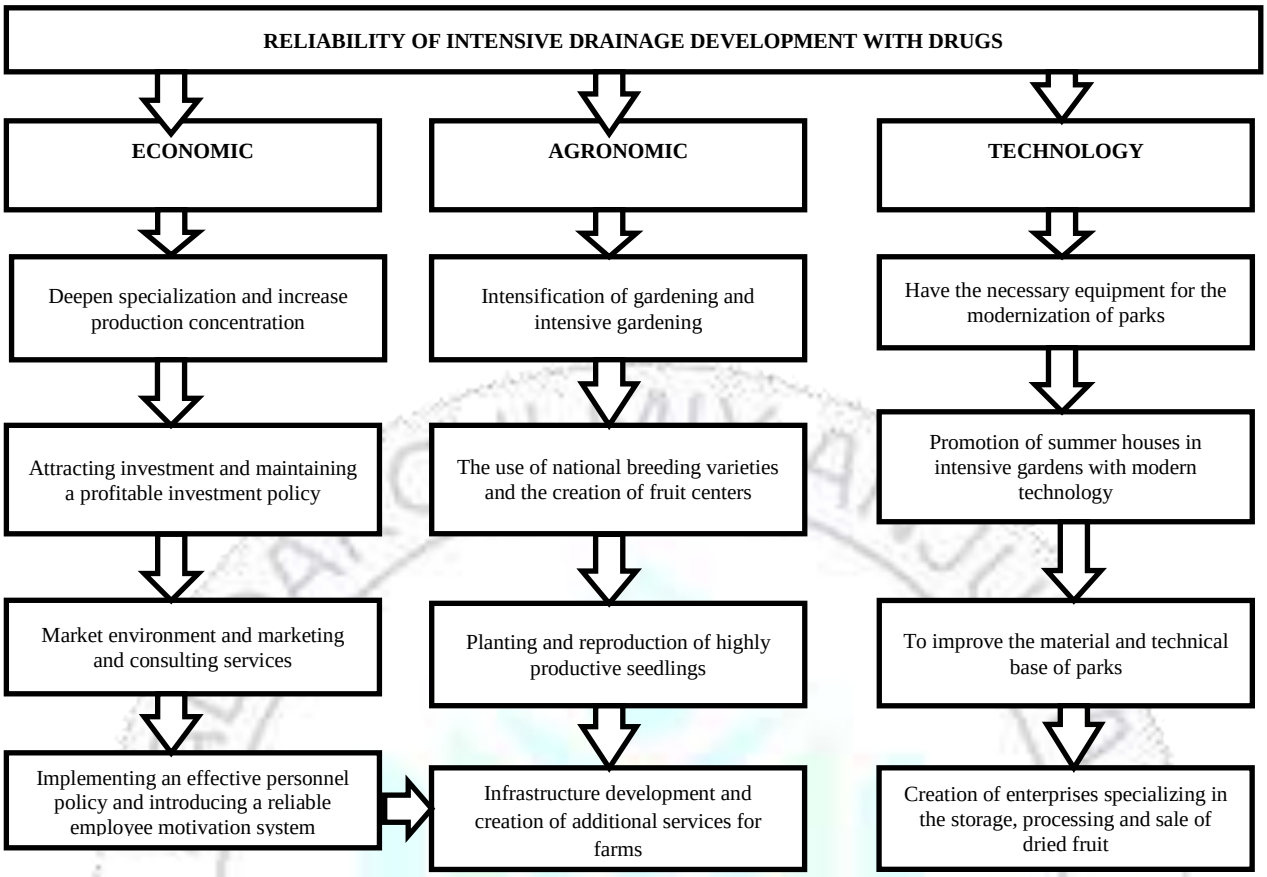
From the point of view of science:

- increasing knowledge and experience in improving the skills of horticultural specialists, improving the quality and average yield of garden products;

- strengthening the exchange of experience and knowledge between manufacturers and industry experts;

- providing education to qualified agricultural producers, etc.

The above reasons determine the development of intensive gardening in the region. Thus, the main task of developing intensive gardening in the region is to rationally and fully utilize the potential available in this region, to develop and implement investment projects. The practical implementation of these projects is to create favorable conditions for the full use of natural resources for the development of intensive gardening and increase in crop production, and therefore the following activities were developed to achieve the goals (Figure 3.2.1).



Currently, 71.3% of horticultural farms are concentrated in dekhkan and farms in the region, their processing amounts to 74.4%.

As a prospect for the development of gardening in the region, it is rapidly moving towards intensive gardening. To achieve this goal, it is important to ensure the success of scientific and technological progress and plant new varieties, introduce varieties that can withstand frost, are resistant to various diseases and provide an average annual crop of high quality fruits.

The main potential aspects of intensive gardening in the region are:

- convenience of natural, climatic and hereditary phenomena;
- the existing socio-economic potential necessary for the development of healthy gardening;
- Experience in agro-economic knowledge and crop production for the development of intensive gardening in the region;
- the hard work of the inhabitants of the region, their experience in agriculture, knowledge and intensity;
- Potential of product manufacturers in the territory and local markets.

Taking into account the above factors, prognostic indicators have been developed for the development of intensive intensive gardening in the Kashkadarya region. (Table 1).

Thus, according to the forecast of the intensification of the growth of gardening in the region, 4,771 new ones will be created by 2025, of which 1997 will be the construction of gardens.

Table 1

Expansion of gardens in Kashkadarya region
Forecast for the period until 2025

Indicators	2020		2025		Total	
	All gardens	stone gardens	All gardens	stone gardens	All gardens	stone gardens
Creating new gardens	2118	832	2653	1165	4771	1997
Creating intensive gardens (hectare)	121	65	213	107	334	172
Restoration of old gardens	747	483	1096	794	1843	1277
Planting area (hectare)	80	21	93	37	173	58
Growing seedlings (thousand pcs.)	2341,6	706,7	3751,8	1074,2	6093,4	1780,9

Currently, the region allocates land for the cultivation and development of intensive gardening in areas of cotton and wheat. For the effective and timely creation of large gardens with great attention is needed new sowing seedlings in the region. According to him, today in Kashkadarya region will need 6093.4 thousand seedlings. To solve this problem, it is important to increase the number of seedlings growing in the region.[5]

These seedlings are the basis for creating intensive orchards in the region and updating existing seedlings with higher yields and higher quality. Also in 1843 it is necessary to reconstruct the gardens and restore many gardens. These reconstructed and restored gardens are also of great importance for increasing the production of garden products in the region. The key and key factors for the development of intensive gardening are the provision of energy efficient and basic production facilities, as well as the creation of highly productive gardens.

According to the results of the forecast, it can be concluded that the rational formation of intensive gardening and the production of coniferous fruits in most cases determine the economic efficiency of the industry.

In addition, the increase in yields and the growth of gardening in the region due to an increase in the melting of the forecast indicators in the table will ultimately improve the overall horticulture system. The development of the horticultural sector is an incentive to increase the export potential of the region and the country.

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MECHANISMS FOR THE IMPLEMENTATION OF STRATEGIC PARTNERSHIP IN THE CONTEXT OF ORGANIZATIONAL AND ECONOMIC TRANSFORMATIONS OF THE GREENHOUSE INDUSTRY

Shakhida Khodjimukhamedova

Tashkent Institute of Irrigation and Agricultural Mechanization Engineers (TIIAME)-National Research University

Akmal Durmanov

Tashkent Institute of Irrigation and Agricultural Mechanization Engineers (TIIAME)-National Research University
akmal.durmanov.1977@mail.ru, 0000-0003-3947-4986

Annotation.

In the article a study was conducted on the issues of strategic public-private partnership in the formation of agrarian structural policy". The necessity of using a synergistic approach to determining the directions of transformations of modern agriculture in general and the greenhouse segment in particular is considered. The prospects of the export orientation of transformational transformations as a mechanism for the implementation of agrarian structural policy have been studied. The ways of improving the transformational transformations of the agrarian sector of the economy are determined on the example of the greenhouse sector. The promising vectors of the direction for improving the agrarian structural policy are analyzed in order to accelerate the transformation processes and increase the effect of the directions of the agrarian structural policy in the greenhouse sector. The study also considered the issue of deepening the development of the agricultural sector through the introduction of public-private partnerships and determining the prospects for their use in the context of the development of agricultural sectors.

Keywords: agriculture, agro-industrial complex, greenhouse economy, public-private partnership

Statement of the problem in general. In the context of global challenges, the content of the structural policy of the national economy should cover all levels of the complex hierarchy of the agricultural sector as a separate system. In this context, we should talk about agrarian structural policy, the main goal of which is a series of measures aimed at systemic changes that give impetus to the progressive and dynamic development of industries and the development of agriculture.

At present, in the Russian Federation, there is an acute dilemma of generalizing the best practices for growing crops in closed soil, an important task is also to determine the main vectors for the development of state policy in the field of agriculture in general, in the direction of greenhouse farming in particular. In the context of the rapid development of the public administration and administration sector and the growth of progressive state influence on the development of the agrarian sector, the concepts of "government mechanism" and "state regulation

mechanism" are quite often used in the scientific community [1]. However, as evidenced by numerous studies, unfortunately, there is no systematic definition of the very mechanism for the formation and phased implementation of state policy, in particular, state policy in the agrarian sector.

Analysis of recent research and publications. Domestic and foreign scientists have studied various aspects of the production of crop production in greenhouses [2].

Modification vectors of development of the world market of closed soil vegetables were studied by Zhurova I.V., [3]. A detailed system analysis of the cost as a determining factor in strengthening the competitiveness of an enterprise was carried out by Alikin S.V. [4]. Aksenov I. A. [5]paid his attention to the economic aspects of the development of the fruit and vegetable market of the Russian Federation . He studied the ecological aspects of growing agricultural products in greenhouse conditions [6].

It should be noted that the results of their research do not cover the fundamental principles of the formation of the state policy for the development of the crop industry in closed soil. In contrast to them, Pronina Yu.Yu., described in detail the methodological foundations of the formation of the agricultural sector in the system of ensuring the economic security of the state [7]. One of the most thorough, in our opinion, recent studies is the study of Krasilnikova L. E. [8]In numerous works, she substantiated the dilemma of the formation, development and implementation of state agrarian policy in the Russian Federation. The author proposed a solution to the issue under study, namely a description of ways to improve the mechanisms for the formation and implementation of state agrarian policy in our state.

The purpose of the article is to study the features of the development of the crop industry at the present stage, as well as to determine the foundations for the formation of state policy in the greenhouse segment.

Presentation of the main material . The issue of ensuring food security is a basic and constant problem of both countries with a low level of economic development and fairly developed countries that are constantly improving the mechanisms for supporting food security.

In the Russian Federation, vegetable growing is a specific industry that has certain disadvantages associated with a low level of product transportability; a high level of diversity of cultivated crops, which are characterized by the aspect of using specific agricultural techniques;

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insignificant mechanization of basic production processes; the use of significant manual labor costs with the active involvement of workers of appropriate specialization for servicing specific types of equipment, organizing the processes of routine commodity processing, storage and sale of vegetables; general high labor intensity of work, which as a result leads to significant total production costs [9].

We also note that agricultural land is used for growing crops.

The development strategy of the crop growing industry in closed soil, taking into account the analysis of the above factual data, should be aimed at increasing the production of high-quality crop products, respectively, while minimizing the cost of obtaining the latter. What is needed to meet the needs of the industry in the necessary financial resources? This is, first of all, the creation of favorable conditions for the implementation of financial transactions, the improvement of investment, innovation, budget and tax policies. State support must be implemented within a certain period of time and be predictable and planned, and not chaotically selective with certain seasonal or political activity of the leading levels of state authorities. For example, on such simple issues within the state as the construction of new greenhouse complexes or the supply of energy, food and plant protection. If we are talking about state policy in the field of crop production of closed soil, unfortunately, the area we are studying is increasingly left without the attention of the domestic legislator and politicians as a whole.

State support for growing plants in greenhouses can be activated through targeted funding aimed at acquiring, improving and repairing greenhouses, modernizing irrigation systems and using more modern types of biologically safe fertilizers, fully providing production with cost-effective energy sources, organizing conditions for storage, processing and subsequent sale of vegetable products, etc. An integrated approach to the implementation of such measures should ensure an increase in production efficiency, while improving the quality of grown products, and an additional factor in the form of lower prices for greenhouse products, which will form an increase in demand for them [10].

In our opinion, in order to support the crop production industry on closed soil, an appropriate strategy should be adopted at the state level, aimed at promoting the development of the industry through the construction, modernization and technical re-equipment of greenhouse complexes and enterprises; provision of state support in the implementation of investment projects for the construction of new generation greenhouses; reducing the financial burden on agricultural producers in the production of crop production of closed soil in terms of reducing the cost of energy carriers by subsidizing part of the costs for the purchase of electrical energy and (or) process gas, for the construction of new generation greenhouses and the purchase of equipment for them.

The implementation of the measures of such a strategy will contribute to the innovative process of developing the crop production industry in closed soil, especially in terms of increasing the efficiency of the industry through the introduction of new energy and resource-saving technologies, will make agricultural products economically competitive, increase the motivation for growing producers of high-quality vegetables and berries in closed soil, ensure a guaranteed supply of the population of the Russian Federation with fresh vegetables during the off-season, regulate the price factor in the consumer market.

Implementation of the activities of such a program will help ensure:

1) economic effect: increase in crop production in closed soil; increase in the area of new generation winter greenhouses; increase in revenue from the sale of crop production of greenhouses;

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2) budgetary effect - the volume of tax and non-tax revenues both in the regional budget and in the state;

3) social effect - an increase in the number of workers employed in the field of greenhouse crop production.

The main risks that may affect the achievement of planned results include: changes in state and regional legislation; insufficient level of co-financing from investors, as well as agricultural producers from their own and borrowed funds; unfavorable market conditions, as well as unpredictable high price growth for seeds, fertilizers, equipment, materials, electrical energy, which can lead to a significant increase in the cost of crop production and difficulties in its sale. Zhakhov N.V. believes that the mechanism of state regulation of the agrarian sector of the economy is a method of action of the subject of regulation, based on such functions and principles that are able to effectively achieve the goals and resolve contradictions [11].

Rural territories, as an object of management at all levels of state regulation, are characterized by the exceptional socio-economic importance of locating agricultural production, employment, recreation, and livelihoods of almost a third of the country's population. Therefore, the provision of large-scale, strategic projects that form the competitiveness of the country and regions is impossible without an effective partnership of state and local authorities with representatives of private business through a public-private partnership (hereinafter referred to as PPP).

Table 1

SWOT analysis development industries crop production protected soil

Strengths (S)	**Weaknesses (W)**
– high quality of domestic products, compliance with environmental standards; – the ability to produce products in the winter; – large areas occupied in the production of protected crop production; – increasing the gross production of protected crop production; – stability of sales in the domestic market, preference by domestic consumers of domestic greenhouse products; – the opportunity to receive the only state support currently provided for the protected soil crop industry: compensation of interest on a loan from banks	– a significant increase in energy prices; – lack of qualified personnel for the introduction of new technologies for the production of greenhouse vegetables; – dependence of the industry on imported equipment and materials; – the complexity of the process of attracting investments in the industry; – lack of guarantees regarding the quick return of invested funds; – the difficulty of communication between greenhouse producers and financial institutions that do not have sufficient technological knowledge, do not understand the mechanisms of the existence of the relevant market, and they are also stopped by complex marketing in the conduct of this business; – sanctions restriction of the export of greenhouse vegetables; – the difficulty of exporting domestic greenhouse products to the EU countries due to their high cost compared to European ones; – saturation of the domestic market of greenhouse vegetables; – low purchasing power of the population; – a short period of storage of products; – seasonality in production.
Opportunities (O)	**Threats (W)**

[11] Ugurchiev , O.B., Albogachieva, A.A. Creation and development of agricultural clusters in the region // Management Accounting. 2022. No.2. pp.371-376.

– modernization and expansion of production capacities; – release of the share of the domestic marke of greenhouse vegetables from imported products due to the depreciation of the ruble; – penetration of domestic greenhouse products into foreign markets through the possible depreciation of the ruble; – introduction of energy-saving technologie and the use of alternative energy sources to optimize production costs, cost reduction, as well as to increase the competitiveness of domestic products; - achieving a reduction in labor intensity in the activities of greenhouses; – creation of scientific and practical centers on the basis of the largest greenhouse farms to provide the industry with highly qualified personnel; – an increase in the production of premium segment products and rare varieties by domestic farms for the subsequent replacement of import positions in the domestic market of greenhouse vegetables.	– uncertainty with the economic and political situation in the country; – further increase in the cost of energy resources; – extension of sanctions to limit the export of domestic greenhouse products; – the difficulty or impossibility for many enterprises in the industry to pass the Global GAP certification process, which at the same time closes the possibility for them to enter the markets of Europe, Canada, the USA and other countries with a high level of purchasing power of the population; – risks associated with the technological process: the likelihood of plant diseases, etc.; – risks associated with the occurrence of natural disasters.

Source: Compiled by the author based on scientific research materials[12]

In the scientific space, a lot of attention is paid to the development of the theory of interaction between government and business. The results of modern studies of institutional ambushes, the economic efficiency of PPP are reflected in the works of such domestic and foreign experts as V. P. Cherdantsev [13], J. Delmon, J. Newman, and others. But many issues of forming effective models of partnerships between business and government, especially in terms of the development of rural areas, have not found a proper theoretical and methodological justification [14].

In world practice, to attract private capital in order to develop and further manage the public private production infrastructure, the mechanism of public-private partnership is used, which is an objective conditional trend of modern economic development and is focused on balancing the interests of the state and private business, the development of innovative activity of economic entities and efficiency community management [15].

The essence of relations within the framework of a public-private partnership is that, unlike other forms of interconnection between the state, business and institutions of public society, such a partnership is a form of joint participation in projects to obtain a socio-economic effect on the one hand and focused on redistribution between participants tasks, responsibilities, risks and profits, on

[12] Trysyachny V.I. Sustainable development of the territorial agro-industrial complex in the context of ensuring food security // Economics and business: theory and practice. 2022. №2. pp.197-199; Ugurchiev O.B., Ugurchieva R.O. Dynamics of development of the agrarian sector of the region // Management Accounting. 2022. №2. pp.316-320.

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the other. The current situation in the Russian Federation, positive changes in the legal field, have actually identified public-private partnerships as one of the highest priority tools for attracting funds from financial partners for the development of rural areas.

The main prerequisites for the initiation of the process of partnership with the private sector by the authorities of rural territorial communities arise if:

- services or a project cannot be provided (implemented) only with the use of financial resources from the budget of a territorial society;
- the participation of a private partner will lead to an increase in the quality of services;
- the participation of a private partner will accelerate the implementation of the project or the start of the provision of services;
- there is support from users of services to attract a private partner;
– there is an opportunity for competition between potential partners;
- it is possible to easily measure the result and establish the cost of services;
- the cost of the implemented project or newly created services can be recovered through the user fee mechanism;
- the project or new services are innovative;
- there is an experience of partnership cooperation between the authorities and the private sector;
- as a result of the partnership, it will be possible to accelerate the economic development of the territorial community [16].

In summary, PPP is an important tool for achieving sustainable rural development by integrating rural perspectives as a natural element in all policies. The application of the PPP mechanism in the context of rural development is quite wide and actually covers all possible forms of activity. In the context of existing needs and development tasks, the most attractive models of public-private partnership in rural territorial communities can be divided into:

- aimed at the development of agricultural production (irrigation and fertilizer application systems, restoration of soil fertility; vegetable and grain storage facilities, processing and storage facilities; transport and logistics infrastructure facilities, including port elevators; greenhouse facilities, incl. including on the basis of heat generation capacities, orchards, vineyards, fish farms, wholesale markets for agricultural products;
- focused on the implementation of the socio-economic needs of the community (reconstruction or construction of social infrastructure facilities (social housing, reconstruction of the heating network, construction of social housing and housing for specialists, etc.), improving the quality of public services - water supply and wastewater treatment, collection and waste management, improving the quality of life - reconstruction of hospitals and educational institutions, etc.) [17].

The state, in particular, regional and local governments responsible for the development of rural areas and natural resources on which rural development is based, should play an important role in managing the process of sustainable rural development through partnerships, namely: initiating, structuring, financing and regulating partnerships. relations. Public-private partnership according to the usual scheme of attracting investments is gradually turning into an effective form of investment

[16] Ermolaeva, G.S. Development of food and processing industries in the region: prerequisites and directions // Bulletin of the Belgorod University of Cooperation, Economics and Law. 2022. №2. pp.241-251.

[17] Karpovich, N.V. Conceptual approaches to the formation of a coordinated agro-industrial policy of the member states of the CU and the SES // Economic issues of the development of agriculture in Belarus. 2022. No. 42. pp.139-147.

project management. The advantage of PPP projects for investing in social infrastructure development is that they provide:

- attracting non-state funding for investments in social infrastructure facilities in rural areas;
- reduction of government spending on the maintenance (operation) of social infrastructure facilities; sharing project risks between municipalities and private investors;
- ensuring cost-effective management of the implementation of an infrastructure investment project by transferring management functions to a private investor;
- attraction of modern highly efficient technologies for the development of social infrastructure in rural areas; improvement of the investment climate in rural areas.

Attracting the experience and funds of private partners on the basis of public-private partnerships significantly reduces risks and provides better investment protection.

The experience of using the public-private partnership format abroad is considered as a priority mechanism for implementing innovation policy in such areas as: strategic cooperation in sectors that are strategically and critically important for the state (social innovations and high technologies); the formation of sustainable ties between science and business, with the alignment of technology transfer into everyday market circulation; program and project support for innovative business entities, private investment in advanced research and program innovation through partnership financing mechanisms and redistribution of risks between public and private partners; promotion of cluster-oriented policy [18].

PPPs can be defined as collaborative mechanisms in which actors from two or more sectors of society (government, business and/or civil society) are involved in a common synergistic decision-making process in order to achieve goals. Although PPP is a voluntary agreement between state and non-state actors, it is based on a set of rules and regulations and involves the development of mechanisms for the creation of public goods, which distinguishes them from ad hoc public-private interactions or lobbying. The concept of partnership is based on the idea that the state itself cannot provide collective benefits such as sustainable development, and support must be sought from other sectors of society.

A feature of the participation of different participants in the partnership is that each party can initiate the development of the project. It is at this stage that a certain set of works is carried out for their successful implementation: a clear definition of the goals and objectives of the project, the appointment of a project manager, the development of a charter, the identification of participants and stakeholders.

Therefore, the participants in the partnership have basically two fundamentally different roles, where the first is to provide state actors with experience and local knowledge, financial and technological tools, and the second is to increase participation or cooperation between sectors and interests through deliberative and expert tools. .

In the first case, PPP is an effective means to achieve the goal of promoting rural development through development strategies, strengthening regional/local competitiveness and identity, encouraging innovation and cluster benefits. They can be created for territorial coordination of activities when combining various types of resources.

In the second, the partnership itself can become an important part of the goal, involving the establishment of partnerships to actively participate in the implementation of local policies, adapt the overall policy objectives to the regional/local level, or participate in PPP monitoring activities. Also, such PWYPs can become an arena for mitigating conflicting interests, trying to reconcile opposing policy goals and finding win-win solutions and/or acceptable compromises between

[18] Suboch , F.I. Classification features of value added chain clustering in the agro-industrial complex based on the formation of an intersectoral corporation of innovation-industrial clusters with "de jure" and "de facto" statuses // Agrarian economy. 2022. №2. pp.43-52.

different stakeholders. In this regard, it is of particular interest to determine what opportunities and legitimacy different types of PPPs have when it comes to resolving conflicts related to natural resource management and rural development.

Through a partnership process, it is envisaged that the public and private sectors can benefit by pooling their expertise, technology, finance and other resources to more effectively create common goods. Participants perform common functions as well as their specific roles, each of which contributes to the sustainable development of rural areas (table 2).

The state plays an important role in the design and management of PPPs for sustainable rural development. PPP can take various forms depending on the goals, types of actors and distribution of powers to make decisions or influence them, which, in turn, determines the role of the state in terms of the ability to achieve and develop consensus based on the potential to pool resources (human, material and financial).

The role of public actors is mainly to initiate, structure, finance and regulate partnerships, i.e. they provide the authority for the functioning of the partnership and are able to regulate and control partnerships, for example by regulating business and providing subsidies to stimulate the participation of certain sectors. Involving the public in solving rural problems by financing the best programs for the development of rural areas can become an effective form of public-private partnership in our country. However, the roles may differ depending on the goals of the partnership and what powers are associated with the partnership.

Table 2

Means and roles of participants in public-private partnership for sustainable development of rural areas

Субъект партнерства	Средства	Роли
Органы государственного управления и местного самоуправление	Законотворчество Политическое целесообразность законность Юридическая легитимность Финансовые средства	Инициатор разработки проекта партнерства Регулятор Финансирование - провайдер Посредник, активатор, координатор
Бизнес структуры	Финансовые средства Право собственности / пользования (оперативное управление) Экспертиза / Знание	Инициатор разработки проекта партнерства Поставщик услуг Финансирование
Организации гражданского общества	Знание / Экспертиза Местные социальные изменения Местная идентичность Социальная легитимность	Инициатор разработки проекта партнерства Консультативная роль Местная мобилизация интересов общины Информационный канал Улучшение подотчетности Мониторинг эффективности реализации проекта Создание социального актива / или снижение социальной изоляции

Source: Compiled by the author based on scientific research materials[19]

[19] Lenskaya, T.I. Improving the economic mechanism for the functioning of agro-industrial integrated formations of the holding type // Economic issues of the development of agriculture in Belarus. 2022. No. 43. pp.108-115.

Thus, the general form of the organizational structure based on these features is viable with the condition of the responsible role of the authorities in partnerships, which will contribute to the sustainable development of rural areas.

Findings. As a result of the study carried out in the article, the main directions of structural policy are defined as structural transformations of agricultural production aimed at diversifying the manufacturing and processing industries. The prospects of the markets for agricultural products of the greenhouse segment for most of the leading countries of the world, as well as for countries that are characterized by instability, a high degree of risk, but contain significant consumer potential, have been determined. The mechanism for implementing the export-oriented direction of the transformation of the greenhouse sector is the development of new forms of public-private partnerships, transport, logistics chains and agricultural infrastructure.

Summarizing the above, it can be stated that the interaction between the public and private sectors is crucial in the context of achieving the goals of sustainable development, which are an integral part of the development of rural areas and their management, using their resources to improve regional and local well- being. Thus, partnerships can serve different purposes and be involved in different activities and processes, and serve a range of individual and specific tasks, from policy development to resource management of rural communities. Therefore, the application of PPP tools is important as they can help the authorities to adjust their strategies depending on the type of partnership – and more importantly – to cope with the lack of integration of policies for management and development in rural areas and agriculture in general, and the greenhouse sector in particular.

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PEDAGOGICAL NORMS IN THE SYSTEM OF CONTINUING PROFESSIONAL EDUCATION.

Dilrabo Inatovna Mukumova.

Associate Professor, Doctor of Philosophy (PhD) in Pedagogical Sciences, National Research University "Tashkent Institute of Irrigation and Mechanization of Agriculture", Tashkent, UZBEKISTAN e-mail: d.mukimova.1975@mail.ru

Sevara Yarova Bakhodir qizi,

Base doctoral student, National Research University "Tashkent Institute of Irrigation and Mechanization of Agriculture", Tashkent, UZBEKISTAN e-mail: yarova.sevara@email.ru

Annotation

In modern society, continuing professional education is becoming one of the main conditions for scientific and technological progress in any country, as well as a condition for the life success of an individual. Of particular importance is the implementation of educational standards established by state acts.

Keywords; system of continuing professional education, pedagogical norms, pedagogical qualitative norms, qualitative technologies, system-qualitative approach, cognitive approach, thesaurus approach, qualimetric approach, pedagogical normology, educational standardology, pedagogical cognitology.

At the present stage of the development of society, the requirements for the quality of training specialists for various fields of production are constantly increasing; the emergence of new branches of knowledge (modeling, technoscience, synenergetics, acmeology, etc.), complex sciences (genetics, cybernetics, introscopy, engineering pedagogy, etc.), "hybrid sciences" (physical chemistry, agrophysics, economic cybernetics, pedagogical qualimetry, etc.) is characteristic. The training of specialists for these areas requires constant improvement, in particular, it is necessary to train specialists who are ready to possess competencies in a certain field of sciences, to make sound scientific and technical decisions in a market economy.

The transition from the knowledge paradigm to the competence one also poses new challenges to professional pedagogy. One of the main objectives of the educational policy outlined in a number of documents (laws on education, on higher and postgraduate education is to ensure high quality training of specialists.

In modern society, continuing professional education is becoming one of the main conditions for scientific and technological progress in any country, as well as a condition for the life success of an individual. Of particular importance is the implementation of educational standards established by state acts. In connection with the above, the problem of designing and implementing pedagogical standards in the system of continuing education is being actualized, including the problem of forming and diagnosing professional competencies, the solution of which will contribute to improving the quality of training of future specialists.

There is a need to solve the problem of specialist training at the scientific and methodological level: the need to eliminate contradictions between the theory and practice of the competence approach in vocational education and its scientific justification for specific areas of training. We believe that a modern specialist should be "multifunctional", that is, have the ability to work in different "related" areas, have a high level of professional competence in his field of activity, be ready to engage in practical activities in real conditions. To solve these problems, we propose using

modern learning technologies, such as - test, distance learning, automated training and monitoring systems, etc.

In general, these problems at different levels are related to the general problem of this study: further improving the quality of training of future specialists in all levels of continuing professional education.

It is known that the methodology of narcology is widely used in economics, law, product quality control and other fields. In the field of education, rationing is applied when financing educational institutions, determining their status, certifying teaching staff, setting requirements for students (exams, USE, state, etc.). However, it should be noted that there is no unified approach to establishing pedagogical standards yet.

The main key concepts of the study:

- the system of continuing professional education in our study includes specialized classes of secondary schools, institutions of primary, secondary and higher professional education, leading training in one or "related" areas;

- the pedagogical norms in this study include requirements for students of a didactic and normative nature (test and examination questions, requirements of the GEC, GAC, for final qualifying works, master's theses, etc.);

- pedagogical quality standards – requirements such as state, HEC, HAC, etc. in a competency-based format, imposed on students;

- qualitative technologies - pedagogical technologies based on system-qualitative and competence-based approaches;

- system-qualitative approach – a complex of systemic, cognitive, thesaurus and qualimetric approaches aimed at improving the quality of education, including professional;

- the cognitive approach involves the use of taxonomic learning models in a competency-based format: matching learning models with the requirements of the HEC, HAC, etc.;

- thesaurus approach - the use of classifiers of knowledge, abilities and competencies in learning technologies;

- qualimetric approach - the use of quantitative indicators to assess the fulfillment of pedagogical requirements for students of a normative nature;

- pedagogical normology is an integral part of educational normology, which considers issues of a financial nature, terms of study, requirements for educational institutions during their accreditation and certification, requirements for teaching staff such as categories of teachers and academic titles, issues of awarding honorary titles, titles of laureates of pedagogical competitions, etc.) and includes the following sections:

- the theory of pedagogical norms of a didactic and normative nature (requirements for students of educational institutions, etc.);

- the theory of the fundamentalization of vocational education, taking into account the features of the modern scientific, technical and technological revolution.

- educational standardology - a section of professional pedagogy on the development of the content of educational standards and methods for diagnosing their implementation;

- pedagogical cognitology is a scientific direction that arose at the intersection of psychology and pedagogy about the typology and formation of students' knowledge;

- regulatory knowledge and regulatory competencies – knowledge and competencies defined by regulations or requirements for students;

- educational qualitaxons – classification elements in pedagogical qualimetry; a group of hierarchical structure indicators characterizing the integral quality of a pedagogical object or process;

- key professional competencies – competencies that determine the qualifications of a specialist and are necessary for his professional activity.

- the conceptual foundations of this study are a set of approaches, concepts and theories necessary for the design and implementation of pedagogical norms of a didactic and normative nature in the system of continuing professional education.

The problem of rationing in pedagogy is directly related to the problem of the quality of education, since the norm is always a measure of the quality of any object or process (Aristotle, Kant, Hegel, K.Marx, Herbert, Husserel; analysis of their ideas on the philosophy of norms as a philosophy of quality standards is given in the works of A.I. Subetto).

Numerous studies of Russian and foreign scientists, practitioners and managers have been devoted to the problems of improving the quality of vocational education. In their works, in particular, the following aspects are considered:

- conceptual, methodological and theoretical basis for the design of pedagogical activity (V. A. Bolotov, B. S. Gershunsky, V. I. Zavozin-sky, N. In. Kuzmin, V. A. Slastenin, D. I. Feldstein, A. V. Khutorskoy, etc.);
- management of the quality of training in professional educational institutions (G. D. Bukharova, L. I. Gore, A. S. Kazarinov, A. A. Kirsanov, G. V. I., V. P. Ovechkin, A. Y. Petrov, Yu. a. Petrov, G. M. Romantsev, Yu. N. Se-min, V. P. Simonov, etc.);
- methodological foundations of pedagogical qualimetry for assessing the quality of education (V.P. Bespalko, I.A. Zimnaya, A.I. Subetto, Yu.G. Tatur, V.S. Cherepanov, A.A. Chervova, Yu.K. Chernova, etc.).

Many researchers note that at present the requirements of society and the market economy are increasing for the level of professionalism of specialists, and the actual level of their training does not always correspond to them. Therefore, the search for new ways to improve the efficiency of professional educational institutions in this direction is relevant. One of such ways, according to a number of researchers, is the scientific justification of the requirements for students based on the methodology of pedagogical normology. It has to be stated that to date, research in this area is conducted inconsistently by different scientific schools. A small number of doctoral dissertation studies have been devoted to this problem (I.D. Belonovskaya, L.V. Yelabina, A.M. Mityaeva, O.G.Pervyakov, O.F. Shikhova, N.V. Yankina). However, these studies considered only general aspects of the problem and did not outline the issues of technology for their implementation.

Currently, the development of pedagogical requirements for the level of formation of knowledge and competencies for students in educational institutions is often carried out without proper scientific justification (meaning the choice of a learning model, classifiers of knowledge, abilities and competencies and justification of the choice of pedagogical control materials for the diagnosis of didactic norms).

The article describes the content of a number of concepts, such as "knowledge" and "types of knowledge", adapted to the research topic. The so-called "knowledge approach" in pedagogy, including professional, according to a number of researchers is the foundation of the competence approach (V.I. Baydenko, L.I. Gurye, E.F. Zeer, I.A. Zimnaya, Yu.G. Tatur, etc.). The analysis of theoretical sources on the competence approach in education has shown that there are several definitions of the concepts of "competence", "competence" and the grounds for their classifications (O.M. Atlasova V.I. Baidenko, E.V. Bondareva, A.A. Verbitsky, L.I. Gurye, E.F. Zeer, I.A. Zimnaya, V.M. Rostovtseva, A.I. Subetto, G.S. Trofimova, A.V. Khutorskoy, etc.). In the Federal State Educational Standard, competence is interpreted as the ability to apply knowledge, skills and personal qualities for successful activity in a certain field. In the existing classifications of competencies, the following are distinguished: universal, key, academic, subject-specialized (I.A. Zimnaya, B.K. Kolomiets, V.V. Kondratiev, A.I. Subetto). These authors refer to universal competencies: general scientific, instrumental, general cultural, social. We believe that it is necessary to add ideological competencies to the listed types of competencies. Analyzing various literary sources, the characteristics of each type of competence are given in the work and various

approaches to their classification are proposed: philosophical-social, cognitive, activity. Based on the proposed classifications, we have given a description of competencies and constructed so-called "competence trees": "competence - knowledge", "competence - attitude", "competence - ability", "competence - readiness", "competence - compliance", "competence - disposition". Fig. 1.

Pedagogical normology, defined as part of educational normology, may have the status of an independent scientific direction. It is shown that the main section of pedagogical normology should be the theory of pedagogical norms. The article partially reveals its basic principles: continuity; fundamentalization; integration; humanization and democratization; technologization, etc. Based on these principles, a structural and conceptual model of pedagogical normology has been developed, presented in Fig. 2.

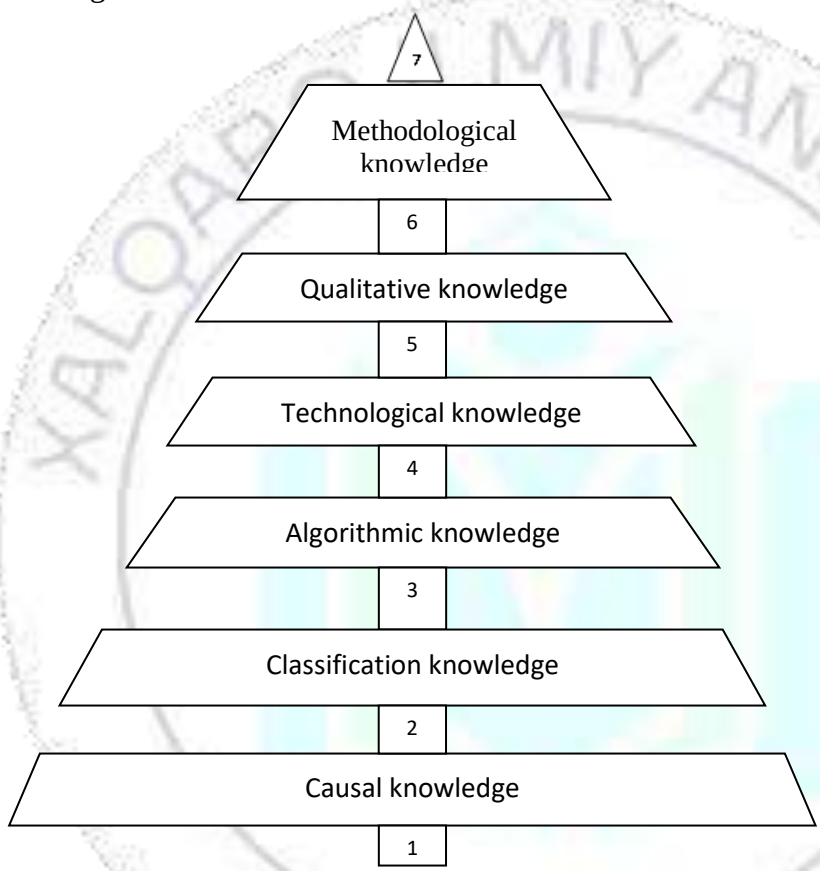

Fig. 1. The Competence – knowledge tree

It is determined that the conceptual foundations of pedagogical normology should include: systemic, activity-based, competence-based and qualimetric approaches, as well as concepts such as the fundamentalization of vocational education, its continuity, philosophy of norms, diagnosticity, multidimensionality, integrativity, etc.

It is shown that the primary tasks of pedagogical normology are: substantiation of the axiomatics and conceptual model of pedagogical normology; development of a qualitative technology for constructing pedagogical norms of various types; creation of tools for the development of pedagogical norms in the field of vocational education.

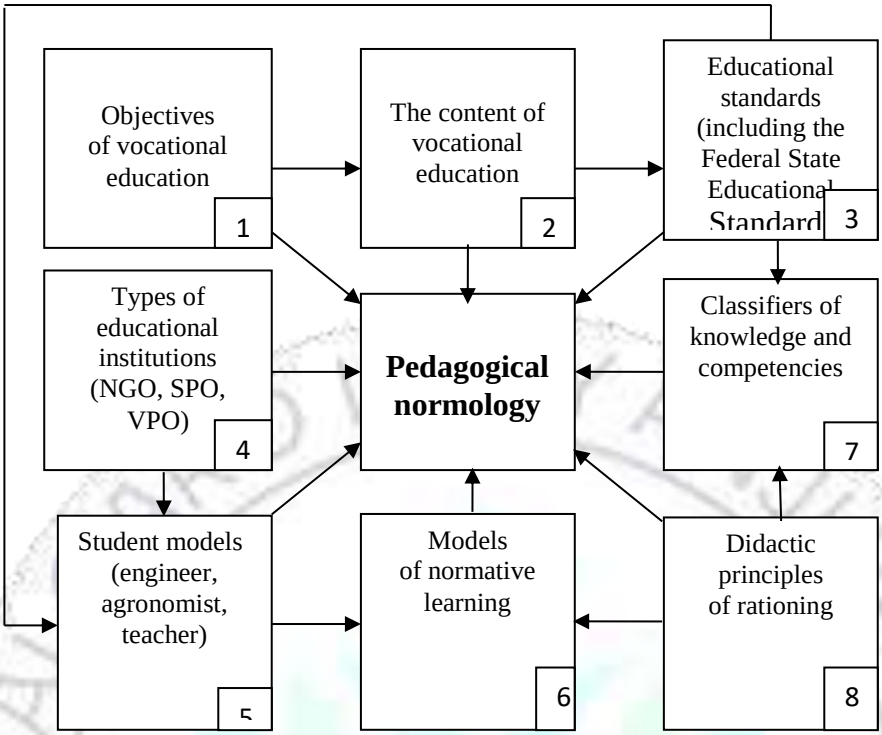

Fig. 2. Structure-forming components of pedagogical normology in the field of vocational education

A special place is occupied by the classifier of pedagogical norms, which contains the norms of the university level;

• general-purpose pedagogical norms (educational standards; competence and qualification characteristics of a future specialist; educational and methodological complexes, requirements for educational institutions, etc.);

• pedagogical norms introduced by the educational institution (rating of students, teachers; requirements for final qualifying works, for innovative projects, for control materials, etc.).

Competencies are proposed to be formed in students at four different levels, for example, the cognitive approach should include the levels: knowledge-understanding, ability-readiness, analysis-evaluation, acmeological; activity approach: student, entrant, student, professional.

Based on the proposed concept of normative competencies, an algorithm of qualimetric technology for designing pedagogical norms was developed, including *3 main stages:*

1. Designing the goals of training specialists in a certain area;
2. Substantiation of the range of competencies of the future specialist (KX);
3. Design of diagnostic tools of the introduced pedagogical norms (PN).

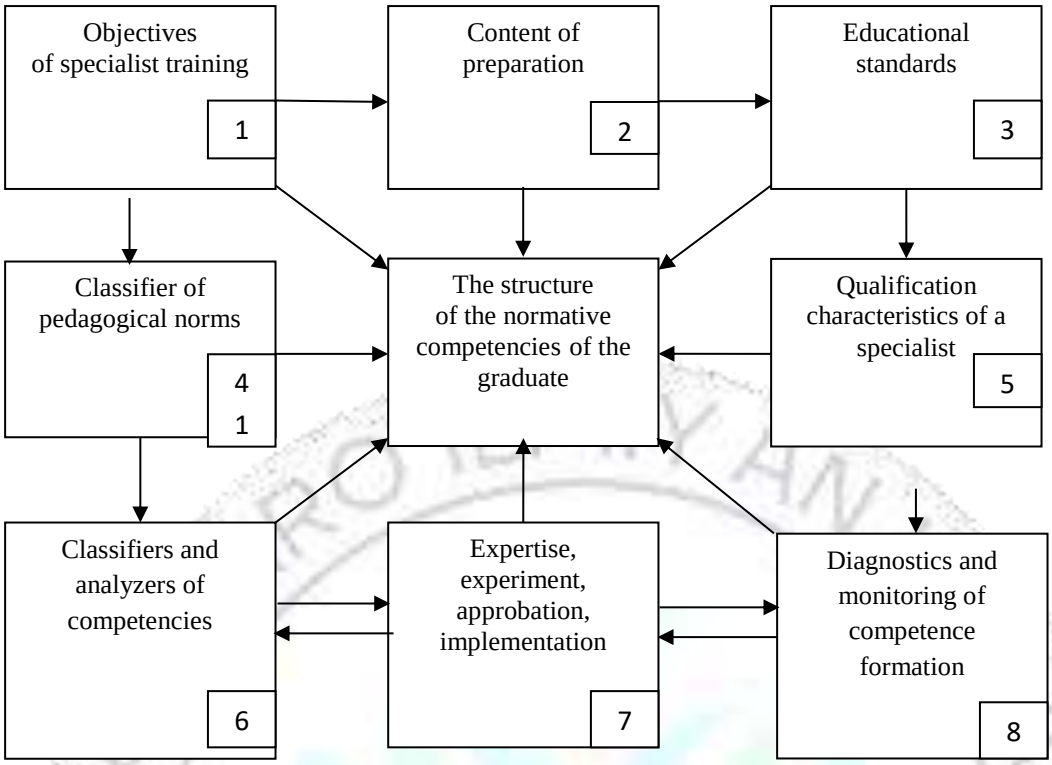

Fig. 3. Block diagram of regulatory competencies of a future specialist

The design of the goals for the introduction of PN has a different status (regional and local at the level of a separate educational institution) and is associated with the justification of the competencies of the future specialist, with the level of competence formation within the framework of the accepted training model and the analysis of the disciplines of the curriculum in terms of the formation of planned competencies.

In the scientific substantiation of the conceptual foundations of the study, substantiation of the status of pedagogical normology in the structure of pedagogical sciences, clarification of a number of concepts and definitions of pedagogical normology, its axiomatics, in the systematization and integration of a number of approaches (philosophical, social, cognitive and activity) in determining the category of "competence", in substantiating the need to apply a qualimetric approach in the design and implementation of pedagogical norms, including the method of group expert assessments; substantiation of the structure-forming components of pedagogical normology in the field of vocational education and the structure of normative knowledge and normative competencies, in the creation of a methodology for constructing "competence trees"; an algorithm for the qualitative technology of designing pedagogical norms in the field of education; in the development of a methodology for constructing pedagogical control materials (PCM) for the diagnosis of pedagogical norms and tools.

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ORGANIZATIONAL AND ECONOMIC MECHANISMS USING GREENHOUSES TO ENSURE OPTIMUM FOOD SECURITY IN UZBEKISTAN

Sukhrob Umarov *Tashkent Institute of Irrigation and Agricultural Mechanization Engineers (TIIAME)-National Research University s.umarov@tiiame.uz, 0000-0003-3854-7696*

A. S. Durmanov *Tashkent Institute of Irrigation and Agricultural Mechanization Engineers (TIIAME)-National Research University akmal.durmanov.1977@mail.ru, 0000-0003-3947-4986*

Abstract

Agriculture plays an important role in providing food and for millennia has been an important factor in the overall economic development of societies around the world. The continued development of agriculture plays a vital role throughout the world in ensuring food security, improving nutrition, eradicating poverty and contributing to the overall economic development of the world. In the past, agriculture in hot and dry countries such as Qatar faced many problems, chief among which was the lack of water for irrigation. This article examines the recent evolution of the agricultural sector in Uzbekistan and explores future trends to address the challenges of a hot arid climate and limited availability of agricultural inputs. In particular, the review analyzes the potential of Uzbekistan to develop a national food security strategy based on a significant expansion of food production in the country. Regardless of the relative economic importance of agriculture, its role in peace and food security means that we ignore its strategic importance at our peril. Moreover, the development of agricultural science, which includes many different activities such as soil tillage, tillage, harvesting, animal husbandry and agriculture, has increased world food production and has enabled humanity to avoid the cycle of population growth leading to to an inevitable reduction in resource constraints. Finally, agricultural products are not limited to food, but include many other products such as fibers, leather, timber, biofuels, etc. In this article, the author made an attempt to critically analyze and scientifically comprehend the organizational and economic mechanisms for using greenhouses to ensure optimal food security in Uzbekistan.

Keywords: development of agriculture, development of the greenhouse complex, ensuring food security, the Republic of Uzbekistan.

materials and research **methods** are determined by the topic and specifics of the tasks, the solution of which requires ***an integrated*** approach. Much of the data relating to the greenhouse sector in Uzbekistan is updated infrequently or has reporting gaps. Since there is no farm structure

database, details regarding equipment and supplies are largely unknown. The study also confirms the absence of a standardized operational database of greenhouse operations. In an attempt to address gaps in wording and reporting, and to collect personal opinions from farmers and others involved in the industry, the author conducted field research in Uzbekistan. Twelve greenhouses in Uzbekistan were visited and semi-structured interviews were conducted with farmers. A number of informal conversations were held with farm workers who were busy sorting and labeling vegetables during the harvest period.

I. Introduction.

Greenhouses are often found in the rural areas of Uzbekistan and are an integral part of Uzbekistan's food system. This promotes sustainability, enhances food security and benefits consumers. This article explores the relative advantages of Iceland's greenhouse sector - using a combination of statistics, observations and interviews to understand the resource needs of greenhouse agriculture, how well greenhouses can mitigate food insecurity and provide local food.

1.1. The role of 5th generation greenhouses in the development of food security in Uzbekistan

In recent years, the greenhouse industry has become one of the most promising and rapidly developing branches of agriculture in many countries of the world. The main reasons for the rapid development of the greenhouse industry in the world are: the growing demand of the population for fresh vegetables, berries, green crops, as well as mushrooms and the emergence of innovative technologies of the so-called "protected soil".

In addition to the use of greenhouses for growing vegetables, more rare types of plant production in protected ground have already been used or are planned to be introduced in the coming years in Uzbekistan.

Today, the systematic construction of greenhouses in almost every major city or its immediate suburbs is recognized as a positive experience of the Soviet period. [1, p. 23]

Over the past 5-6 years, the greenhouse industry in Uzbekistan has indeed developed rapidly, largely due to two types of state support: through subsidies to reimburse the costs of building new greenhouses, and through subsidizing interest rates on loans. Private business began to actively invest in the greenhouse industry thanks to state support. However, we emphasize that state subsidies were issued only for the construction of new generation greenhouses (4th and 5th), with the so-called light culture (with the possibility of year-round differentiated additional illumination), whose share today is about 50% of the total area of winter greenhouses. [2, p. 11]

The construction of greenhouses takes an average of six months to a year. In the current macroeconomic situation, it is possible to recoup investments in greenhouses, taking into account EBITDA , at the level of 45-50% in an average of 7-10 years. Therefore, without subsidizing loans, which are paid for up to 45% of revenue, this industry practically cannot develop.

It is important to note that, given the fact that the state allocates subsidies only for new generation greenhouses, they are *actually inaccessible to small businesses in Uzbekistan today.*

It should be noted, however, that in order to accommodate the actual greenhouses of the latest generation, as well as old greenhouses, a fairly flat area is required. But in comparison with other natural conditions, this factor is one of the most easily overcome. [3, p. 5]

Requirements for the environmental friendliness of the resulting crop products (especially vegetables, berries, mushrooms) play a crucial role in the organization of all processes in the greenhouse industry. This corresponds to the trend of development of all modern agriculture, expressed as an imperative: “... in modern conditions of cultivation of agricultural crops, it is important not only to find and apply new effective methods of growing plants that would guarantee high yields and growth, but it is also important that these technologies did not disrupt the ecological balance. [4, p. 33]

In modern greenhouse farms, high-precision dosing of the amount of mineral and organic fertilizers supplied to the substrate is used, which ultimately makes it possible to obtain a safe residual amount of them in the finished product. Plants are pollinated inside the enclosed space of greenhouses by specially bred species of bumblebees, and this method provides the best taste characteristics of the resulting crop. Plant protection is carried out by a biological method with the help of special insects - entomophages, which also makes it possible to completely eliminate the use of chemical methods of protection. All this highlights the quality and safety of the products of new generation greenhouses in comparison with plant agricultural products grown in the open field.

Thus, we can probably assume that in this industry the model of an almost completely closed local ecosystem has already been achieved and is widely used, which scientists have been dreaming about for so long.

It should be noted that the negative impact of the greenhouse industry on the external environment is not yet as impressive in terms of safety, controllability and size as in the internal space of greenhouses. This is primarily due to the fact that modern advanced greenhouse facilities have appeared relatively recently, at least in our country. So far, their influence on various components of the environment has not been sufficiently studied. Unlike conventional crop production in the open field, there is no areal impact on the land, there is no annual cyclicity and variability in the types and number of impacts, it is possible to use a closed water circulation, cleaning all used water, air and solid waste discharged outside. That is, although the greenhouse industry belongs to the branches of agriculture, in its technological essence it is a typical industrial enterprise of an almost closed loop. Thus, all the requirements that are currently applied to any industrial enterprise, which at the same time has its own pronounced industry specifics, can and should be applied to it. [5, p. 29]

In addition, in the greenhouse industry, the negative impact on the environment, as in many conventional industries, primarily in industry, does not affect the quality of finished products and the competitiveness of farms. Therefore, since greenhouse farms are not economically interested in the costs of protecting the environment outside the greenhouses, it is necessary to use other mechanisms that force the enterprise to invest in the best available technologies to minimize the negative impact. [6, p. 44]

At present, judging by a number of publications on the impact of greenhouses on the environment, the following types of greenhouses and related problems can be noted [7, p. 7].

1) The impact on the atmosphere is associated with the need to provide greenhouses with heat and energy. This is expressed by the presence of electricity generating capacity in the greenhouse facilities, as well as one or more boiler houses. The composition and volume of air emissions from these enterprises depend primarily on the type of fuel used, its quality and quantity, and on the presence or absence of treatment facilities. This is a well-developed side of the assessment of the impact on the atmosphere from greenhouse farms, although it requires more detail. In particular, it is not entirely clear how to calculate the allowable emission from several point sources or from one (aggregated) source on a small production site.

2) Impact on water resources can be divided into two types:

a) quantitative aspect - the volume of water withdrawn, and the volume of waste water discharged. Although the volume of water intake per unit of finished product is relatively not as large as, for example, in the chemical industry, nevertheless, as a result of water intake from wells, the probability of lowering the level of the groundwater horizon and the formation of a depression funnel around the wells increases over time;

b) the quality of the discharged waste, incl. drainage water, with or without treatment. There are still poorly worked out points in this issue, since the additional purification and heating of the water required in the production process occurs with the formation of a certain amount of

wastewater with increased salinity, and the discharge of waste and drainage water without sufficient treatment can lead to pollution of reservoirs, groundwater and adjacent lands .

3) *The formation of solid industrial waste* in greenhouses largely depends on the type of substrate used for growing plants. In the most advanced greenhouses, as a rule, the technology provides for the use of a substrate made of mineral wool or other inert materials produced by specialized enterprises outside the greenhouses themselves. However, greenhouses with less advanced technology still use soils and mixed substrates that, after their cycle of use, must either be recovered or disposed of as solid waste. In a number of greenhouse farms, both substrate options are involved, since the farms that arose earlier, including back in the days of the USSR, still retained the old greenhouse fund, along with the construction of new, advanced greenhouses. In addition, after harvesting in greenhouses, a large amount of plant residues are formed that require disposal.

A study of trends in the development and location of greenhouse farms in Uzbekistan over the past 20 years has shown that at the level of large regions of the country, southern and central regions predominate in terms of the area of new greenhouses and the production of greenhouse vegetables. In these regions, greenhouse farms are developing with a focus on warmer climates, free land, population density (labor and product sales), as well as energy security . In the more northern and northeastern regions, these placement factors are mostly worse, with the exception of energy supply (and even then not everywhere), but the placement of individual new modern greenhouses is more likely to be associated with the need to provide the local population with local greenhouse vegetables, as well as the task of creating new jobs . Therefore, in addition to "natural" factors, the factor of the state imperative, supported by more reliable financial support, works here to a certain extent. [8, p. 29]

A certain dependence was noted in the ratio of the number of greenhouses of spring and winter, year-round type, as well as the number of greenhouses in large farms and small entrepreneurs, farmers, etc. The further south the region, the closer this ratio is to 50% by 50%. In more northern regions, in recent years, new large farms with modern year-round greenhouses clearly predominate, since such greenhouses are economically inaccessible for small entrepreneurs, and spring ones are even less effective here. In addition, small and spring greenhouses could not count on financial assistance from the state in recent years.

At the intra-regional level, there has been a gradual departure from the previous trend of preferential choice of the location of greenhouse facilities in the areas closest to the regional center to localization in the outlying areas.

Trends in the creation of greenhouse clusters, agro-complexes and the placement of greenhouse farms within the boundaries of Agro-industrial parks, caused by the orientation of investors to lower infrastructure costs, have also been identified. [9, p. 12]

Despite environmental sustainability, food security benefits, and general consumer support in Uzbekistan, the future of horticulture in Uzbekistan remains uncertain. The industry requires both government subsidies and protective tariffs to reduce operating costs and remain competitive with imports, a practice that has proven controversial. [10, p. 13]

The future of greenhouse agriculture, and indeed of all agriculture in Uzbekistan, depends on state support for the industry. Uzbekistan supports its greenhouse agriculture sector in three ways: tariffs, energy subsidies and direct payments.

Tariffs have proven to be effective in ensuring the competitiveness of Uzbekistan's meat and dairy products in the domestic market. Policies are flexible and tariffs are waived when goods are not available in Uzbekistan to protect Uzbek consumers from unnecessarily high food prices.

Domestic produce struggled to compete with less expensive foreign competitors, and many farms went out of business.

As with many island nations, the cost of agriculture and transport in Uzbekistan is higher than in neighboring countries, so the industry requires more financial support to remain viable and competitive. Indeed, support for agriculture in Uzbekistan is well above average.

1. 2. Digital transformation of agriculture in Uzbekistan

In Uzbekistan, the development of the digital economy is one of the priorities of the state economic policy. Today, agriculture occupies an important place in the economy of Uzbekistan. According to the State Statistics Committee, in 2019, the share of agriculture in the country's GDP was 32%. 27% of the able-bodied population is employed in agriculture. [11, p. 35]

The Decree of the President of the Republic of Uzbekistan states that "The state is taking large-scale measures to develop the digital sector of the economy, introducing electronic document management systems, developing electronic payments and improving the regulatory framework in the field of electronic commerce."

The natural and climatic conditions of our country, together with a properly developed strategy in this area, contribute to the effective development of the agricultural sector and increase the export potential. Tasty, ecological pure fruits of the earth and the sun are grown in Uzbekistan, which are in great demand in the world markets. In the context of the coronavirus pandemic, when the topic of food supply is escalating around the world and some states impose bans on the export of food products, issues of agriculture and food production become the most relevant. In our country, much attention is paid to the development of agriculture and the agrarian sector. In particular, a number of legal documents have been adopted, such as the Concept for the Development of the Agricultural Engineering Industry in the Republic of Uzbekistan for the period 2018-2021, the Decree of the President of the Republic of Uzbekistan dated April 17, 2019 “On measures to improve the public administration system in the field of agriculture”, the Decree of the President of the Republic Uzbekistan No. UP-5853 dated October 23, 2019 “On approval of the agricultural development strategy of the Republic of Uzbekistan for 2020–2030”.

In fulfilling this task, there is currently a rapid growth in the use of the digital economy on a global scale in almost all branches of human activity.

Agriculture is no exception, including in the Republic of Uzbekistan, where in recent years e-commerce has been adopted in the development of the digital economy, which includes: electronic data interchange (EDI), electronic funds transfer (EFT), e-commerce, electronic money (e - cash), electronic marketing, electronic banking (e- banking) and electronic insurance services (e-insurance). [12, p. 12]

In the Message of the President of the Republic of Uzbekistan Shavkat Mirziyoyev to Oliy The Majlis was told: “In 2020, we must make a radical turn in the development of the digital economy, first of all, it is necessary to fully digitalize the areas of construction, energy, agriculture and water management, transport, geology, healthcare, education, cadastral and archiving.”

In addition, the President of the Republic of Uzbekistan Shavkat Mirziyoyev proposed a systematic program for the development of the economy. In his speech, the head of state launched a strategic vector for the transformation of the country, which can provide significant benefits in the medium term. Among the three priority areas identified in the report, the leading role is given to the digital economy in the agricultural sector of the economy.

Over the next five years, the priority task for Uzbekistan will be to accelerate the transition to a digital economy in the field of agriculture. The formation of a digital economy in the field of agriculture will require appropriate infrastructure, huge funds and labor resources, and this should be done today, otherwise it will be too late tomorrow. The problem of the formation and development of a new economic order in the field of agriculture is relevant not only in theoretical, but also in practical terms, including at the state level due to the decisive role of digital technologies in the strategic competitiveness of the country related to food security. [13, p. 42]

With the advent of the digital economy, the world today is experiencing truly revolutionary changes in the field of agriculture associated with new technologies that are transforming industries and production systems, increasing productivity and giving rise to new business models in the agricultural sector of the economy. In this regard, the acceleration of economic development, international competitiveness and integration of Uzbekistan into the world economy largely depends on the development of the digital economy in the field of agriculture. [14, p. 11]

The digital economy in agriculture helps to reduce the cost of providing services, provides access to exports through e-commerce in agriculture, positively affects the flow of investment and, in general, economic activity.

1. 3. The role of greenhouses in agriculture in Uzbekistan

Greenhouses are an amazing and frequent occurrence in the rural landscape of Uzbekistan. They are also an integral part of the food system of Uzbekistan, providing the country with fresh products. The practice has become more sophisticated due to technological advances in horticulture, and today greenhouses have become a common sight in the countryside of Uzbekistan. This agricultural technique arose from the need to increase crop yields and provide the population with sufficient food, as well as for the export of greenhouse products.

In this regard, Uzbekistan is not unique. As countries develop, they tend to outsource agriculture, which leads to a reduction in domestic food production and the use of farmland for other purposes. This shift is useful, even necessary, as it allows public resources to be invested in more specialized industries. However, domestic agriculture can still be an asset to countries that no longer rely on it for their food supply. [15, p. 24]

In the case of Uzbekistan, agriculture has many benefits that need to be continued and supported, including promoting resilience, improving food security, and benefiting consumers. However, the benefits of greenhouse agriculture also come at a price. In this article, we discussed the changing role of greenhouses in Uzbekistan in today's globalized economy. We argue that the benefits of greenhouse agriculture are significant in terms of food security and local food supply, but the barriers are also huge. This raises the question of whether subsidizing greenhouse agriculture is worth the cost. [16, p. 55]

The first indoor greenhouses were surrounded by natural materials and later replaced by plastic. Most greenhouses today are covered in glass, although some use plastic for smaller or seasonal operations. Advances in greenhouse technology, such as automatic irrigation systems and precise temperature control, allow for greater variety and quantity of crops to be grown than would ever be possible outdoors in Uzbekistan's climate.

According to the study, by 2023, the area of greenhouses will reach 582 hectares. With ever-evolving technology and almost complete control over growing conditions, it would seem possible to grow anything from lettuce and peppers to bananas and temperamental vines. Tomatoes and cucumbers make up the majority of the total greenhouse crop.

Gardening has an advantage over traditional methods due to the ability to control all environmental factors, including sunlight, water, temperature and nutrients. Given the scarcity of arable land and the harsh climate in Uzbekistan, greenhouses provide the opportunity for greater diversity, longer growing seasons, and higher crop yields than could be achieved with the traditional method. Uzbekistan already possesses and produces most of the resources needed to operate greenhouses, and food produced in this way is significantly less energy intensive than its imported counterparts. A closer look at these key operating resources reveals both success and opportunities for domestic renewables. [17, p. 37]

It should be noted what is the basis of agricultural technology? Agricultural technologies are the interrelation of methods and techniques in animal husbandry and crop production, which increase the yield of crops, increase the number of livestock while maintaining and improving the quality of the products produced.

In order to increase production volumes on the basis of agricultural technology, it is necessary to increase the efficiency of digital transformation in agriculture.

From our point of view, among the priorities of implementing the concept of smart agriculture, the following provisions can be noted: [18, p. 11]

- increasing the quantity and quality of promising digital management technologies in agriculture through internal and external investment of significant funds in this vital area for the republic in order to ensure food security;
- the introduction of various modern resource-saving technologies in the field of agriculture, including the use of precise sowing mechanisms, the elimination of the loss of mineral fertilizers by accurately calculating their consumption per unit of sown area;
- wide use in the field of agriculture of the drip irrigation system on open and closed land plots using modern farming technologies and appropriate digital information and communication management systems;
- the widespread use in agriculture of methods and methods of growing local and tropical crops in enclosed spaces, shelters and greenhouses, using technologies developed in some developed countries;
- training and involvement of modern specialists in the field of high technologies to work in various directions in the field of agriculture of the republic;
- introduction of advanced innovative technologies and advanced foreign experience in various areas of agricultural clusters of the Republic of Uzbekistan;
- the transition of agriculture to a digital method of information exchange, first at the level of regional centers with a further transition to a nationwide scale;
- reducing the number of paper, accounting and reporting forms, followed by the transition to electronic media and electronic office work;
- improving the efficiency of interaction between agricultural workers , agro- clusters , farmers and private producers with government bodies;
- creation of a mechanism for continuous monitoring and evaluation of the state of agricultural crops and lands in order to ensure an effective management mechanism;
- introduction in agriculture of methods of growing various local and tropical crops using artificial substrates, including perlites and aerons;
- development of methods for growing crops using modern methods of aeroponics and hydroponics in smart greenhouses with digital program control;
- the use of agricultural mechanisms and technological equipment provided with navigational equipment in order to accurately record the organization and conduct of various agricultural works;
- the introduction of robotics for the care of agricultural machinery and equipment, animals, milking milk and cutting meat;
- the use of drones to monitor the state of agricultural land, record the use of land resources and monitor the state of herds of animals in the fields;
- development and implementation of methods, tools and appropriate consulting companies to advise agricultural workers and farmers on the cultivation, processing, storage, marketing and marketing of agricultural crops;
- creation of a digital platform in agriculture for effective management, consultation and monitoring of agriculture at the republican and regional levels;
- development of a technology for growing crops that can adapt to changes in climate, the external environment based on modern achievements in digital technology and thereby achieve the sustainability of crops to external influences;
- development of work on genetic engineering to develop new varieties of crops that are resistant to local climatic conditions;

- development of new methods, technologies, equipment and automated devices for long-term storage and long-distance transportation of vegetables, fruits, flowers and herbs;

- formation of a structure in agriculture focused on the market, export and ensuring the competitiveness of agricultural products on a global scale;

- on a planned basis, ensure the introduction of "Smart Agriculture" technologies based on the most advanced foreign analogues;

- based on the introduction of innovative solutions to increase the efficiency of the logistics infrastructure of agricultural producers.

For the successful implementation of this concept in agriculture, it is necessary to widely use the means and methods of digital technologies in the agriculture of Uzbekistan. And it is also necessary to ensure effective planning for the implementation of the above provisions on a temporal and spatial scale. It is also planned to use artificial intelligence technologies for collecting, processing, transmitting and storing data on agriculture in Uzbekistan, as well as virtual and augmented reality technologies for modeling and managing the state and development of crops in various conditions. [19, p.10]

The benefits of greenhouse agriculture lie in its ability to grow food that would otherwise be impossible. However, they require certain resources to operate effectively. Fortunately, most of these resources are renewable and greenhouses can be quite efficient in how resources are used, especially in the context of Uzbekistan.

Almost all electricity produced and used in Uzbekistan comes from non-renewable sources. About 85% of electricity **generation** comes from thermal power plants, mainly powered by natural gas, the rest from hydroelectric power plants. Because this electricity is produced domestically, it has the added benefit of price stability and protection against disruptions. Greenhouses require electricity and gas to operate, especially during the winter months when artificial lighting compensates for the lack of natural sunlight. Other electrical needs include ventilation, irrigation, backup heating, and computer processing. [20, p. 22]

Many greenhouses in Uzbekistan are hydroponic, and while the water requirement may seem high for this practice, greenhouse-grown vegetables require a tenth of the water needed by their outdoor counterparts. This is because water is used more efficiently in hydroponic systems, reducing losses from evaporation and reuse of water not used by plants. The renewable and abundant nature of Uzbekistan's water supply contributes to the self-sufficiency and environmental friendliness of the horticulture industry.

A tomato is 90 percent water, so water quality is important. We are lucky in Uzbekistan, we can water our plants with the same water that we drink in our homes, and we have a lot of clean water.

Although food security is usually discussed in the context of developing countries, industrialized countries also face threats to adequate food supplies. According to a 2004 World Bank report, nearly two-thirds of developed countries lack the domestic infrastructure to produce and distribute enough food to feed their populations. Reliance on imported food is an often overlooked threat to food security, namely the consequences of disruptions in global supply chains. Examples of factors that have affected food supply chains include natural disasters, political conflicts and economic crises. Uzbekistan's vulnerability to disruption was clearly exposed at a time of financial trouble, proving that food shortages quickly follow disruptions in the import network.

Today, Uzbekistan is an autonomous country that actually relies on other countries for its food supply, including many essentials. In addition, other inputs needed for food production must be imported. Uzbekistan's history of transition from self-sufficiency to import dependency shows that as it became more dependent on external food, the domestic agricultural sector has been

significantly weakened. Following the trend in other developed countries, Uzbekistan has lost the ability to feed its population and has become vulnerable. [21, p. 10]

Since the financial crisis, food importers have been hesitant to do business with Uzbekistan due to the unstable economic climate, and many suppliers have temporarily suspended operations. There was a brief period of panic as some Uzbeks hurriedly bought groceries from grocery stores and stocks quickly ran out.

If food imports are stopped, Uzbekistan will not be able to feed its population. Suggestions for improvement include building grain reserves, contingency plans, and conducting further research on food security in Uzbekistan.

Uzbekistan needs to address its vulnerability to food insecurity and protect its food stocks from the unpredictable nature of international trade. While it is true that outsourcing food production is cost-effective and even necessary, the vulnerability associated with it is undeniable. To mitigate this security threat, domestic food production and distribution networks can be maintained not as a substitute for imports or achieving self-sufficiency, but as a temporary food supply to protect against disruptions. In addition to other local food systems such as lamb and dairy farming, greenhouse agriculture in Uzbekistan is a sustainable industry and offers the unique advantage of growing food all year round and regardless of weather conditions. [22, p.10]

In general, residents of Uzbekistan have a positive attitude towards local products. According to the study, more than 70 percent of consumers in Uzbekistan believe that local food is healthy and safe, and more than 80 percent are satisfied with the quality of their purchase. Respondents emphasized the importance of supporting local farmers and reducing environmental impact, and were willing to pay a little (but not too much) more for food grown to support these goals. [23, p. 47] .

Locally produced products are also a source of national pride. Many food producers in Uzbekistan capitalize on "food nationalism" through marketing that emphasizes the Uzbek nature of their products.

Conclusion

Although Uzbekistan is heavily dependent on imported food, it still benefits from a sustainable agricultural sector. Domestic food production can protect against the unpredictable nature of international trade networks and enable the supply of food from local sources. One way Uzbekistan has been able to overcome some of its climate constraints is through the development of geothermal greenhouse agriculture. Greenhouse farming can provide a stable and nutritious source of food all year round. However, its effectiveness requires government support, which currently takes the form of direct payments and protective tariffs. National spending is proportionately high compared to other European countries, leading some to doubt the viability of agriculture in Uzbekistan. We also argue that a comprehensive and regular survey of farms is necessary to gain accurate access to environmental sustainability and opportunities for industry sustainability.

Our study explored the costs and benefits of greenhouse farming based on interviews with local farmers and agricultural representatives. Farmers were most concerned about the government's policies that protect and support the industry, and how the fate of the industry depends so much on these laws. These include protective tariffs on imported goods, subsidies on energy costs and production quotas. The farm visits provided valuable information on some of the common practices, including types of culture media, fertilizers, and automated systems, factors not often reported in the literature.

We have found that there is significant market demand for greenhouse products and that greenhouses can help promote food security and local food supply. In addition, greenhouses also benefit from renewable resources. At the same time, greenhouses require electricity and depend on significant government subsidies. These subsidies have decreased over the past few years, resulting

in a decline in greenhouse production. The question is whether Uzbekistan decides that the loss of much of its agricultural sector and local food is worth the social and political costs.

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ҚИШЛОҚ ВА СУВ ХЎЖАЛИГИ ИСТЕЪМОЛЧИЛАРИ ЭНЕРГИЯ ТАЪМИНОТИДА ҚАЙТА ТИКЛАНУВЧИ ЭНЕРГИЯДАН ФОЙДАЛАНИШГА ТИЗИМЛИ ЁНДАШУВ

Dilshod Kodirov[1]

[1]*National Research University "Tashkent Institute of Irrigation and Agricultural Mechanization Engineers", Tashkent, Uzbekistan* ***E-mail: kodirov.dilshod@gmail.com***

Abstract

Мақола қишлоқ ва сув хўжалиги энергия таъминотида анъанавий ва қайта тикланувчи энергия манбаларининг оқилона комбинацияси танлаш асосида қуёш ва сув энергиясидан биргаликда фойдаланиш кўриб чиқилган. Бунда, комбинацияланган яхлит энергия таъминоти тизимини шакллантирилган. Қайта тикланувчи манбадан олинган энергия истеъмолчини тўлиқ таъминласа ва ундан ортган энергияни марказлашган тамоққа (N") узатишлади, агар тармоқдан олинаётган энергия тармоққа берилаётган энергиядан кам бўлса тавсия этилаётган тизимнинг самарадор (N"') эканлиги келтирилган.

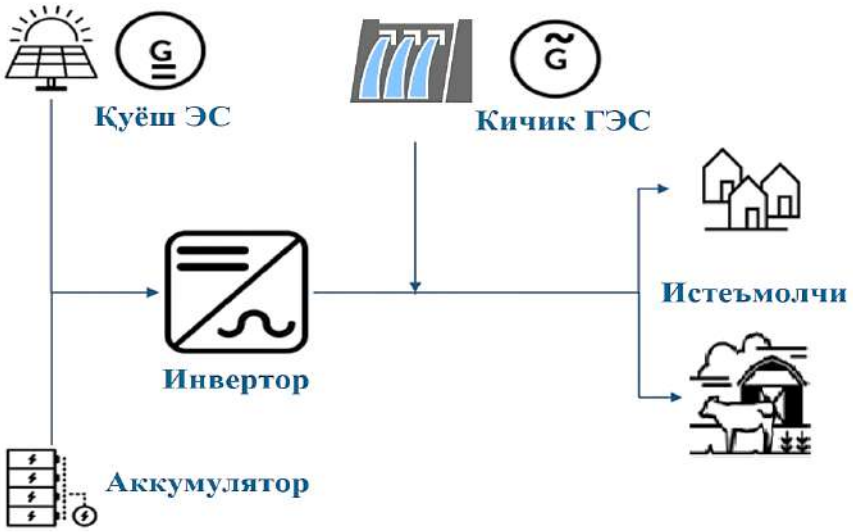
Introduction. Электр таъминоти тизими самарадорлиги сезиларли даражада ошириш техник ечимларга боғлиқ. Шунинг учун интеграциялашган энергия таъминоти тизимида нафақат қайта тикланадиган, балки анъанавий манбалардан самарали фойдаланиш учун техник ечимларни ишлаб чиқиш зарур ҳисобланади.

Ҳозирги вақтда қуёш ва шамал электр станцияларидан алоҳида ва биргаликда фойдаланишга имкон берувчи турли хил техник ва схемали эчимлар мавжуд [1, 2, 3]. Энг долзарб муаммо қуёш ва сув энергиясидан биргаликда фойдаланишдир. Улардан бир вақтнинг ўзида фойдаланиш билан қайта тикланадиган энергиянинг кирувчи оқимларидан максимал даражада фойдаланиш ва шу билан улардан фойдаланиш самарадорлигини ошириш керак. Ушбу шартларни қондириш учун тегишли эчимларни ишлаб чиқиш керак.

Ишлаб чиқилган техник ва схемали эчимлар қайта тикланадиган ҳамда анъанавий манбаларни бир-бири билан истеъмол режими уйғунлаштириш тамойилига асосланиши керак. Бундай ҳолда, кунлик энергияга бўлган эҳтиёжни таъминлаш шартидан келиб чиқиш керак.

Қишлоқ ва сув хўжалиги истеъмолчилари электр таъминоти учун қуёш ва кичик гидро электр станциялар ёрдамида схема ишлаб чиқилган. Техник ечим энергия манбаларидан смарали фойдаланиш учун оқилона комбинацияси билан ажралиб туради.

Гидро турбина ўзгарувчан электр токини ишлаб чиқаради. Қуёш электр станцияси ўзгармас электр токини ишлаб чиқаради. Ишлаб чиқарилган ўзгармас электр токи инвертор ёрдамида ўзгарувган электр токига ўзгартирилади. Қуёш электр станцияси ишлаб чиқарилган электр энергиясининг бир қисми истеъмолчига етказиб берилади, бир қисми аккумулятор батареясини заряд қилиш учун ишлатилади. Батарея тўлиқ зарядга етганда контроллер уни ўчиради ва ишлаб чиқарилган энергия тўлиқ истеъмолчига узатилади (1-расмга қаранг).

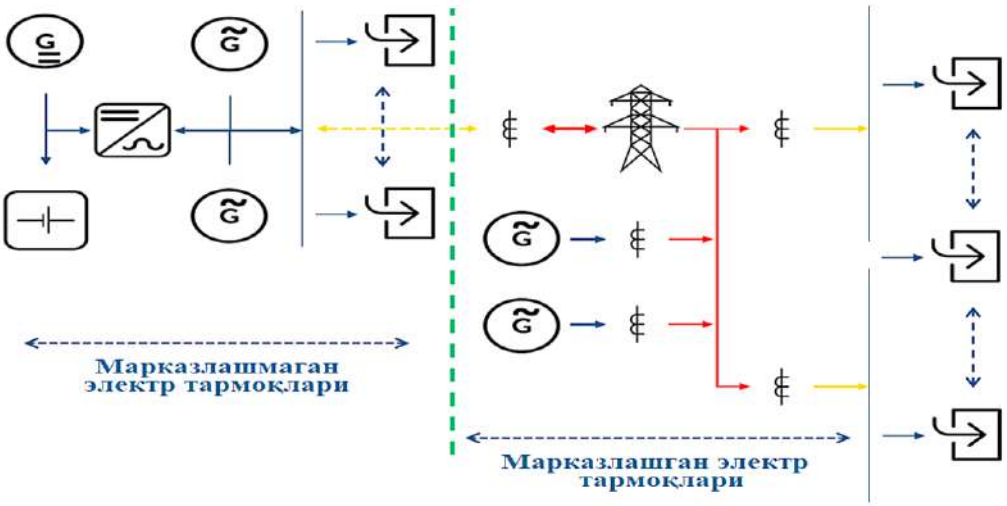


1-расм. Қуёш ЭС ва кичик ГЭСларнинг комбинацияси.

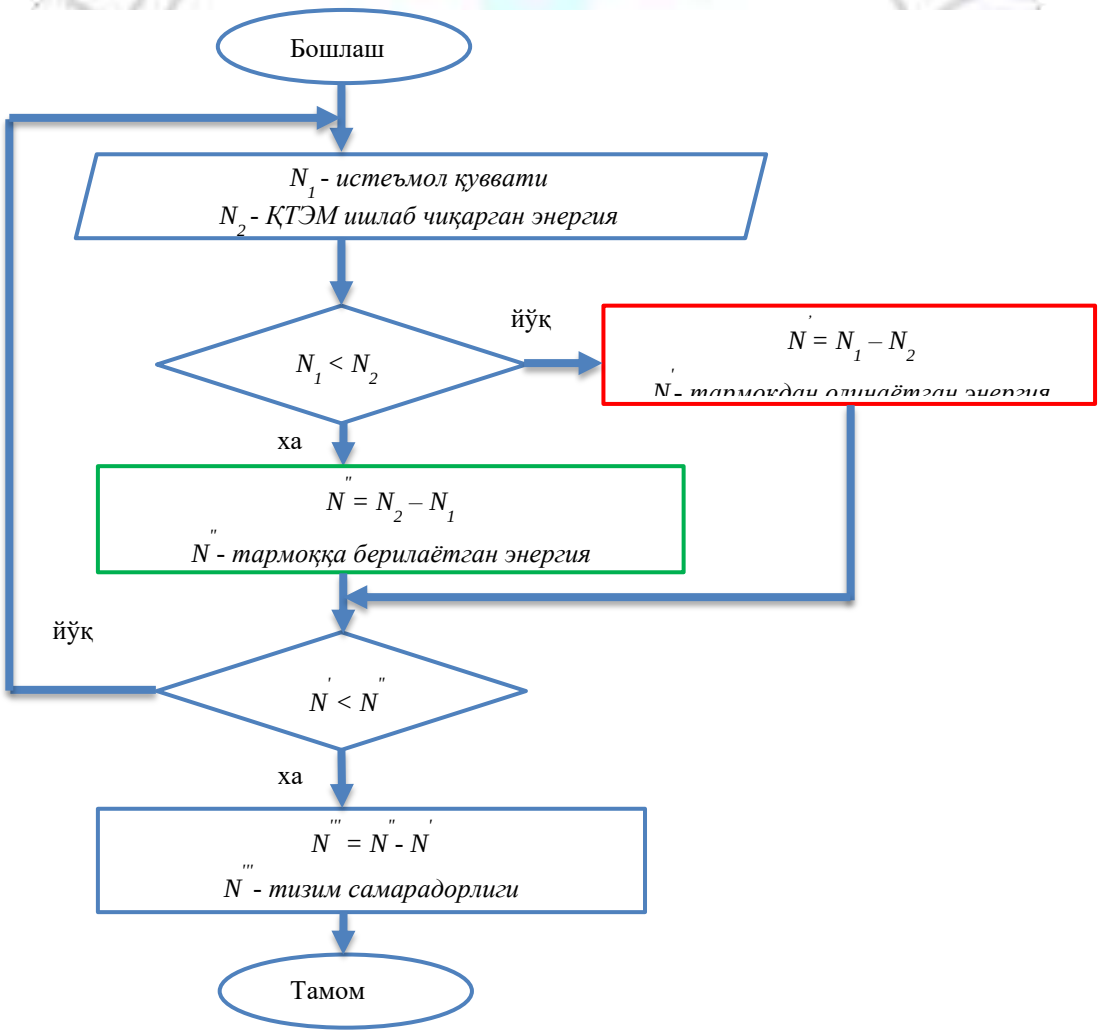
Қувват истеъмолининг ортиши гидро турбина чиқишидаги кучланишни пасайтиради ва стабилизатор керакли кучланишни ушлаб туролмаса, қуёш электр станциясидан ёки батареядан керакли энергияни олинади. Ишлаб чиқарадиган электр энергияси миқдори қувват регулятори томонидан бошқарилади, бунда истеъмолчи электр энергиясини гидро турбина ёки қуёш электр станциясидан олиши мумкин [4, 5].

Research Methods. Сув оқими йўқлигида ёки унинг тезлиги паст бўлганда ва қуёш электр станцияси керакли қувватни етказа олмаса, истеъмолчи электр энергиясини марказлашган электр таъминоти тизимидан олади. Марказлашмаган электр таъминоти тизими тўлиқ қайта ишга тушгандан сўнг қувват регулятори томонидан истеъмочи марказлашган электр таъминоти тизимидан автоматик узилади. Электр энергияси истеъмолчилари бўлмаган ёки кам бўлган тақдирда, марказлашмаган электр таъминоти тизими ишлаб чиқарилган энергия қувват регулятори томонидан марказлашган электр тармоқлариган юборилади (2-расмга қаранг) [6, 7, 8].

Шундай қилиб, истеъмолчиларга марказлашмаган электр таъминоти учун таклиф этилаётган электр таъминоти тизими қишлоқ ва сув хўжалиги истеъмолчиларини қайта тикланувчи энергиядан фойдаланиш самарадорлигини оширишга имкон беради. Тавсия этилган схемалар электр таъминоти тизимидаги анъанавий ва қайта тикланувчи энергия манбаларнинг мувофиқлаштирилган таъминоти учун техник ечимларни ишлаб чиқиш ва уларнинг ишлаш режимларини ҳисоблаш имконини беради [9, 10].



2-расм. Марказлашган ва марказлашмаган электр таъминоти тизимининг комбинацияси



3-расм. Тизим самарадорлиги баҳолаш алгоритмми

Марказлашган ва марказлашмаган электр таъминоти тизимининг энергия самарадорлиги баҳолаш алгоритмми 3-расмда келтирилган. Бунда, истеъмолчи (N_1) қайта тикланувчи энергия (N_2) билан тўлиқ таъминланмаса, зарур энергия марказлашган энергия таъминотидан (N') олинади. Қайта тикланувчи манбадан олинган энергия истеъмолчини тўлиқ таъминласа ва ундан ортган энергияни марказлашган тамоққа (N'') узатиши мумкин. Агар тармоқдан олинаётган энергия тармоққа берилаётган энергиядан кам бўлса тавсия этилаётган тизим самарадор (N''') ҳисобланади.

Ҳозирги вақтда визуал моделлаштириш тизими мураккаб динамик тизимларни таҳлил қилиш учун қулай восита бўлиб, турли илмий ва муҳандислик тадқиқотларида кенг қўлланилади. Визуал моделлаштириш тизимининг асосий афзалликлари [11]*:*

- ҳар қандай моделни иерархик тузилма шаклида ифодалаш имкноияти;
- амалга оширилаётган моделнинг ташкил етувчи барча блокларини вертуал ўзаро боғлаш ва бунда юзалага келадиган хатоликларни олидиган баҳолаш имконият;
- симуляция пайтида тизимда содир бўлаётган жараёнларни Симулинк дастури ёрдамида кузатиш имконият.

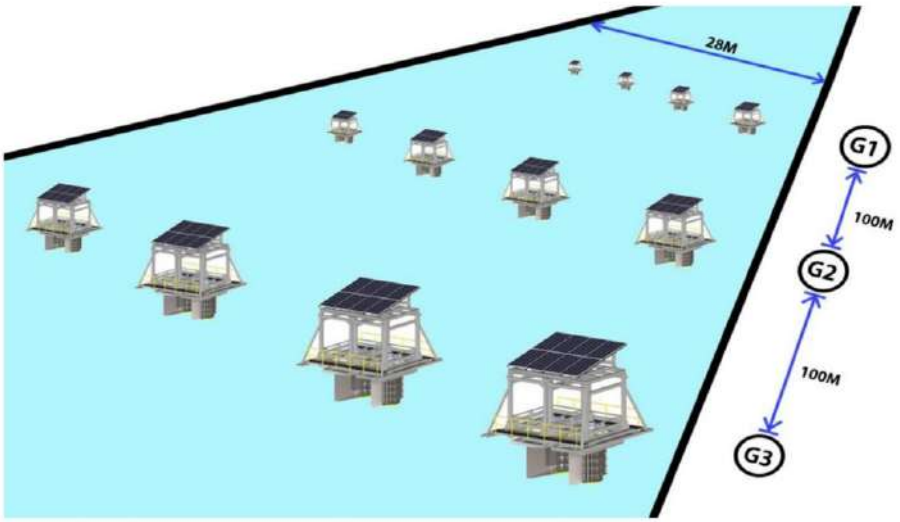
Интеграциялашган қуёш ЭС ва кичик ГЭС визуал моделлаштириш ёрдамида қурилмаларни ишлаб чиқиш, ўнатиш ва синовдан ўтказиш учун Тошкент вилоятининг Қорасув канали танлаб олинди (4-расмга қаранг).

4-расм. Қибрай туманидаги Қорасув канали

Ўтказилган тадқиқотлар натижасига кўра, Қибрай тумани Хосилот махалласидан оқиб ўтувчи Қорасув каналининг кенглиги – 28 метр, ўртача босими – 4 метр, сув сарфи 3 – $м^3/с$, бундан ташқари танлаб олинган ҳудудда қуёш нурланишининг интенсивлиги кунига ўртача 4,6 $кВт/м^2$ эканлиги аниқланди.

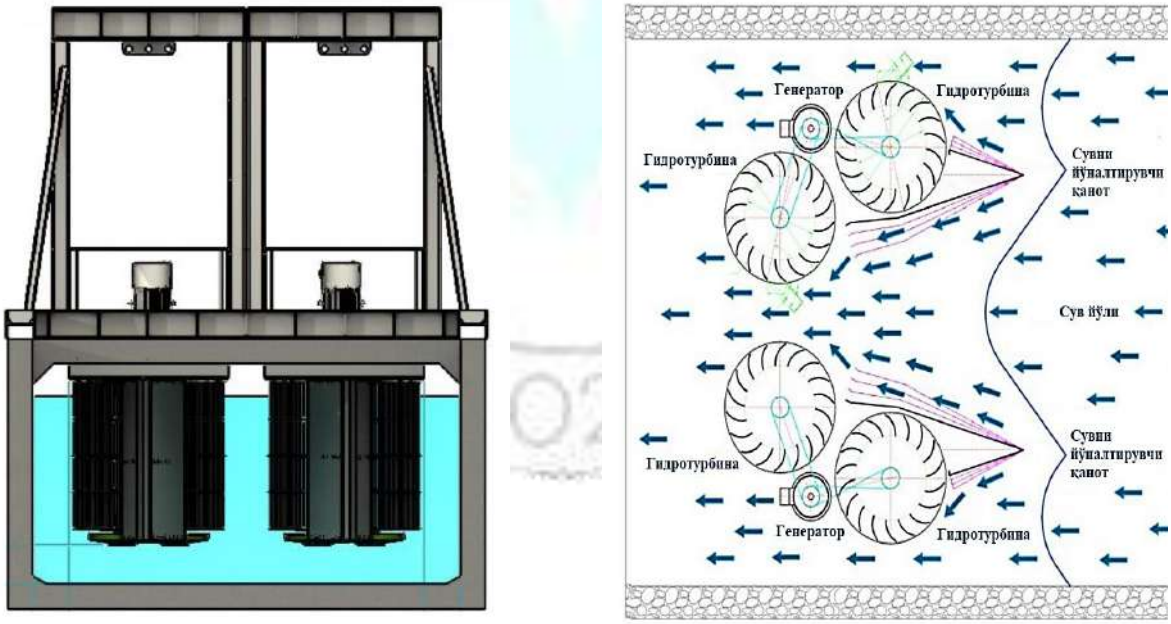
Қуёш ЭС ва кичик ГЭСнинг комбинациялашган курилманинг техник, эксплуатацион ва дизайн параметр жиҳатидан ўрнатиш учун видуал модел мувофиқ жойлаштирилди (5-расмга қаранг).

Ишлаб чиқилган қуёш ЭС ва кичик ГЭСнинг комбинациялашган визуал модели турли шароитларда ишлашини симуляция қилиш имкон беради. Шундай қилиб, симуляция моделида иккита блокдаги сув оқимининг гидро турбиналарга тасирини кўриш мумкин.



5-расм. Қуёш ЭС ва кичик ГЭСнинг комбинациялашган визуал модели

Results and Discussions. Симуляция моделининг ўзига хос хусусияти шундаки, сув оқимининг максимал даражада кинетик энергия фойдаланиш имконини беради. Бунда, сув оқимига кўндаланг жойлаштирилган гибрид қурилманинг турбиналари дойим бир томонга харакатланиши учун сувни тўғридан тўғри-турбинага йўналтирувчи қанот жойлаштирилган. Механик қувватни ошириш учун бир вақтнинг ўзида иккита турбина тасмали узатма ёрдамида битта генераторга уланади. ни харакатга келтиради (6-расмга қаранг) [12].



а **б**

6-расм. Сув оқими, турбина ва генератор харакати бўйича симуляцион модели. Ён томондан (а) ва пастдан кўриниш (б).

Кичик ГЭС турбинасининг ўлчамлари – сув тезлиги (v), фиксирланган вақт моментидаги турбина парракларига уриладиган сув ҳажми (Q) ва сув сатҳининг чуқурлигига (Н) боғлиқ бўлади. Турбинанинг ташқи диаметри $d_1 \geq 2d_2$ бўлганда энергия самарали юқори бўлиши адабиётда келтирилган [1, 13]. Трубинанинг ички чуқурлиги қуйидаги эмперик усулда аниқланади:

$$\gamma = k\sqrt[3]{\frac{d_1}{d_2}}, \quad (1)$$

бунда $0{,}6 \leq k \leq 0{,}7$ сувнинг турбинага таъсир коэффициенти. Трубинанинг кенглиги:

$$X = \frac{Q}{vk\gamma} \quad (2)$$

формула ёрдамида ифодаланади. Турбинанинг ичики юзаси:

$$S = \gamma X\left[1 + \frac{cos\,2\theta}{sin\,\theta}\right], \quad (3)$$

бу ерда θ – сувни икки тамонга йўналтирувчи қанотлар орасидаги бурчак, таклиф этилаётган гидротубина учун θ бурчак муҳим катталик ҳисобланади. Бу бурчакни шундай танлашимиз керакки, натижада, битта қурилмага жойлаштирилган икки турбина сув билан таъсирлашиши максимал бўлиши, айланиш моментида эса минимал бўлиши лозим, бу бурчак қуйидаги формула ёрдамида аниқланади (7-расмга қаранг):

$$\theta = 180^\circ - arcsin\left(\frac{d_1 - 2E}{d_1}\right), \quad (4)$$

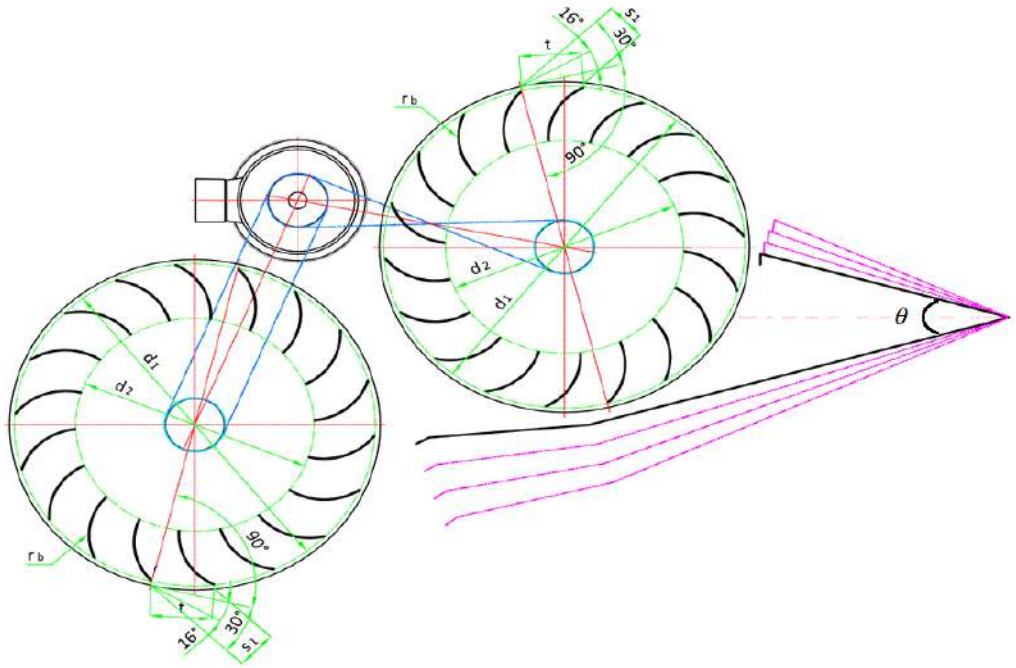
бунда E парракнинг узунлиги:

$$E = \sqrt{X^2 + \gamma^2} \quad (5)$$

Энди турбинага таъсир қилувчи сув массаси, яъни, парраклар орасига тушган сувнинг массасини топамиз. Сувнинг массаси қуйидаги дифференциал тенглама билан аниқланади:

$$\frac{dm}{dt} = \rho S(v - \bar{v}), \quad (6)$$

бунда ρ – сув зичлиги, $\bar{v}$ – сув парракка урилгандан кейинги тезлиги. Парракнинг сув оқими бўйлаб ҳаракатланишида турблентлик ҳодисаси содир бўлади, шунинг учун унинг тезлиги $\bar{v}$ одатдаги v тезлигидан фарқ қилади, яъни $\bar{v} = \partial v$, бунда $0 < \partial < 1$ оралиғида бўлади.



7-расм. Гидротуриналарнинг ўлчамлари

Турбинанинг бурчак тезлиги эса бевосита $\bar{v}$ чизиқли тезликка боғлиқ равишда топилади:

$$\varphi = 4v/[d_1(1 + cos\,\theta\,/\,sin\,\theta)] = \bar{v}\frac{d_1}{2}. \quad (7)$$

Турбина парракларига таъсир этувчи куч (F) ҳам ўзгарувчи ва қуйидаги дифференциал тенглама билан топилади:

$$F = \frac{d}{dt}(m(v - \bar{v})) = \rho S v^2(1 - \partial^2). \quad (8)$$

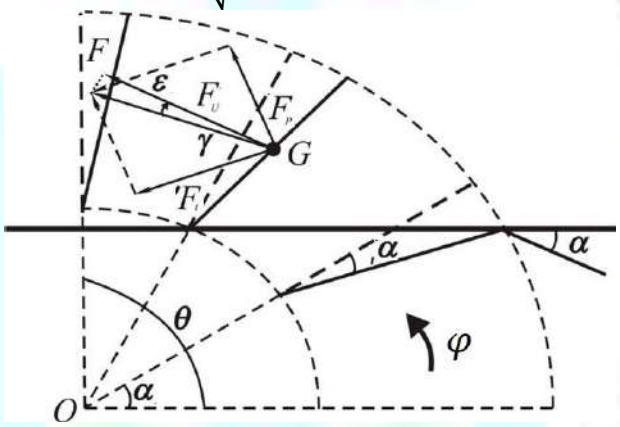
Физик нуқтаи назардан парракларига таъсир қилувчи (8) кучни аниқлаш учун дастлаб F_p «узатиш кучини» ва F_t тортиш кучини топишимиз керак.

Узатиш кучи F_ρ ва тортиш кучи F_t мос равишда қуйидаги формулалар ёрдамида аниқланади:

$$F_\rho = \mu\frac{\rho}{2}\bar{v}^2 S, \;\; F_t = \eta\frac{\rho}{2}\bar{v}^2 S \quad (9)$$

бунда μ, η – пропорционаллик коэффициентлари. (8) формулалар ёрдамида аниқланган кучлар вектор катталиклар бўлгани учун тенг таъсир этувчи F кучни иккита векторнинг йиғиндиси кўринишида тасвирлаш мумкин (8-расмга қаранг).

$$F = \sqrt{F_p^2 + F_t^2} \quad (10)$$



8-расм. Турбинага таъсир қилувчи кучлар

Бундан ε бурчак остида таъсир қилувчи фойдали куч:

$$F_u = F\,cos\,\varepsilon, \quad (11)$$

бунда $\varepsilon = arctan\frac{\mu}{\eta} - (\alpha - \gamma)$.

Математик моделнинг реал жараёнга яқинлигини таъминлаш мақсадида турбинанинг айланиш қонуниятини ўрганамиз. Айтайлик, парраклар $U_i, i = 1,2, \dots, n$, бу ерда n парраклар сони бўлсин. Парракларини қўзғалмас Oz ўққа нисбатан (4.28) формула ёрдамида аниқланувчи φ бурчак тезлик билан айланувчи жисм деб фараз қилайлик. Кинетик моментнинг ўзгариши ҳақидаги теоремага мувофиқ:

$$\frac{dK}{dt} = U_1(F_u) + U_2(F_u) + \cdots + U_n(F_u) = \sum_{i=1}^{n} U_i(F_u). \quad (12)$$

Қаттиқ жисмнинг қўзғалмас Oz ўқи атрофида айланиши натижасидаги кинетик момент:

$$D = B_z\varphi \quad (13)$$

формула ёрдамида топилади, бу ерда B_z– механик системанинг фиксирланган вақтдаги O_z айланиш ўқига нисбатан инерция моменти, у қуйидаги формула ёрдамида топилади:

$$B_z = m_1r^2 + m_2r^2 + \cdots + m_nr^2 = \sum_{k=1}^{n} m_kr^2 \quad (14)$$

(13) формуладан фойдаланиб (10) дифференциал тенгламани қуйидагича ёзамиз:

$$B_z \frac{dw}{dt} = \sum_{i=1}^{n} U_i(F_u). \quad (15)$$

Қаттиқ жисм кинематикасидан маълумки:

$$w = \frac{d\theta}{dt} = \dot{\theta}, \quad (16)$$

бунда $\dot{\theta}$ – турбинанинг Oz ўқига нисбатан айланиш бурчаги.

Натижада қуйидагига эга бўламиз:

$$B_z \frac{dw}{dt} = B_z \frac{d^2\theta}{dt} = \sum_{i=1}^{n} B_i(F_u), \quad (17)$$

(17) ифода қаттиқ жисмнинг қўзғалмас ўқ атрофида айланишининг дифференциал тенгламаси дейилади. (17) тенгламада B_z инерция моменти (6) формула бидан аниқланувчи m массанинг аналогидир, $\frac{d^2\theta}{dt}$ – чизиқли тезланиш ролини бажаради, $\sum_{i=1}^{n} U_i(F_u)$ йиғинди эса таъсир қилувчи F_u кучларнинг бош вектори ролини бажаради. Одатда турбина (11) формула билан аниқланувчи бир нечта куч таъсир қилади, шунинг учун $F_u = \sum_{k=1}^{n} F_u^k$. $\{F_u^1, F_u^2, \dots, F_u^n\}$ кучлар таъсирида чархпалак ўқидаги подшипникларда R_1 ва R_2 реакциялар хосил бўлади, бу реакциялар ҳам ташқи куч ҳисобланади, лекин уларнинг моменти Oz ўқига нисбатан нолга тенг.

Энди турбинанинг айланиши натижаси бажарилган ишни топамиз. Турбина $U_i, i = 1,2, \dots, n,$ паррагига (11) формула билан аниқланадиган F_u куч α бурчак остида таъсир қилсин. Бу кучнинг бажарган иши турбина айлантириш учун бажарилган ишга тенг. Шунинг учун бажарилган иш:

$$dA = F_u \cdot r \cdot \sin\theta \, d\theta. \quad (18)$$

Айланиш ўқига нисбатан (13) куч моменти $D = F_u r \sin\alpha$ эканлиги ҳисобга олсак, қуйидаги формулага эга бўламиз:

$$dA = Dd\theta \quad (19)$$

(19) тенгламанинг ҳар икки томонини интеграллаб турбинанинг чекли $d\theta$ бурчакка бурилгандаги иш, умумий ишларнинг интеграл йиғиндисига тенг эканлигини топамиз, яъни:

$$A = \int_{\theta_1}^{\theta_2} D \, d\theta. \quad (20)$$

Демак, турбинанинг айланма ҳаракати давомида бажарилган иш таъсир этувчи куч моментлари билан айланиш бурчаги кўпайтмасига тенг экан.

Conclusions

Обобщая результаты исследований, относящиеся к данной работы, можно сделать следующие выводы:

1. биринчи марта қуёш электростанцияси ҳамда гидроэлектростанцияларидан алоҳида ва биргаликда фойдаланишда алмаштирилган энергия улушини ҳисоблаш модели ишлаб чиқилган, бир вақтнинг ўзида қуёш ва гидроэлектростанцияларини кунлик зарур энергия билан таъминлаш шартларига қараб танлаш имконияти аниқланган;

2. қуёш электростанцияси ва гидроэлектростанцияларининг оптимал ечимларини танлашда аналитик ифода олинган ҳамда қайта тикланувчи энергияни етказиб бериш ва истеъмол қилиш режимларини мувофиқлаштириш орқали энергия таъминоти тизимининг узлуксизлиги ва ишончлилиги баҳоланган;

3. биринчи марта қайта тикланувчи ва анъанавий энергия манбаларининг оқилона комбинациялаш алгоритми ва уларнинг иш режимларини ҳисоблаш модели ишлаб чиқилиб, у орқали янги энергия таъминоти тизимининг иқтисодий самарадорлиги баҳоланган;

4. тадқиқот натижалари назарий ва амалий аҳамиятга эга бўлиб, олинган усул, модель ва алгоритмлардан фойдаланиб қишлоқ ва сув хўжалигида электр энергияси истеъмолини

баҳолаш ва талаб этиладиган энергия меъёрларини аниқлаш, қайта тикланувчи энергия манбаларидан фойдаланиш ва уларни амалиётга кенг жорий этишда муҳим ўрин тутади.

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PROSPECTS OF THE DEVELOPMENT OF AGROCHEMICAL SERVICES IN AGRICULTURE

Tabaev Azamat Zaripbaevich, *"Tashkent Institute of Irrigation and Agricultural Mechanization Engineers" National research university, Associate Professor*
Rajabov Ruslan Bakhtiyorovich*, accountant of "KRAVZIT" LTD*

Abstract

The article presents the current state of development of the agrochemical services, the problems and factors affecting them, as well as scientific suggestions for the effective organization of the agrochemical services in agriculture.

Key words: *agrochemical services, agroclusters, infrastructure, stock exchange, subsidies, factors, futures contracts, innovative technologies.*

Introduction. Since the country gained independence, large-scale economic reforms have been carried out in agriculture. As a result of economic reforms in the agrarian sector, farmers and peasant farms, which have property and entrepreneurial freedom, have become the main agricultural products producer. Also, the special attention paid to the development of agroclusters in our country has led to changes in the nature of property relations and service infrastructures in agriculture, that is, the liberalization of the economy in agriculture has gained practical importance. The reduction of irrigated land resources per capita in the republic and the increase in demand for agricultural products have an impact on the need for agrochemical services.

Only 20.7% of the 20.2 million hectares of agricultural land is irrigated land. Over the past 15 years, irrigated land per capita has decreased by 24 percent (from 0.23 ha to 0.16 ha). According to forecasts, the irrigated land area may decrease by 20-25% over the next 30 years [1].

In order to eliminate these problems, it is necessary to develop agrochemical services, which are an important link of production intensification, involving innovative technologies in the agricultural sector. If an additional yield is obtained as a result of the rational use of mineral and organic fertilizers, the yield is maintained and the quality is improved due to the protection of plants from pests, diseases and weeds with the help of chemical (pesticides) and biological means.

Materials and methods. Today, the specific aspects of the development of agrochemical services are as follows:

- availability of agricultural enterprises of various forms and sizes, as well as their high number;
- that modernizing agricultural machinery based on smart technologies, instead of materially and morally outdated machinery, is the demand of the time;
- formation of free competition of agrochemical services through the purchase of mineral fertilizers and chemicals by various economic subjects in the commodity exchange trading system in the conditions of shortage of financial resources in agricultural enterprises;
- as a result of the diversification of agricultural crops, the demand for a number of new agrochemical services (chemical processing, biofertilizer delivery, etc.) in the field of fruit and vegetables and horticulture is increasing;
- coordination of activities of agricultural and agrochemical service enterprises.

Taking into account the above, in order to create an integrated system of providing agriculture with mineral fertilizers, chemical and biological means of plant protection, agrotechnical services for agricultural crops and to improve the quality of services for protection from pests and diseases, the President of the Republic of Uzbekistan dated October 24, 2016 "Protection of plants and Decision PR-2640 "On measures to improve the system of providing agrochemical services to agriculture" was adopted, and this decision became an important turning point for solving problems

in the field. As a result, the Joint Stock Company "Agrokimyohimoya" was formed, and agrochemical services of plant nutrition and protection were integrated into a mutually integrated system [2].

The head of our state emphasized the problems of the sector and noted that the large-scale reforms implemented in the chemical industry are also giving positive results, but the systemic problems that have existed in the industry for many years have not yet been resolved. For example, the lack of financial resources of industrial enterprises producing mineral fertilizers. Lack of attention to the financing of agriculture or a superficial approach to the issue caused defects in the system of mutual settlements in this area [3].

The issues of conducting scientific research work and introducing the results into production, improving the skills of employees and providing laboratory services are neglected. Development of the chemical industry and ensuring competitiveness in the world markets, radical diversification of the industry is directly related to the potential of scientific research, design, engineering, diagnostic centers and qualified personnel.

In order to solve the existing problems in the provision of agrochemical services in the Republic in 2016-2017, the President of the Republic of Uzbekistan and industry officials at the meeting on December 28, 2017, dedicated to the " Financial and economic situation of chemical industry enterprises and issues of development of the industry" done. In this regard, since 2018, "Uzkimyosanoat" Joint Stock Company has started selling mineral fertilizers to consumers through stock exchanges. This change directly caused the transition of the agrochemical services market to a new format.

As a result of this reform, it was possible to form free competition for agricultural agrochemical service enterprises. Based on the needs of agricultural enterprises based on different ownership, agrochemical services companies are demanding that they act as "service providers" instead of "supplier" functions. Because the changes in the composition of services in the economic indicators of "Agrokmyohimoya" Joint Stock Company in recent years prove it.

In the last 10 years, the composition of the services provided by the "Agrochemical Protection" Joint Stock Company was studied. In 2016-2019, the types and volume of agrochemical services increased, and from 2020, a sharp decrease in the volume of agrochemical services is observed. The sharp decrease in demand for centralized agrochemical services was directly caused by the development of agroclusters and their establishment of agricultural infrastructure functions based on market mechanisms.

T.Sh.Shoghiyasov recommended regarding the selection of the factors affecting the economic activity of the enterprise into positive and negative factors, (internal) factors related to the enterprise's activity, unrelated (external) factors, intensive and extensive factors of production, factors of production and transaction processes [4].

While researching and studying the activity of entities providing agrochemical services to agriculture, we believe that it is important to classify the factors affecting economic activity based on the signs of internal and external factors. Because the influence of external factors on the activity of agrochemical enterprises is strong, and internal factors determine its capabilities. The internal factors in the organizational direction include such factors as determining the demand for mineral fertilizers and chemicals, effective management and motivation of employees, improving the skills of employees, and forming a digital economy in the service sector. External factors include the implementation of government decisions and programs, the implementation of research results, the effective organization of the activities of dealerships and branches, the improvement of contractual relations, the holding of exchanges and fairs.

Internal economic factors include factors such as effective management of working capital and investments, increase in labor productivity, strengthening of the material and technical base of the enterprise, and external factors include state incentives (preferential credit, tax policy, grants,

subsidies, leasing relations), discounts from suppliers. and the granting of bonuses, the introduction of futures contracts, the allocation of funds by investors, the organization of insurance in the service sector and other factors affect it. Also, the introduction of innovative technologies to improve the technologies of agrotechnical activities carried out in agricultural enterprises has a direct effect as an internal factor. Studies show that the introduction of cost-effective technologies as a result of the introduction of innovative technologies also affects similar agrotechnical technologies. For example, in "Tortkol Agrotech Cluster" JSC, the results of providing agrochemical services have increased in the case of effective use of water resources in cotton fields.

The results of providing agrochemical services with efficient use of water resources on 1 hectare of cotton land in JSC "Tortkol Agrotech Cluster"

No	Naming	The measurement is the same	Quantity	Average price	Amount
1	Area where drip irrigation technology is introduced	to	1	25,000,000	25,000,000
2	Subsidy for introduction of drip irrigation technology	to	1	8,000,000	8,000,000
	THE DIFFERENCE				**17,000,000**
	Productivity before introduction of drip irrigation technology				
1	field	to	1.0	tons	2
2	amount of cotton	tons	1	6,500,000	13,000,000
3	water consumption tax	cubic meters	3 600	200	720,000
4	electricity consumption	kW.	5,500	450	2,475,000
5	land tax (varies by region)	to	1	13 461	13 461
6	salary expense	piece	2	1,500,000	3,000,000
7	agrotechnical service (2-cultivation and tillage) with fuels and lubricants	to	1	550,000	550,000
8	Mineral fertilizers				
	Nitrogenous	kg	300	3000	900,000
	Phosphorous	kg	100	3 500	350,000
	Potassium	kg	50	2500	125,000
8	**TOTAL profit 2-3-4-5-6-7-8**				**4,866,539**
	Productivity after introduction of drip irrigation technology				
1	area (at the expense of 40 centners)	to	1	tons	4
2	amount of cotton	tons	1	6,500,000	26,000,000
3	water consumption tax	cubic meters	300	200	60,000
4	electricity consumption	kW.	1500	450	675,000
5	land tax (varies by territory)	to			
6	salary expense	piece	1	1,500,000	1,500,000
7	agrotechnical service (2-cultivation and tillage) with fuels and lubricants				
8	Mineral fertilizers				
9	Nitrogenous	kg	150	3000	450,000
10	Phosphorous	kg	70	3 500	245,000
11	Potassium	kg	25	2500	62,500
8	**TOTAL profit 2-3-4-5-6-7-8**				**23,007,500**
1	THE DIFFERENCE				18 140 961
2	Cost of technology implementation				17,000,000
3	Residual profit per year				1 140 961

Analyzes show that as a result of the use of water-saving technology, the consumption of mineral fertilizers has decreased up to 2 times, that is, nitrogen fertilizers have decreased from 300 kg to 150 kg per hectare, phosphorus fertilizers from 100 kg to 70 kg, and potash fertilizers from 50 kg to 25 kg. At the same time, the increase of the average yield per hectare from 20 t/ha to 40 t/ha ensured a 4-fold increase in the efficiency of agrochemical services.

Therefore, in order to develop the provision of agrochemical services in the country, taking into account the specific aspects of agrochemical services, the priority tasks of the sector in the "Strategy for the Development of Agriculture of the Republic of Uzbekistan for 2020-2030", approved on the basis of the Decree of the President of the Republic of Uzbekistan No. PD-5853 of October 23, 2019 It is desirable to effectively organize the specified tasks on a scientific basis.

Conclusion

Taking into account the important aspects of the strategy, in order to systematically eliminate the problems identified as a result of scientific research, it is necessary to further implement the following tasks in the field of agrochemical services for agriculture:

- liberalization of prices by further improving the activities of the Commodity Exchange of the Republic of Uzbekistan for the sale of mineral fertilizers;
- formation of equal competition between participants in the market of agrochemical services;
- accelerate the process of digitalization of agrochemical services and ensure the transparency of economic relations;
- privatization of state enterprises in the field of supplying agricultural enterprises with mineral and organic fertilizers and agrochemical service and targeted orientation of state benefits;
- promote activities on the basis of futures contracts instead of providing resources and providing services through soft loans;
- further stimulation of the introduction of innovative technologies for the intensive development of the sphere of agrochemical services.

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ПОВЫШЕНИЯ КАЧЕСТВА ЭЛЕКТРИЧЕСКОЙ ЭНЕРГИИ, НАДЕЖНОСТИ ЭЛЕКТРОСНАБЖЕНИЯ И ЭЛЕКТРОБЕЗОПАСНОСТИ СЕЛЬСКИХ НАСЕЛЕННЫХ ПУНКТОВ

Музафаров Ш.М. *Национальный исследовательский университет . «ТИИИМСХ»*

Аннотация

В статье приводится анализ состояния вопроса электроснабжения сельского населенного пункта на примере кишлака Шампан Ташкентской области. В частности количество Трансформаторных подстанций 10/0,4 кВ и протяженность сетей 10 и 0,4 кВ. Собраны статистические материалы по уровню напряжения у абонентов, общей нагрузки трансформаторов и нагрузки на отдельных фазах. На основании этих данных дано заключение о неудовлетворительном состоянии вопроса электроснабжения населенного пункта. Для повышения надежности электроснабжения рекомендовано использования самонесущих изолированных проводов (СИП) на напряжения 0,4 и 10 кВ. Для повышения качество электроснабжения снизить разовую мощность трансформаторных подстанция до 25 кВА и заложить в проект установленную мощность одного дома равную 4 кВт. Для обеспечения электробезопасности разработана схема с изолированной от земли нейтралью с двумя нулевыми проводами: рабочим и защитным. Разработаны схемы защиты от однофазных замыканий на землю. Коммутация в сетях 10 кВ производится реклоузерами - автоматическими пунктами секционирования (АПС). Проведен расчет снижения стоимости потерь в сетях 10/0,4 кВ.

Ключевые слова: Электроснабжение, самонесущий изолированный провод, изолированная нейтраль, особо опасный, качество электрической энергии, электробезопасность, надежность, сельские электричебские сети.

Введение

В разделе 3.2. «Повышение конкурентоспособности национальной экономики за счет углубления структурных преобразований, модернизации и диверсификации ее ведущих отраслей» стратегий действий по пяти приоритетным направлениям развития Республики Узбекистан в 2017—2021 годах указывается «Сокращение энергоемкости и ресурсоемкости экономики, широкого внедрения в производство энергосберегающих технологий, расширение использования возобновляемых источников энергии, повышение производительности труда в отраслях экономики» [1].

В настоящее время в Республике Узбекистан осуществляется экономическая реформа в Республике Узбекистан. В этих условиях больше внимания уделяется проблематике взаимоотношений общественной и экономической эффективности в энергетике, выбору вариантов оптимального развития и функционирования энергетических систем. Важность этой проблемы вытекает из того, что наше общество ежегодно расходует от одной трети до половины капиталовложений в промышленность только на развитие энергетического хозяйства [2].

Быстрый рост электрификации сельскохозяйственного производства, последовавший за ним некоторым спадом, создание агропромышленных комплексов, требует дальнейшего развития электрических сетей в сельской местности. Повышаются требования к пропускной способности, надёжности электроснабжения и качеству электрической энергии, Решение которых основано на правильном проектировании электрических сетей районного значения. [3,4,5].

Одной из особенностей сельских потребительских сетей является повсеместное применение воздушных линий напряжением 0.4 кВ большой протяженностью. Отсюда низкая надежность сетей и большие потери напряжения в сетях. Это приводит к значительному ухудшению качества электроэнергии по важнейшему показателю – величине напряжения. Эти вопросы решались в настоящей статье [6,7].

Схемы распределения электрической энергии по территории сельских населенных пунктов зависит от надежности электроснабжения, числа домов, планировочного решения поселков, наличия предприятий и учреждений
(магазины, ателье, школы, детские учреждения, почтамт, парикмахерские, мастерские и др). Эти схемы не имеют общего принципа построения и отличаются индивидуальностью.

В таблице 1 приведены общие данные по трассам 10 и 0,4 кВ, количеству и мощности трансформаторных подстанций .

Общая длина линии ВЛ 10 кВ составляет 2310 метра, при числе опор 33 штук. ВЛ 10 кВ выполнена проводом АС 32.

Население населенного пункта «ШАМПАН» составляет 2058 человек (На состояние 31.01.2020 г.) Количество домов - 370, в которых проживают 596 семей.

Таблица 1.

Общие данные по трассам 10 и 0,4 кВ, количеству и мощности трансформаторных подстанций кишлака Шампан

N	Обозначение ТП	Мощность кВА	Число опор Вл 0,4кВ	Число абонентов	Длина линии 0.4кВ (м)	Марки проводов линии 0.4 кВ, м		
						А25	А16	А10
1	ТП 277	100	27	28	1200	800	400	-
2	ТП 278	100	43	52	2600	1800	600	200
3	ТП27	250	172	200	7700	4100	2800	800
4	ТП439	250	31	50	1100	900	200	_
5	ТП197	250	41	40	1900	800	600	200
	Σ = 5	Σ = 950	Σ = 314	Σ = 370	Σ=14500	Σ=8400	Σ=4600	Σ=1200

Таблица 2

Напряжение на выходе из ТП и у самого удаленного абонента ($U_{днем}$; $U_{вечером}$.)вольт

Обозначение ТП	Напряжение у самого близкого от ТП абонента, В		У самого удаленного от ТП абонента, В	
	Uднем	Uвечером	Uднем	Uвечером
ТП 277	220	220	217	209
ТП 278	220	220	212	210
ТП 27	220	220	210	183
ТП 27	220	220	210	183
ТП 439	220	220	217	216
ТП 197	220	220	215	212

Для сравнения результатов измерений напряжения на выходе трансформатора и у самого удаленного от ТП абонента в дневное и вечернее время, измеренные напряжения на были пересчитаны из условия, что на выходе трансформатора напряжение равно 220 В (таблица 2).

Общий вывод к проведенному анализу заключается в том, что существующая схема электроснабжения кишлака Шампан не в состоянии обеспечить требования стандарта к качеству электрической энергии по величине напряжения.

Исследование состояния электроснабжения кишлака Шампан проводилось также для нагрузок по фазам выходов 0,4 кВ трансформаторов, результаты которых приведены в таблице 3. Анализ результатов измерений и проведенных на их основе расчеты нагрузок по фазам отдельных трансформаторов и обшей нагрузки по фазам показал на существенное разницу как на отдельных трансформаторах, так и общей токовой нагрузки по всему кишлаку.

Токовая нагрузка фазы А трансформатора Т277 составляет 24 А, а фазы С – 2,7 А. Что является грубейшим нарушением требований правил устройства электроустановок. Аналогичные нарушения повторяются у трансформаторов ТП278, ТП439, ТП197. Суммарная нагрузка по фазам всех трансформаторов также отличаются друг от друга.

Таблица 3

Результаты измерения фазных нагрузок трансформаторов кишлака Шампан на стороне 0,4 кВ и общая нагрузка по фазам

Обозначение ТП	Фидеры	а	в	с
ТП 277	1	**24**	**22,3**	**2,7**
ТП 278	1	2,2	27	31,3
	2	4,8	0	0
	Σ	**7**	**27**	**31,3**
ТП27	1	28,5	51,4	23,8
	2	28,2	25,5	32,1
	3	41,5	75,5	69,5
	4	0,01	0,2	0
	5	0,03	0,01	9,9
	Σ	**98,24**	**152,61**	**135,3**
ТП439	1	4,2	0,03	0,01
	2	29,8	22,3	2,7
	3	0	0	0
	4	0,05	3,5	0,04
	Σ	**7,05**	**25,83**	**2,75**
ТП197	1	28,2	27	4,6
	2	0	0	0
	Σ	**28,2**	**27**	**4,6**
Σ		**164,49**	**254,74**	**176,65**

Таблица 4

Мощность, приходящаяся на одного абонента кишлака Шампан

N	Обозначение ТП	Мощность кВА	Число абонентов	Мощность приходящаяся на одного абонента, кВА
1	ТП 277	100	28	3,57
2	ТП 278	100	52	1,92
3	ТП27	250	200	1,25
4	ТП439	250	50	5,0
5	ТП197	250	40	6,25

Также следует отметить неправильный выбор мощности трансформаторов (таблица 4). Мощность, приходящаяся на одного абонента питающего от трансформатора ТП197 составляет 6,25 кВА, а от ТП 27 всего 1,25 кВА. Последняя мощность явно недостаточна, если учесть насыщенность домов различными электрическим приборами: холодильники, телевизоры, компьютеры, утюги, электрические бытовые приборы, местное и общее освещение и пр.) Установленная мощность всех электроприборов составляет в среднем от 4 до 7 кВА. По данным таблицы 4 можно сделать заключение, что электроснабжения кишлака Шампан проведено с грубыми нарушениями требований нормативной документации **[8, 9, 10].**

Повышение надежности электроснабжения

В настоящее время основным способом электроснабжения сельских населенных пунктов является использования воздушных линий электропередач напряжением 10, 6 и 0,4 кВ которые выполняются голыми алюминиевыми (типа А) или стале алюминиевыми проводами (типа АС). В настоящее время идет повсеместная замена голых проводов на изолированные типа СИП (самонесущий изолированный провод).

К числу таких преимуществ, существенно повышающих надежность электроснабжения потребителей и удешевляющих строительство воздушных линий с изолированными проводами (ВЛИ), можно отнести следующие:

• Высокая надежность ВЛИ в обеспечении потребителей электроэнергией.

• Резкое снижение эксплуатационных затрат, вызванное высокой надежностью и бесперебойностью энергообеспечения потребителей.

• Возможность совместной подвески на опорах на ВЛИ проводов с разным уровнем напряжения и проводов телефонных линий.

• Исключение случаев возникновения на КЗ между проводами фаз или на землю, а также опасности возникновения пожаров [16].

• Высокая безопасность обслуживания ВЛИ.

• Отсутствие или незначительное обрастание гололедом и мокрым снегом.

• Существенное уменьшение затрат на монтаж ВЛИ, связанное с возможностью прокладки СИП по фасадам зданий в условиях городской застройки.

• Снижение потерь в проводах ВЛИ из-за уменьшения более чем в три раза реактивного сопротивления.

• Сокращение объемов аварийно-восстановительных работ.

• Значительное снижение несанкционированного отбора электроэнергии на ВЛИ.

Отметим также некоторые недостатки ВЛИ:

• Большая стоимости СИП по сравнению с неизолированными проводами марок А и АС.

Разработка вопроса обеспечения электробезопасности

Электроустановки напряжением 220/380 В выполняются с глухозаземленными нейтралями (рис.1). Отсюда все помещения по степени опасности поражения человека электрически током подразделяются на безопасные, опасные и особо опасные. К безопасным относятся помещения в которых температура не превышает 30 ^{0}С, относительная влажность не превышает 75%, пол не токопроводящий, нет возможности одновременно прикосновения к фазному проводу и заземленным конструкциям, наличие химически активных газов и паров. Если в помещении есть в наличии хотя бы одно из ограничений, то помещение считается опасным, если 2 и более ограничений, то помещение считается особо опасным.

Сельскохозяйственные производственные, животноводческие и птицеводческие помещения, насосные станции, можно с большей вероятности отнести к особо опасным помещениям. То же относится и к бытовым электроустановкам. Особенно если электроустановку монтируют и эксплуатируют в помещениях без изолированных полов (коровники, птичники, кладовки, летние кухни, бани, душевые и т.п.

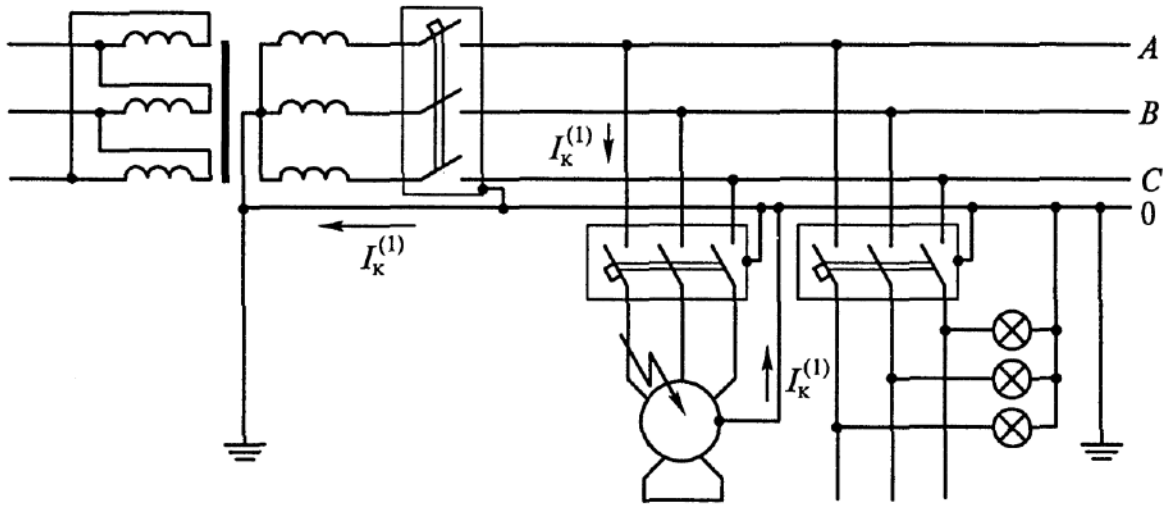

Рис.1. Сеть 220/380 В с глухозаземленной нейтралью

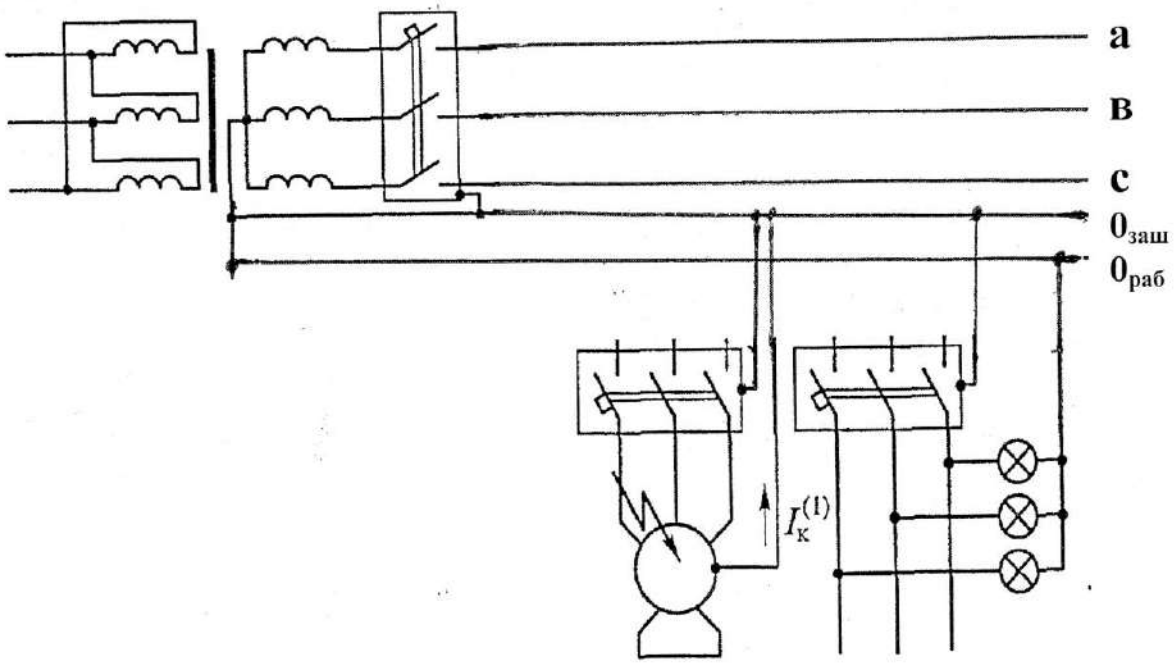

Рис.2. Сеть 220/380 В с изолированной нейтралью и двумя нулевыми проводами (рабочим и защитным)

Основной причиной данного положения является использование в сетях 220/380 В глухо заземленную нейтраль (рис.1) и четырех проводную сеть (3 фазных провода и один нулевой) это обуславливает то, что более 95 % несчастных случаев связанных с поражением электрическим током происходит в цепях фаза-земля, или цепи - фаза заземленные корпуса электроустановок. Отсюда единственным способом устранения смертельных случаев и электротравматизма является изолировать сеть от земли и использовать два нулевых провода: рабочий и защитный (рис.2.). Однако в этом случае появляется необходимость разработки методов защиты от однофазных замыканий на землю.

Защита от однофазных замыканий на землю может быть реализована на основе двух разных подходов [8]: путем общего неселективного контроля состояния изоляции сети относительно земли; избирательно (селективно) действующими средствами, выявляющими замыкания на землю на отдельных присоединениях.

В соответствии с определением симметричных составляющих напряжение нулевой последовательности представляется так:

$$U_0 = 1/3(\dot{E}_{A0} + \dot{E}_{B0} + \dot{E}_{C0}). \quad (1)$$

Здесь $\dot{E}_{A0}$, $\dot{E}_{B0}$, $\dot{E}_{C0}$ - векторы ЭДС фаз А, В, С относительно земли.

Отсюда следует, что в нормальном симметричном режиме, когда потенциал нейтрали сети равен нулю, а модули векторов $\dot{E}_{A0}$, $\dot{E}_{B0}$, $\dot{E}_{C0}$ равны соответствующим модулям векторов фазных ЭДС, напряжение нулевой последовательности в сети U_0=0.

При замыкании фазы С на землю:

$$\dot{E}_{C0} = 0 \, , \, \dot{E}_{ло} = \dot{E}_{лс} \, , \, \dot{E}_{во} = \dot{E}_{вс} \, . \quad (2)$$

Тогда

$$U_0 = 1/3(\dot{E}_{A0} + \dot{E}_{B0} + \dot{E}_{C0}) = 1/3(\dot{E}_{A0} + \dot{E}_{B0}) = 1/3(\dot{E}_{AC} + \dot{E}_{BC}) = -1/3(3 \dot{E}_{C0}) = - \dot{E}_{C0}. \quad (3)$$

Как видно в выражении (3), при металлическом замыкании фазы на землю модуль напряжения нулевой последовательности равен модулю фазной ЭДС сети. Следовательно, действующее значение напряжения нулевой последовательности равно действующему

значению фазного напряжения. Интегральное значение этого напряжения можно контролировать через трансформатор напряжения (рис. 3).

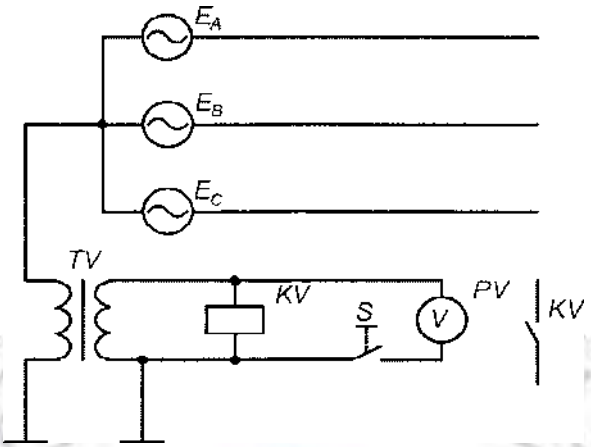

Рис.3. Схема контроля напряжения нулевой последовательности с помощью реле подключаемого к нейтрали сети

Для контроля напряжения нулевой последовательности часто используется фильтр напряжения нулевой последовательности, построенный на основе трехфазного трансформатора напряжения, вторичные обмотки которого соединены по схеме разомкнутого треугольника (рис. 4) [8].

Значение напряжения срабатывания (в масштабе первичных значений) выбирается по условию отстройки от максимально возможного напряжения нулевой последовательности, возникающего в контролируемой сети в нормальных для нее режимах:

$$U_{СЗ} > U_{OHPmax}, \quad (4)$$

здесь Uсз - действующее (первичное) значение напряжения срабатывания защиты;

U_{OHPmax} - наибольшее возможное в нормальных режимах действующее напряжения нулевой последовательности.

Значение напряжения U_{OHPmax} определяется предельно допустимым потенциалом нейтрали $U_{N\ max}$, которое в свою очередь обусловлено степенью несимметрии емкостей фаз сети относительно земли и составляет 5-10 % номинального фазного напряжения сети $U_{ф\ ном}$.

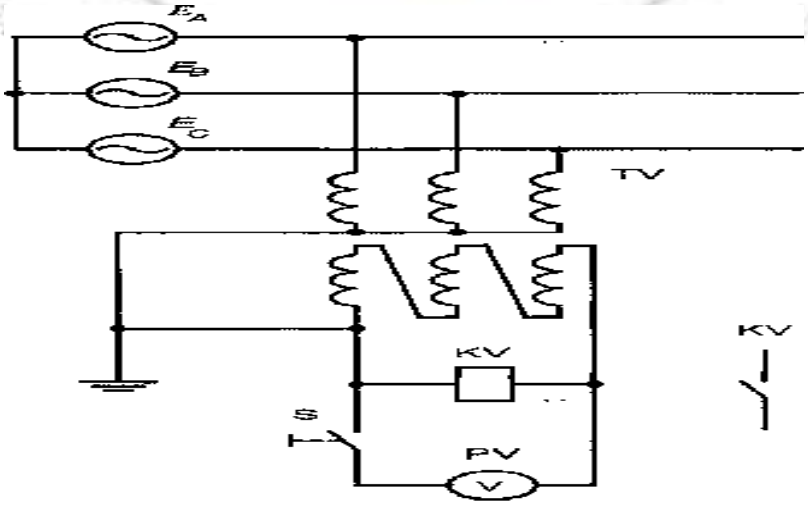

Рис.4. Контроль напряжения нулевой последовательности с помощью фильтра напряжения нулевой последовательности

Кроме этого напряжение нулевой последовательности может возникать в сети как проявление замыканий на землю в смежных (внешних) сетях и погрешностей тракта измерений. В результате совместного воздействия этих двух факторов оно может составить 3..5 % $U_{ф\ ном}$.

Принимая во внимание возможность появления напряжения нулевой последовательности под действием всех отмеченных факторов, как правило, выбирают:

$$Uсз = 0{,}15\ U_{ф\ ном}. \quad (5)$$

Напряжение срабатывания реле определяется с учетом коэффициента трансформации трансформатора напряжения k_{TV}:

$$U_{СР} = Uсз / k_{TV}. \quad (6)$$

При стандартном значении максимального выходного напряжения трансформатора (фильтра) напряжения нулевой последовательности 100 В, напряжение срабатывания реле равно 15 В. Это значение напряжения срабатывания иногда устанавливается без расчетов, т.к. оно соответствует минимально возможному напряжению срабатывания реле типа РН-53/60Д, используемого в защитах.

Изменения в схеме электроснабжения кишлака Шампан

Для устранения недостатков в схеме электроснабжения кишлака Шампан необходимо проведение следующих изменений:

- Уменьшить протяженность сети 0.4 кВ;
- Уменьшить единичную мощность трансформаторных подстанций при одновременном увеличении их числа;
- Повысить установленную мощность, приходящуюся на один дом кишлака;
- Увеличить протяженность сети 10 кВ;
- Трансформаторные подстанции соединить по петлевой распределительной схеме;
- Все линии электропередач выполнить самонесущими изолированными проводами типа СИП или кабелем.

Выбор числа, мощности трансформаторных подстанций и схемы распределительной сети 10 кВ

Мощность, приходящаяся на одного абонента в кишлаке шампан колеблется от 6,25 кВА до 1,25 кВА. Последняя мощность явно недостаточна, если учесть насыщенность домов различными электрическим приборами. Недостатком сельских электрических сетей 0,4 кВ является большая их протяженность. Поэтому нами предложено резко снизить разовую мощность трансформаторных подстанция до 25 кВА и заложить в проект установленную мощность одного дома равную 4 кВт. В этом случае от одного трансформатора будут запитаны 6 домов. При количестве 370 домов в кишлаке суммарная установленная мощность всего кишлака будет равной 1480 кВА, а количество трансформаторов – 60.

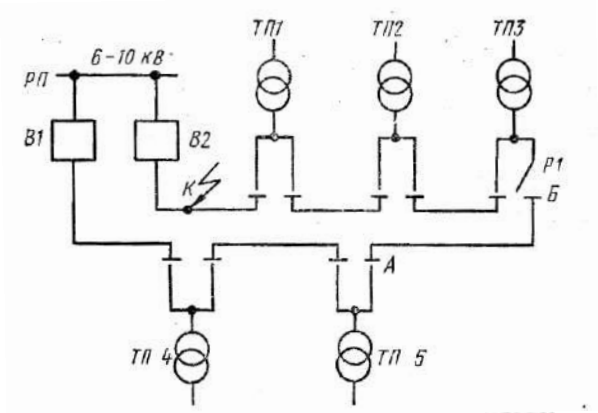

Рис.5.Петлевая распределительная линия с питанием от двух фидеров 10 кВ подстанции 35/10 кА «Шампан»

Для бесперебойного снабжения абонентов кишлака все трансформаторные подстанции необходимо разбить на 4 группы в которых трансформаторы соединить по петлевой распределительной схеме с питанием от двух фидеров трансформаторной подстанции 35/10 кВ «Шампан» (рис.5).

Для повышения надежности электроснабжения примем распространенную в крупных городах распределительную сеть 6-10 кВ, выполненной по петлевой схеме. Эга схема не автоматизирована, но создает возможность двустороннего питания каждой трансформаторной подстанции. Поэтому петлевая схема применяется для электроснабжения электроприемников 2-й и 3-й категорий.

Петлевой линией в распределительной сети называют линию, имеющую двойное питание. Работая по разомкнутой схеме, она может питаться либо от одного, либо от двух РП. На рис. 5 изображена петлевая распределительная линия, питающаяся от одного РП. В нормальном режиме петлевая линия разомкнута разъединителем Р1 и каждая магистральная линия питается от РП независимо. При повреждении какого-либо участка на одной из линий автоматически отключается масляный выключатель В1 или В2 и прекращается питание всех потребителей, присоединенных к этой линии. Найдя место повреждения, этот участок отключают разъединителями и, замкнув перемычку А—Б, разъединителем Р1 восстанавливают питание потребителей. Для такой линии самое тяжелое повреждение бывает в точке К, так как питание всей нагрузки осуществляется по одной линии. Чтобы провода могли выдержать увеличенную нагрузку, необходимо сделать проверочный расчет линии на нагрев по аварийному режиму. Кроме того, необходимо проверить линию на потерю напряжения. Количество трансформаторных подстанций, присоединяемых к одной петле, не должно быть более 10—12 (т. е. 5—6 подстанций на линию). Недостаток петлевой схемы заключается в том, что в нормальном режиме резервная перемычка не используется для передачи энергии.

Выбор реклоузеров для схемы электроснабжения кишлака Шампан

Слово «реклоузер» еще лет десять назад было абсолютно незнакомым и ставило в тупик многих энергетиков. Сегодня же оно стало привычным и даже модным. В действительности, реклоузеры под названием пункт секционирования воздушных линий существовали с начала 60-х годов прошлого века. Тогда они использовались почти исключительно энергоснабжающими организациями для обеспечения бесперебойного электроснабжения предприятий и населенных пунктов, подключенных к воздушным линиям

электропередачи. Из-за больших габаритов и высокой стоимости конечными потребителями эти устройства не использовались.

Рис. 6. Реклоузер РВА/TEL "Таврида Электрик"

Настоящая революция произошла после появления компактных и быстродействующих вакуумных выключателей. Это позволило сделать реклоузеры малогабаритными, с возможностью размещения непосредственно на опоре ЛЭП, а также в значительной мере позволило автоматизировать работу пунктов секционирования, которые стали именоваться автоматическими пунктами секционирования - АПС. При этом АПС приобрели главную черту, которая сделала их реклоузерами - АПС стали необслуживаемыми, то есть не требовали регулярного присутствия персонала. Пионером в продвижении реклоузеров в нашей стране является компания "Таврида Электрик" - производитель вакуумных выключателей. Первоначально вакуумные выключатели разрабатывались для применения на подводных лодках, но потом очень пригодились и на суше (рис.6).

Реклоузеры РВА/TEL "Таврида Электрик" отличаются высоким качеством и включают ряд уникальных технических решений, но представляют собой достаточно дорогие устройства. В последнее время на рынке появилось много независимых производителей реклоузеров, которые используют как вакуумные выключатели ВВ/TEL "Таврида Электрик", так и выключатели других отечественных, а также зарубежных производителей.

Реклоузер состоит из двух частей: высоковольтного модуля (ВМ) и шкафа управления (ШУ), связанных между собой соединительным кабелем.

Высоковольтный модуль установлен в верхней части опоры и подключен к линии через проходные изоляторы. Внутри высоковольтного модуля находятся: вакуумный выключатель, трансформаторы тока и трансформатор собственных нужд.

Шкаф управления устанавливается в нижней части опоры на высоте человеческого роста. В нем находится микропроцессорное устройство защиты и органы ручного управления реклоузером.

Алгоритм работы реклоузера следующий. Трансформаторы тока, установленные в высоковольтном модуле, измеряют ток в линии и по передают сигнал на терминал защиты, находящийся в шкафу управления.

Микропроцессорный терминал защиты сравнивает ток в линии (а также, возможно, другие параметры) с заданными уставками. Если текущие параметры линии выходят за границы заданного диапазона, терминал защиты выдает команду на отключение вакуумного выключателя, который разрывает цепь. Но на этом работа реклоузера не заканчивается.

Терминал защиты выдерживает заданный промежуток времени, например, 1 секунду, и подает на вакуумный выключатель сигнал на повторное включение (автоматическое повторное включение - АПВ). Если неисправность на линии после отключения не самоустранилась, то с трансформаторов тока на терминал снова приходит "тревожный сигнал", и защита снова отключает линию. Так повторяется от одного до трех раз, в зависимости от настроек реклоузера. Если автоматическое повторное включение не помогло устранить неисправность, то реклоузер отключает линию, передает по линии связи сигнал в диспетчерскую и ждет приезда ремонтной бригады, которая устранив неисправность на линии, вручную включает реклоузер. Согласитесь, это выглядит очень красиво - почти искусственный интеллект!

Расчет технико-экономические показателей от повышения качества электрической энергии, надежности электроснабжения и электробезопасности в кишлаке Шампан

Разработанные вопросы обеспечения качества электрической энергии, надежности электроснабжения и электробезопасности не подлежат прямой экономической оценки, ввиду необходимости составления полной проектной и сметной документации. Поэтому экономический расчет проведем при сравнении стоимости потерь электроэнергии в существующей схеме электроснабжения со стоимостью потерь в разработанной схеме электроснабжения.

Потери энергии в линиях электропередач определяются как произведение сопротивления проводника R на квадрат среднего значения протекающего по проводам тока I^2 в течении 24 часов:

для однофазной сети

$$W_i=24(R_{пр.i}\ I_i^2);$$

для трехфазной сети

$$W_i=3\bullet24(R_{пр.i}\ I_i^2).$$

Ввиду сложности определения среднего значения тока протекающего по проводам в течении суток, воспользуемся произведением квадрата максимального тока и временем использования максимальной нагрузки (8 часов), тогда:

для однофазной сети

$$W_i=8[R_{пр.i}\ (\Sigma P^2_{уст}/U^2)];$$

для трехфазной сети

$$W_i=8\bullet3[R_{пр.i}\ (\Sigma P^2_{уст}/U^2)].$$

Здесь $\Sigma P_{уст}$ – установленная мощность всех потребителей, кВт;

U – фазное напряжение сети, В.

Таблица 5.

Расчет потерь электрической энергии в существующих сетях 10/0,4 кВ в электрической сети кишлака Шампан

Uсети, В	Длина, м	$R_{уд}$, Ом/км	$R_{пр}$, Ом	$\Sigma P_{уст}$, кВт	W_i кВт•час	Ц, тыс.сумм в год
10000	2310	0,92	6,38	950	1.38	
220	8400	1,28	32,26	950		
220	4600	1,98	27,32	950		
220	1200	3,16	11,38	950		
Σ			70,76	950	31,67	
Σ					**33,05**	**4825**

В расчетах потерь энергии в проводах по разработанной схеме электроснабжения суммарная мощность абонентов кишлака была принята равной 1480 кВА, из расчета 4 кВА на одного абонента. Общую длину сети 10 кВ приняли равной 3 км. Сеть 10 кВ выполняется проводом типа СИП-3 с тремя алюминиевыми жилами сечением 35 мм^2. Общую длину сети 0,4 кВ, ввиду незначительной длины, ориентировочно приняли равной 1200 м. Результаты расчетов приведены в таблице 3.3.

Таблица 6.

Расчет потерь электрической энергии в разработанных сетях 10/0,4 кВ в электрической сети кишлака Шампан

Uсети, В	Длина, м	$R_{уд}$, Ом/км	$R_{пр}$, Ом	$\Sigma P_{уст}$, кВт	W_i кВт•час	Ц, тыс.сумм в год
10000	3000	0,92	2,76	1480	2,99	
220	1200	1,2	1,44	1480	1,56	
Σ					**4,55**	**664**

Анализ проведенных расчетов показал, что кроме обеспечения качества электрической энергии, надежности электроснабжения и электробезопасности, разработанная схема электроснабжения кишлака Шампан позволяет за счет снижения потерь в электроэнергии в сети снизить затраты на потери электрической энергии в распределительных сетях на **4825 – 664 = 4 161 тыс. сумм.**

ЗАКЛЮЧЕНИЕ

1. Основным преимуществом самонесущих изолированных проводов является возможность их монтажа на уже находящиеся в эксплуатации опоры. Для этого необходимо использовать поддерживающие, натяжные, ответвительные и соединительные зажимы и другие элементы линейной арматуры для крепления СИП к опорам.

2. Сельскохозяйственные производственные, животноводческие и птицеводческие помещения, насосные станции, можно с большей вероятности отнести к особо опасным помещениям. То же самое относится и к бытовым электроустановкам. Особенно если электроустановку монтируют и эксплуатируют в помещениях без изолированных полов (коровники, птичники, кладовки, летние кухни, бани, душевые и т.п.

3. Основной причиной данного положения является использование в сетях 220/380 В глухо заземленную нейтраль и четырех проводную сеть (3 фазных провода и один нулевой) это обуславливает то, что более 95 % несчастных случаев связанных с поражением электрическим током происходит при в цепях фаза-земля, или фаза заземленные корпуса

электроустановок. Отсюда единственным способом устранения смертельных случаев и электротравматизма является изолировать сеть от земли и использовать два нулевых провода: рабочий и защитный.

4. Защита от однофазных замыканий на землю может быть реализована на основе двух разных подходов. Во-первых, путем общего (неселективного) контроля состояния изоляции сети относительно земли. Во-вторых, избирательно (селективно) действующими средствами, выявляющими замыкания на землю на отдельных присоединениях.

5.Для контроля напряжения нулевой последовательности часто используется фильтр напряжения нулевой последовательности, построенный на основе трехфазного трансформатора напряжения, вторичные обмотки которого соединены по схеме разомкнутого треугольника.

6. Для устранения недостатков в системе электроснабжения кишлака Шампан необходимо: уменьшить протяженность сети 0.4 кВ; уменьшить единичную мощность трансформаторных подстанций при одновременном увеличении их числа; повысить установленную мощность, приходящуюся на один дом кишлака; увеличить протяженность сети 10 кВ; трансформаторные подстанции соединить по петлевой распределительной схеме; все линии электропередач выполнить самонесущими изолированными проводами типа СИП или кабелем.

7. Поэтому нами предложено резко снизить разовую мощность трансформаторных подстанция до 25 кВА и заложить в проект установленную мощность одного дома равную 4 кВт. В этом случае от одного трансформатора будут запитаны 6 домов. При количестве 370 домов в кишлаке суммарная установленная мощность всего кишлака будет равной 1480 кВА, а количество трансформаторов – 60. Для бесперебойного снабжения абонентов кишлака все трансформаторные подстанции необходимо разбить на 4 группы в которых трансформаторы соединить по петлевой распределительной схеме с питанием от двух фидеров трансформаторной подстанции 35/10 кВ «Шампан».

8. Разделение воздушной линии на секции производилось с помощью пунктов секционирования – реклоузеров. Появление компактных и быстродействующих вакуумных выключателей позволило сделать реклоузеры малогабаритными, с возможностью размещения непосредственно на опоре ЛЭП, а также в значительной мере позволило автоматизировать работу пунктов секционирования, которые стали именоваться автоматическими пунктами секционирования - АПС.

9. Анализ расчетов технико-экономических показателей выявил, что кроме обеспечения качества электрической энергии, надежности электроснабжения и электробезопасности, разработанная схема электроснабжения кишлака Шампан позволяет за счет снижения потерь в электроэнергии в сети снизить затраты на потери электрической энергии в распределительных сетях на **4825 – 664 = 4 161 тыс. сумм.**

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[16]. E-mail: ilqam.enerqy@mail ru

[17]. www.servomatik.com - iafo@servomatik.com

УЛУҒ ИНСОН ВА ЭНГ ЯҚИН ДЎСТИМ ҲАҚИДА АЙРИМ ТАЪСУРОТЛАРИМ

Қурбон Чариев

“ТИҚХММИ” миллий тадқиқот университети профессори, и.ф.д., профессор

Ҳаёт даврида бўлғуси авлод учун бой мерос, шогирд ворислар, яқин кишилари қалбида чуқур ўчмас из ва ҳурмат қолдириш шарафига муяссар бўла оладиган, Аллоҳнинг назари тушган, гўзал инсоний фазилат ва хислатлар соҳиби, таниқли олим бўлиш ҳаммага ҳам насиб этмайди. Қадрдоним, маслакдошим ва энг яқин Дўстим Ўктам Пардаевич ана шундай инсонларнинг ёрқин намоёнда ва тимсоли сифатида бутун умрини эзгуликка, инсонларга яхшилик қилишга бағишлаган талантли раҳбар ва мехрибон мураббий даражасида сермазмун ва серқирра ҳаёт кечириб ўтдилар (Аллоҳ рози бўлсин).

Ўктам Пардаевич билан илк бор бундан 34 йил муқаддам Ўзбекистон (аввалги собиқ Ўрта Осиё) қишлоқ хўжалиги иқтисодиёти илмий-тадқиқот институтида танишганман. Биринчи суҳбатдаёқ бу инсоннинг бирданига асосий мақсадга ўтиши ва бунинг сабабларини қисқа баён эта олиши менинг эътиборим ва ҳурматимни қозонган эди. Маълум бўлишича ушбу танишишга қадар Ўктам Пардаевич менинг ресурслар назарияси, қишлоқ хўжалиги ресурс салоҳияти иқтисодий категориясига бағишланган докторлик диссертациям ва бошқа илмий асарларимни ўрганганларини, шу йўналишда илмий-тадқиқот олиб бориш истаги борлигини билдириб, илмий маслаҳатчи бўлишга розилик сўраган эди. Бу таклифни мен хурсандчилик билан қабул қилганман, бунинг асосий сабабларидан бири шунда эдики, дастлаб республикамиз шароитида академик Жорилқоган Медутуллаев (Алоҳ рози бўлсин) агросаноат мажмуи салоҳияти (агропрмышленный потенциал) мавзусида илмий-тадқиқот ишлари олиб борган, кейин эса қишлоқ хўжалиги ресурс салоҳияти бўйича тадқиқотни давом эттириш менга насиб этган эди.

Ўктам Пардаевичда ушбу мавзу ва у билан боғлиқ муаммолар бўйича чуқур билим мужассам бўлганлиги ва ресурслар назарияси бўйича яна бир иқтидорли тадқиқотчи шаклланганлиги мени қувонтирган эди. Шунинг учун ҳам қисқа вақтда Дўстимнинг докторлик диссертациясининг архитектоникаси ва иш режаларини тузиб биргаликда иш бошлаганмиз. Эътиборли томони шундаки, бизнинг ишларимиздан фарқли равишда ўзининг диссертациясини аграр сектор салоҳияти муаммоларига бағишлашини айтиб, ўз фикри ва ғоясига эга эканлигини асослаб берган эди. Ва ниҳоят 2003 йилда диссертация муваффаққиятли ҳимоя қилинган ва Ўктам Пардаевич иқтисод фанлари доктори илмий даражасини олишга муяссар бўлган эди. Ўзбекистон иқтисодий илм-фан соҳасида яна бир талантли ва таниқли олим сифатида Ўктам Пардаевич кейинги илмий фаолиятини қишлоқ ва сув хўжалиги ихтисослигида фалсафа ва фан докторлари тайёрлаш масалаларига алоҳида эътибор қаратди. Бу инсоннинг ташаббуси ва саъй-ҳаракати натижаси ўлароқ институтда 08.00.04-Қишлоқ хўжалиги иқтисодиёти ихтисослигида Илмий кенгаш ташкил этилди ва бугунга қадар фаолият кўрсатиб келмоқда.

Узоқни кўра оладиган, янгиликларга интилувчан Ўктам Пардаевичнинг яна бир таҳсинга сазовор ишларидан бири сифатида нуфузли хорижий олий таълим ва илмий-тадқиқот муассасалари билан ўзаро интеграция алоқаларини ривожлантириш, иқтидорли маҳаллий ёшларни чет элларда таҳсил олишга ва уларни доимий қўллаб-қувватлашга қаратилган фаолиятини алоҳида эътироф этиш лозим. Умуман, қадрдон Дўстимнинг илм-фан соҳасидаги ва юқори малакали илмий кадрлар тайёрлаш бўйича жонбозлик кўрсатган ишлари бениҳоя улкан ва уларнинг ҳаммасини ушбу сатрларга сиғдириш мушкул. Шу боис, бу Улуғ инсон билан бошқа масалаларда кўп фикр алмашар эдик.

Жумладан, иш кабинетидаги суҳбатимизнинг бирида мазкур институтни университет мақомида ташкил этиш ва ўша даврда тақдири мавҳум бўлиб турган, бир пайтлар нафақат Ўрта Осиё миқёсида, балки собиқ иттифоқда ҳам нуфузли ҳисобланган Қишлоқ хўжалиги иқтисодиёти ИТИни университет таркибиги олиш таклифини берганимда, бирданига суҳбатни ўзлари давом эттириб, бу борада ташкилий-ҳуқуқий ишлар бошланганини айтган эдилар. Ҳа, бугун Ўктам Пардаевич бошлаган ишлар ва орзу-мақсадлари рўёбга чиқди (Арвоҳи шод бўлсин). Айтгандай, эсимга тушди, шу суҳбатимизнинг охирида, мени кузатиш пайтида қўлимга бир китоб бердилар. Бу нашр ёзувчи Ўктам Ҳакималининг "Яхшилик боғининг боғбони"[20] номли асари экан. Бу китобнинг туғилишида асосий сабабчи ва ташаббускор сифатида Ўктам Пардаевичнинг хизматлари бениҳоя салмоқли. Асарнинг ўзаги ва мазмунини Дўстимнинг падари-бузруквори Парда отамизнинг босиб ўтган ҳаёт сўқмоқлари, сабоқлари ва раҳбарлик фаолияти, шунингдек, бу улуғ инсоннинг ибратли гўзал фазилат ва хислатлари, барчага фақат яхшилик қилганлари, ёрдам берганлари, кадрлар тайёрлаш ва бошқа жабҳалардаги фаолияти моҳирона реал баён қилинган.

Одамийлик, меҳр-оқибат ва меҳрибонлик бобида тенгсиз беназир Ўктам Пардаевичнинг нафақат фарзандлари, балки шогирду-талабаларга ҳам ватанга ва ўз халқига содиқлик туйғуларини сингдириш, сидқи дилдан хизмат қилиш, атрофдагиларга фақат яхшилик қилиш борасидаги тарбияси Парда отамизга бориб тақалишини таъкидлаш жоиз. Парда отамиз 48 ёшда, энг навқиронлик пайтида оддий нотўғри жарроҳлик натижасида бу оламни тарк этган кунда 3 яшар Ўктам тумонат одамлар йиғиларининг сабабини тушина олмаган ҳолда ўзи ҳам шашқатор кўз ёшлар тўккан. Кейинчалик улғайган сари Парда отани таниган, бирга ишлаган кишилардан сўраб-суриштириб тўлиқ маълумотлар тўплаган ва ўзининг барча соҳалардаги фаолиятида уларга асосланган. Буни, масалан, кичик ўғли Сардор Ўктамович тимсолида кўриш мумкин. Умид жамғармаси йўлланмаси билан Англияда таҳсил олган, нуфузли банкларда ишлаган, барча имкониятлар мавжуд шароитда яшаган Сардор 5 йилдан сўнг ўз жоножон Ватанига, халқининг ва ота-онасининг бағрига қайтиб келганлиги аслида аввалombор Ўктам Пардаевич ва меҳрибон Онаси Замирахоннинг тўғри тарбиясининг маҳсули эканлигини таъкидлаш ўринли.

Умуман, Ўктам Пардаевич табиатан ўта камтар, самимий, ҳар қандай ёшдаги кишилар билан умумий тил топа олган, суҳбатдошини сабр билан охиригача тинглаб кейин ўзининг фикр-мулоҳазаси ва қарорини айтган, бирга ишлаётган барча каттаю-кичик кишиларга доимо яхшилик ва ғамхўрлик кўрсата олган, шогирдларига ҳам талабчан, ҳам доимо ўз ёрдамларини аямаган меҳрибон мураббий, эл-юрт манфаатларини ўз манфатларидан устун қўйган фидойи инсон бўлганлари ҳеч кимга сир эмас. Шунинг учун ҳам, ўз даврининг етук раҳбари ва иқтисодчи олими, бағри кенг комил инсон Ўктам Пардаевичнинг ёркин хотираси ҳамиша қалбимизда муҳрланиб қолади.

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USE OF ELEMENTS AND ALGORITHMS OF INTELLIGENT SUPPORT IN THE AUTOMATION OF TECHNOLOGIES FOR CONTROL AND QUALITY MANAGEMENT OF BULK MATERIALS

1st **Polvon I. Kalandarov** *Department "Automation and control of technologyprocess in production"«Tashkent institute of irrigation and agricultural mechanization engineers» National Research University* Tashkent, Uzbekistan eest_uz@mail.ru

2nd **Shakhnoza R. Ubaydulayeva** *Department "Automation and control of technology process in production"«Tashkent institute of irrigation and agricultural mechanization engineers» National Research University* Tashkent, Uzbekistan ushr@rambler.ru

3rd **Rano T. Gaziyeva** *Department "Automation and control of technology process in production"«Tashkent institute of irrigation and agricultural mechanization engineers» National Research University* Tashkent, Uzbekistan ranogazieva1960@gmail.com

4rd **Nikola N. Nikolov** *Department of Automation, Faculty of Computer Science and Automation Technical University of Varna 1, Studentska Str., 9010 Varna, Bulgaria* nn_nikolov@tu-varna.bg

5rd **Mariela I. Alexsandrova** *Department of Automation, Faculty of Computer Science and Automation Technical University of Varna 1, Studentska Str., 9010 Varna, Bulgaria* m_alexandrova@tu-varna.bg

Abstract

The article deals with the choice of criteria for efficiency, applicability in measuring technology, analytical andconstruction, on the basis of which a methodology for assessing the quality of structures of measuring devices of moisture of materials of the agro-industrial complex is proposed. The standard deviation of the random error characterizing the accuracy of measurements is shown. A complex efficiency criterion is discussed, including the dominant particular parameters: accuracy, reliability, cost, allowing to solve the problem of optimal design of humidity control devices for the materials under consideration. As an optimal option, a differential measuring device is analyzed, which practically eliminates random and systematic errors and makes it possible to design a multiparameter measurement method that considers the features of a heterogeneous environment, such as bulk grain materials of the agro-industrial complex

***Keywords*— design, efficiency criteria, moisture of materials, moisture measurement, error, standard deviation, accuracy, reliability, measuring device**

Introduction

Currently, an extensive material has been accumulated that illuminates the physical foundations of moisture-measuring (high-frequency, ultra-high-frequency) method of measuring the moisture content of various materials of the agro-industrial complex (AIC), numerous designs of measuring devices have been used and proposed for implementation [1-10].

Analysis of literary sources [11-15], as well as a number of scientific studies [16-20] aimed at the development of methods and synthesis of measuring transducers of agricultural materials, there are no data on such important issues of modern instrumentation as the use of efficiency criteria, on the basis of which the quality of measurements is assessed and the structures of moisture measuring devices are optimized.

The construction of private and complex criteria for the effectiveness of information converters (IC) is one of the most important and complex stages of external design [21]. External design of IC is understood as the design of external parameters characterizing the accuracy of measurement, speed, reliability and cost, each of which can be considered as a particular indicator of the quality of IC [22].

Due to the fact that particular indicators characterize the quality of IC only from a certain angle and do not give a sufficiently complete picture of its effectiveness as a whole, in practice they use a complex (generalized) criterion of efficiency $Q = (\text{эффект})/(\text{затраты})$, which connects in the required proportions the main, most important functional and cost particular indicators, such as "accuracy-cost" or "speed-cost" [23].

Various information criteria are used to characterize IC. This is an entropic error, the speed of information transmission, information ability, etc., which have a certain metrological color [24].

On the basis of these information criteria in the theory and technique of information transformation, generalized criteria for the effectiveness of IC are designed, which, along with the accuracy of measurements, also allow to consider the reliability and cost of converters [25].

Proposed Methodology

Automation of production processes, and especially where perishable raw materials are processed, requires the use of express methods for controlling its basic parameters, providing the desired expected effect from the introduction of automation systems. There are still losses due to the lack of means of express determination of the moisture content of raw materials.

For the choice of method and synthesis on their basis, the IC of material moisture control and control of technological processes of industrial processing of agricultural materials allows us to conclude that humidity plays a dominant role in the formation of the quality of the final product and the optimization of technological processes at various stages of its processing.

For these purposes, in practice, most researchers use the electric (dielcometric) method of measuring the moisture content of bulk materials of the agro-industrial complex. The dielcometric method for measuring the humidity of the materials in question is based on the dielectric constant of the material. Recently, the main task in most cases was given to technical tasks and, to a lesser extent, to scientific ones: the study of the properties of the studied materials as objects of automatic control, the justification of the type of devices and their metrological parameters, based on their properties and grade of agricultural materials and the conditions for their collection, transportation, storage and industrial processing.

Studies of the electrical properties of the grain mass significantly expand the existing understanding of the factors affecting its electrical properties and make it possible to implement scientifically based methods for calculating the parameters of primary transducers and measuring circuits of humidity control devices [26].

Outcomes

To meet the basic requirements of the considered method and build a comprehensive criterion for the effectiveness of IC in [27], a heuristic algorithm for the synthesis of partial parameters of the following type is proposed.

$$Q = \frac{R^{-q_R}\left[\frac{3600}{(\lambda_0+\lambda_{\text{ПИ}})}\right]^{q_H} \cdot B^{q_B} x^{q_T}}{\prod_i [(C_0)_i + (C_{\text{ПИ}})_i q_i}. \quad (1)$$

Where: R is an estimate of the average information performance, characterizing the amount of information about the converted signal into a unit of time, when the measurement accuracy is taken as the dominant parameter;

B – IC performance (number of conversions per second);

x is an uninformative characteristic of accuracy;

C_i- cost parameters;

q_R, q_B, q_H, q_T - Boolean variables that take the value 1 if the corresponding parameter is dominant, and the value 0 - otherwise. Moreover, variables q_R, q_T, q_B, q_i- must satisfy the following ratios:

$$q_R \Lambda q_T = 0, \qquad q_R \Lambda q_B = 0, \qquad q_i \Lambda q_j = 0, \qquad q_T \Lambda q_H \Lambda q_B \Lambda q_i = 0,$$

Where Λ - is the symbol of the logical conjunction operation.

Algorithm (1) allows you to obtain a broadcriterion for the effectiveness of IC, which have the properties of prostate representativeness and versatility, which will later be used in the engineering assessment of the quality of the structures of measuring devices. Mass moisture ratio (MMR) is one of the main qualitative indicators of AIC materials, it is advisable to take the accuracy of measurements as the main particular parameter when building complex efficiency. At the same time, accuracy is a vector parameter determined by the static and dynamic components of the resulting error. The resulting error in this case can be considered as the output signal $W_{(t)}$ of some multifaceted nonlinear dynamical system, the input signals of which are the convertible signal $U_{(t)}$. To characterize the error$W_{(t)}$, we will use such functionalities that reflect individual properties of the error that are of interest in a particular situation. Such functionalities include, in particular, modules of maximum relative and reduced errors, confidence interval, modulus of relative and reduced errors of standard deviation (SD), dispersion of error, etc. [27].

On the basis of the SD, a number of authors [28], in the field of measuring instrumentation - P.N. Novitsky, in the field of analytical instrumentation in the design of fluorescent analyzers - Prof. I.V. Korablev and Prof. M.V. Kulakov, the deviations of the real characteristics of devices from the nominal ones, due to such random factors as the change in the radiation power of the electromagnetic wave, the variation in the transmission coefficients of receivers and radiation amplifiers, etc., i.e. the studied factors caused by the instability of the parameters of the scheme and the intrinsic noise of the IC, on the basis of which the quantitative statistical criterion of the quality of IC is formed - the SD of random error.

Currently, very effective methods forsuppressing systematic error have been developed, for example, the method of periodic verification of two points of the instrument scale, often performed automatically [28] or this error is considered during calibration, or by the substitution method, etc.

From the point of view of the application of coex and the conditions under which this criterion most fully characterizes the quality of IC, we will use the model presented in Fig. 1.

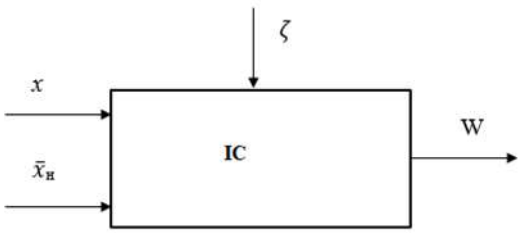

Fig.1. Converter Information Model

Where: *x* is the measured value;

W – measured output signal;

$\bar{x}_n$ – uninformative influencing factors;

$\bar{\zeta}$ – IC's own noises.

From Fig.1 it can be seen that the output signal of IC depends not only on the measured value *x* but also on the parameters of IC, the conditions under which the conversion is carried out

(temperature, pressure, ambient humidity, etc.), i.e. uninformative parameters $\bar{x}_{\text{п}}$ ($\bar{x}_{\text{п}} + x = 1$) and own IC noise. $\bar{\zeta}$

Considering the listed characteristics of the transformation functions, we will write in the following form

$$W = f_1(x, \bar{x}_{\text{п}}, \bar{U}, \bar{\zeta}). \qquad (2)$$

Where $\bar{U}$ determines the IC parameters and external measurement conditions. The type of function $f_1$depends on the method of analysis and the structure of the IC. The ratio (2) is a mathematical model of the IC. This model may be adequate to the real IC when measurements $\bar{U}$ change significantly slowly than transients are established in IC, i.e. when there is at least a quasi-static measurement regime. When quasi-static is performed, vectors $\bar{x}_{\text{h}}$ $\bar{U}, \bar{\zeta}$ are random variables. Therefore, under real conditions, the response of W IC is a random value (even with a fixed but unknown *value of x*). This fact leads to the involvement of statistical criteria for the quantitative assessment of the quality of IC.

If the deterministic function $\widehat{W}(x)$ is called the nominal (average) value of IC, which characterizes the transformation *of x* to W_B of nominal conditions, i.e. when the vectors $\bar{x}_{\text{h}}$ have $\bar{U}$ a nominal value $\hat{\bar{x}}_{\text{of n}}$, $\hat{\bar{U}}$, and there is no eigenstate noise ($\zeta = 0$), then provided that there are few deviations $\overline{\triangle x_{\text{н}}} = \bar{x}_{\text{п}} - \hat{\bar{x}}$; $\overline{\triangle U} = U - \hat{\bar{U}}$; of the nominal conditions ($\delta x_{\text{н}} = \frac{\overline{\Delta x_{\text{н}}}}{\bar{x}} \ll 1, \delta U \ll 1$) the expression (2) at fixed *x* can be decomposed into a series by the powers of the increments$\bar{x}_{\text{h}}$, $\bar{U}, \bar{\zeta}$.

Limiting ourselves to linear approximation (due to the smallness of deviations $\bar{x}_{\text{н}}$, $\bar{U}, \bar{\zeta}$) in the vicinity of the nominal point with coordinates $\hat{\bar{x}}_{\text{н}}$, $\hat{\bar{U}}$, , $\bar{\zeta}$ we get

$$\Delta W = W - \hat{\bar{W}} = \frac{dW}{dx_{\text{н}}}\left|\hat{\bar{W}} \cdot \overline{\triangle x_{\text{н}}} + \frac{dW}{dU}\right|\hat{\bar{W}} \cdot \overline{\triangle U} + \frac{dW}{d\zeta}\left|\hat{\bar{W}} \cdot \zeta\right. \qquad (3)$$

Where: ΔW- uncontrolled deviations of the signal W from nominal $\hat{\bar{W}}$, caused by random factors $\overline{\triangle x_{\text{н}}}$, , $\overline{\triangle U}$ ζ.

The value ΔW characterizes the error IC reduced to its output. with a fixed *x* , the error ΔW causes an error in the evaluation of the measurements of the value *x*

$$\Delta W = \frac{dW}{dx} = \hat{S} \cdot \Delta x.$$

Where: $\hat{S} = \frac{dW}{dx}\left|\widehat{W}\right.$ – nominal sensitivity of IC.

$\Delta x = x - \bar{x}$ - Absolute error in estimating *x*.

A quantity Δx (as well as ΔW) a random one; the properties of this quantity in static mode are characterized by a mathematical expectation of $M\{\Delta x\} = \Delta C$i.e., the probability of a quantity. the current mean determines the systematic error of the set of similar IC and the measure of scattered quantities Δx about ΔC

$M\{[\Delta x - M\{\Delta x\}]^2\} = \delta^2 \Delta x$, the positive value with which

$$\sigma_{\Delta x} = \sqrt{M\{[\Delta x - M\{\Delta x\}]^2\}}$$

is called the SKO of random error IC [30]. Indicators ΔC and $\sigma\Delta x$ - quite fully determine the properties of IC and in accordance with GOST 8.009-84 are standardized metrological characteristics.

Currently, there are quite effective ways to suppress systematic error ΔC, so the presentation is allowed $\Delta C = 0$. In this case, the main criterion for the quality of measurements will be the SD of random error $\sigma_{\Delta x}$, which characterizes the potential accuracy of IC.

Other most important external parameters of the IC can be speed and reliability. However, if accuracy is the dominant parameter, then the speed may not play a dominant role due to the fact that at a given input signal of the IC it is uniquely related to dynamic errors, which are considered when assessing the accuracy of the IC.

It follows that performance can only be dominant when accuracy does not play a dominant role.

The reliability of IC can be considered in relation to catastrophic and permanent (degradation) failure.

CONCLUSIONS

From the analysis of patent and scientific and technical literature [33-35] it can be noted that on the basis of the construction of measuring circuits, analog devices for monitoring the humidity of agricultural materials are divided into single-channel, with a direct reading of the physical quantity, bridge, operating in differential mode and compensatory, with a zero-measurement method.

It follows that the construction of structural diagrams in analytical instrumentation and, consequently, the method of assessing the quality of luminescent analyzers with some changes can be used to assess the quality of measuring instruments based on the dielcometric method for various materials of the agro-industrial complex. At the same time, we believe that it is advisable to assess the effectiveness of structures on the basis of a comprehensive performance criterion, which includes the SD criterion as a particular external parameter. This most fully characterizes the developed and further design of measuring instruments.

Based on the analysis of existing methods and devices for controlling the humidity of agricultural materials, the criteria for assessing the accuracy of measuring transducers of the electrophysical properties of bulk materials have been substantiated; a methodology for calculating their transformation characteristics has been proposed; a mathematical model of the primary transducer of the capacitive sensor of technological parameters has been obtained, on the basis of which the conditions for achieving the highest sensitivity of the conversion characteristics of the primary transformation have been obtained. Converter.

The evaluation is based on a comprehensive efficiency criterion, including the dominant single indicators: accuracy, reliability and cost of the designed humidity control devices both in discrete mode and as part of an automated system of technological processes.

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DIETARY DIVERSITY FOR ENSURING FOOD SECURITY

Fotima Saydullaeva, Shavkat Hasanov, **Khusniddin Pardaev**, **Shukrullo Muratov**,

[1, 4] *"Tashkent Institute of Irrigation and Agricultural Mechanization Engineers" National Research University*

[2,3] *Samarkand branch of Tashkent State Agrarian University*

Annotation

10.8% of population in the world or more than 840 million people are undernourished. The report of the FAO (Food and Agriculture Organization of the United Nations) states that although population growth has been slowing down in recent years, this growth is expected to increase in some countries until 2050.There is a high emergency of increasing food insecurity all over the world. In the case of Uzbekistan, the population is growing rapidly annually. Yet, in the country prevalence of both obesity and overweight are increasing. Additionally, micronutrient deficiencies remaining at a high level both women reproductive age and children. In this article, one of the best indicators of food security in respect of food access Dietary Diversity Score (DDS) used in order to analyze and spread healthy diet in rural households of Samarkand region. Total 140 observations were taken from rural households. Mean Households DDS was 8.2. Results indicated most of food groups consumed through own production. Though more than 50% of all members living in the households did not consume any fruits, greens, pulses and legumes due to lack of food access. It seems, there is a positive correlation between dietary diversity and own production in some circumstances, but not in all cases. In that case, own production positively associated with dietary diversity in some situations, but not in absolutely. Nevertheless, appropriate nutrition sensitive agricultural programs will encourage both food production and consumption. Analysis shows nutrition information have a significant role in improving DDS. Promoting nutrition education via interventions for example information on healthy eating and well-balanced diet by the way of mass media, educational institution curriculum, field days to upgrade better nutrition at household and individual level.

Key words: Dietary diversity score, nutrition information, household, Samarkand region.

Introduction: Agriculture plays crucial role in sustainable food supply of the world's population. Although the positive effects of technological changes increased food productivity in this sector recent years there are still cases of hunger and malnutrition in the world. 10.8% of the population in the world or more than 840 million people are undernourished [1]. The report of the FAO (Food and Agriculture Organization of the United Nations) states that although population growth has been slowing down in recent years, this growth is expected to increase in some countries until 2050 [2]. In the case of Uzbekistan, the population is increasing rapidly annually and according to the end of 2021, the population exceed 35 million and got leading dominance among the countries of Central Asia[3]. However, the level of undernutrition decreased from 16.2% in 2002 to 2.5% by 2020[4]. But the rate of obesity in the country is increasing annually. The Ministry of Health of the Republic of Uzbekistan reported that 51% of the population is overweight, and 28% have a higher level of obesity. The regulation on the procedure for organizing the activity of the "Healthy Lifestyle" platform was approved in 2021 in order to solve the obstacle in the country and prevent it from increasing in the future[5]. According to the regulation, 3000 sums will be transferred to the electronic wallet of the citizens of Uzbekistan aged 18 and older who walk ten thousand or more steps in one day in the territory of Uzbekistan. In addition, various marathons on walking are held in of all organizations in the country.

Nevertheless, many programs are being implemented to support a healthy lifestyle and sport, at the same time, the lack of micronutrients in the population remains at a high level.

Sadly, 1/4 children under the age of two is anemic, 75% of these cases are as a consequence of iron deficiency [6]. The level of iron deficiency in teenage girls was almost 50 percent, and it was also found that women of reproductive age in Uzbekistan suffer from strong hidden hunger [7]. 1/5 non-pregnant women is anemic and deficient in vitamin B12. 50 % of women in reproductive age experience folate deficiency. Cause of these deficiency is unhealthy diet can be explained. Because, FAO and WHO experts mutually recommended at least 400g of fruit and vegetables intake per day (except starchy tubers, potatoes and other) for protection of various chronic illnesses and mitigate several micronutrient deficiencies [8].

Furthermore, mostly rural households are vulnerable in terms of food insecurity. Therefore, we considered our research at a rural household level. Previous empirical research at rural households' levels have been conducted topics related to nonfarm income[9] and analysis of the possibility of contract sales of farm products[10], diversification of smallholders agricultural production[11]. However, food security research has been conducted more at the national level than at the household level [12].

In this article, we intend to determine food access using DDS offered by international organizations in the case of rural households and provide a broad overview of its possibilities. Based on the above food security and nutrition problems, we addressed to find out following research questions: 1. Which aspects effect dietary diversity in the country? 2.Does nutrition information have association with improvement of dietary diversity? Our hypothesis that, there are positive association with farm production and nutrition information in rural areas in Uzbekistan.

Materials and methods.

The research was conducted in Samarkand province which is a major agricultural area in Uzbekistan, which agricultural production share was the highest (12.9 percent) in 2021. Data collection through in-person interviews, started from January up to end of March 2021. 140 respondents were randomly selected regarding the methodology of collecting DDS data in nine districts (Akdarya, Bulungur, Ishtixan, Jambay, Kushrabat, Payarik, Pastdargom, Taylak, Urgut) of Samarkand province.

Table 1

Data collection by districts

District name	Number of households interviewed
Akdarya	19
Bulungur	20
Ishtixan	15
Jambay	26
Kushrabat	4
Pastargom	6
Payarik	18
Taylak	17
Urgut	15
Total	140

Source: Data from the survey conducted by authors in 2021.

In this article, one of the best indicators of food security in respect of food access DDS [13]used in order to analyze and spread healthy diet in rural households of Samarkand region. Since it has been verified that DDS reflects the both physical and economical food access, the

adequacy of nutrients in the diet as a result of several previous scientific and practical studies[14].

Methodological usage and calculation of the DDS was developed by international organization Food and Agriculture (FAO) in 2010 on the framework Food and Nutrition Technical Assistance (FANTA) project[15]. According to the guidelines there are several crucial points and requirements in order to get correct data during a survey. Thus, we constructed and conducted this research under the following requirements.

1.We took consideration to measure of DDS at the household level, information given from a respondent covers a period previous 24 hours. As a result of the conducted research, the most optimal period of 24 hours was highlighted, due to the reduction of incorrect answers by the respondents and the ease of recall [16,17,18].

2. It is important to focus on consumption patterns when creating DDS. We took into account the usual daily food consumption in household, unusual days, such as holidays, weddings, and Ramadan, did not coincide with periods that affect food patterns. Also, the source of food is as follows will indicate food access more clearly: *1=self-grown; 2=bought is specified*. We considered all household members consumed food at home in this period. Since, it is not possible to capture accurately DDS at household level.

3. In addition it is essential to categorize food intakes. Swindale and Bilinsky proposed using data on food intakes categorized into 12 different food groups[15]. The DDS is a count variable that include 12 food groups from 0 to 12. In the paper food groups categorized into cereals, roots and tubers, vegetables, greens, fruits, nuts and pulses, meat, eggs, milk and dairy products, sugar, beverages, oil and fat.

4. When calculating the index of dietary diversity in rural areas, it is appropriate to take a survey in each season, paying attention to seasonality. In several studies, it was considered important the study should hold during the lean period after harvesting the main crop in rural areas, because it was noted that there may be difficulties in ensuring food security during this period.

5. Knowing the names and composition of local foods during the survey made it possible to get accurate information; Several food groups are used at the same time in the preparation process, and there is no need to set minimum amounts of food at the household level, so even a small amount of food (for example, meat included in a mixed meal is very small part) is taken into account. Whereas the score is tailored to reflect the economic access of food, and therefore even a small amount of a food item reflects the ability to purchase that item. Regarding on the technical requirements the above we listed strengths and weaknesses of DDS on Table 2

Table 2

Advantages and disadvantages of DDS

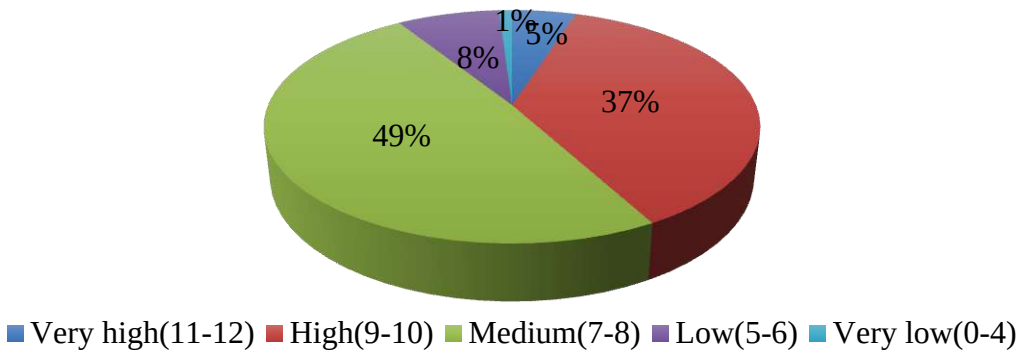
Advantages	Disadvantages
✓ Convenient and easy to use; ✓ It takes less time to get a questionnaire; ✓ Allows monitoring of seasonal changes in food consumption; ✓ It can be determined at individual and household levels; ✓ It is possible to adjust according to rural and urban areas; ✓ It is possible to repeat and compare; ✓ Can determine economic and physical availability of food for households	✓ Does not collect information on quantity; ✓ It is impossible to estimate the extent to which consumption is sufficient in terms of calories.

6. At the household level, the respondent was chosen the person responsible for preparing food for the household on the previous day. The respondent was asked about all the meals eaten at home by all member of the household during the day and night.

Results. Based on the survey results, the household DDS was found an average value of 8,2. According to the 5-point categories of Likert scale [19], out of 49% of HDDS were recorded at the medium level, 37% at the high level, 5% at the very high level, 8% at the low level and 1% at the very low level respectively.

Figure 1

Categorization Households Dietary Diversity by value



Source: Data from the survey conducted by authors in 2021.

Table 3 presents the indicators of Households which largely consumed from food groups included Cereals (100%), Root and tubers (86), Vegetables (98.5%), Oil and fat (98.5), Sugar and sweets (81%), Beverages (84%) respectively. Low consumption among food groups were witnessed on Greens (37%), Eggs (39%) and Fruits (46%). In terms of main source, high consumption of food groups through own production observed Root and tubers (91%), Greens (71%), Nuts and pulses (77%), fruits (70%), milk and dairy products (85%). Contrarily, households' consumption through own purchasing among food groups were meat (96%), sugar and sweets (81%), beverages (95%), Oil and fat (77%).

Table 3

Households' consumption of food groups and its sources, %

Food groups	Consumption		Main source			
	Consumed		Own produced		Bought	
	Nb	%	Nb	%	Nb	%
Cereals	140	100	2	1.5	138	98.5
Root and tubers	120	86	109	91	11	10
Vegetables	138	98.5	80	58	58	42
Greens	52	37	37	71	15	29
Fruits	65	46	46	70	19	30
Nuts and pulses	60	43	46	77	14	23
Meat	100	71	4	4	96	96
Eggs	55	39	24	44	21	56
Milk and dairy products	82	58	70	85	12	15
Sugar and sweet	113	81	21	19	92	81
Beverages	118	84	7	5	111	95
Oil and fat	138	98.5	45	33	93	77

Source: Data from the survey conducted by authors in 2021.

According to the results of the calculations, all respondents engaged in crop growing and out of 82 percent of households engaged in animal husbandry. Additionally, 53 percent of households reported that their main income source comes from agriculture. In sum, households mainly cultivated vegetables, roots and tubers regarding to land sizes. In respect of animal husbandry poultry and cattle rearing were observed to be more common in these households compared to sheep and goats and others.

Table 4

Descriptive statistics of the households' agricultural activities

Types of crop/livestock	Total area each crop (hectare)/number of livestock each group
Vegetables	12.35
Fruits	2.35
Pulses, Legumes and Nuts	1.68
Greens	0.16
Root and tubers	3.95
Cattle	344
Sheep and goat	191
Poultry	544
Other livestock (horse, rabbit)	31

Source: Data from the survey conducted by authors in 2021.

Following previous literatures, we constructed three questions and those questions were asked from each household member which responsible for food preparation and having nutritional knowledge which is important in dietary diversity[20] .

1. Do you aware any health problems or diseases which are related to consuming too much oil and fat products?

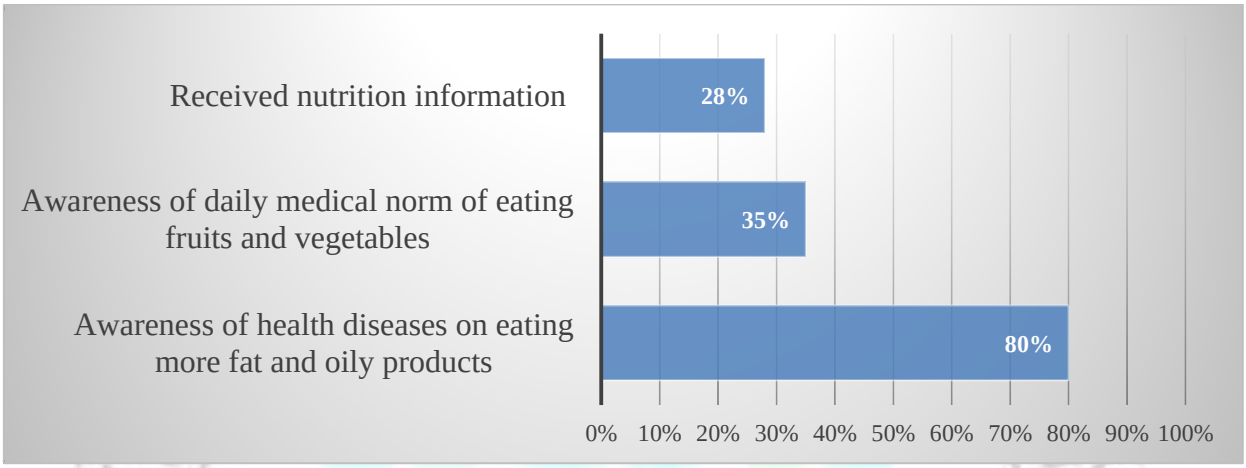
2. In your view, how many grams of fruit and vegetables should be consumed daily by an average person of your age and sex to maintain good health?

3. Do you often get information on nutrition through medical personnel at your location, various training platforms such as health community clubs, digital communication platforms (Telegram, Instagram)

Results in each question presented that 80% of those households' members are aware about health diseases concerning oil and fat consumption, 35% of them know recommended norm of daily fruit-vegetable consumption and only 28 % of households reported that they received nutrition information (Figure 2).

Figure 2

Access of nutrition information of the households



Source: Data from the survey conducted by authors in 2021.

Discussions

As stated by the results, more than 50% of all members living in the households did not consume any fruits, greens, pulses and legumes due to lack of food access. Respectively, other households who consumed fruits, greens, pulses and legumes their main source of consumption of these food groups through own production was higher than 70 percent the day before the survey conducted. It expresses the households have a positive association DDS with own fruit-vegetable production but less economic access for these food groups. Similar results were found in many developing countries [21, 22, 23] Survey results showed high consumption of bread and grain-based products, oil and fat, sweets as traditional Uzbek high energy-dense diet. As a results year by year overweight and obesity rate is increasing in the country. Another point that, lack of nutrition information can lead for the persistence of this diet. Thus, only 28 % of respondents reported that they received the information. We can estimate there is a positive association nutrition information and dietary diversity. Besides that, 35% of them said that they know the recommended norm of daily intake of fruits and vegetables. As well as in the case of Zimbabwe and Ethiopia nutrition knowledge had considerable improvements in households' and individuals' dietary diversity[24]. Hence, increasing promotion of nutrition education, dissemination nutrition information will accelerate households' healthy eating diets.

Conclusions

In summary results indicated most of food groups consumed through own production. Though more than 50% of all members living in the households did not consume any fruits, greens and pulses, legumes were determined by using DDS. In that case, own production positively associated with dietary diversity in some situations, but not in all. Nevertheless, appropriate nutrition sensitive agricultural programs will encourage both food production and consumption. However, Samarkand region has the largest share in the country in terms of agricultural production, in rural areas there is a real shortage of fruits, vegetables, legumes,

and eggs consumption. In order to solve this problem, it suggests to support the cultivation and processing of fruits for year-round harvests (apples, berries, bananas, kiwi) on home gardens. As well as mixed farming practices are important in dietary diversity. The obtained results of the study showed that share of households who received nutrition information is low. At the same time in the world practice, this factor might be significant influence on increasing DDS as well as fruit, greens, pulses and legumes consumption. Further it leads inherent value of promoting nutrition education via interventions for example information on healthy eating and well-balanced diet by the way of mass media, educational institution curriculum, field days to upgrade better nutrition at household and individual level.

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MITIGATING THE IMPACT OF RISKS ON ECONOMIC INTEGRATION BETWEEN ENTITIES IN THE AGRI FOOD SUPPLY CHAIN

Khusniddin Pardaev, **Shavkat Hasanov**, **Shukrullo Muratov**, **Fotima Saydullaeva**,

Samarkand branch of Tashkent State Agrarian University, Samarkand, Uzbekistan

Abstract

The paper aims to assess and reduce the level of risks associated with infrastructure, financial, natural and environmental, farm management and political changes among entities in the smallholder tomato supply chain. Risk darajalarini baholashda mahsulot ishlab chiqarish zanjirida producer, buyer, infrastructure, finance, natural and environmental, management and political changes related uncertainties hisobga olingan. These threats were assessed using Fuzzy Linguistic Quantifier Order Weighted Aggregation (FLQOWA) model. Olingan natijalar shuni ko`rsatdi, production, cooperation, infrastructure and financial masalalarda yuzaga keladigan risk darajalari yuqori bo`lgan. Shu bilan birga, tadqiqotda risk darajalarini pasaytirish choralari ko`rilgan. Natijalarga ko`ra, application "written contract" and "insurance" to collaborative relationships to reduce risk levels has been shown to reduce risks until 0.6 coefficients. The results obtained from this investigation will have a positive effect if policy makers use the applications to increase the economic cooperation between the subjects in STSC.

Keywords: Agricultural Economics, Agricultural Policy, Food Security, Risk Management

JEL code: Q13, Q18

Introduction The agrifood supply chain (ASC) is encompassed inextricably linked blocks of input resource provision, production, packaging and processing, wholesale, and retail trade (Porter, 2021). This system fulfills the task of providing sufficient, safe and stable food products produced in agriculture, which necessary for the consumption of the population and industry. In agriculture, each of products has its own unique characteristics and problems faced by actors in ASC (Constas et al., 2021). These problems arise from various inconsistencies related to climate change, over use of chemical inputs and infrastructure, financial, environmental, management and political changes. As a result, the risks that occur under their influence have a negative effect on the effective operation of the system of delivering the product "from the field to the table" (Gadhok et al., 2020). Such risk factors prevent the implementation of economic relations with partners for producers of agricultural products, as a result, lead to a decrease in their income.

Recently, the COVID-19 pandemic has threatened human lives around the world and has been one of the shocks that have negatively affected the agricultural production chain. In particular, it caused major disruptions in food production and supply chains and destabilized the economies of countries (Aday & Aday, 2020; Pardaev et al., 2021). According to the report of the Food and Agriculture Organization of the United Nations, as a result of the impact of the COVID-19 pandemic, there has been a disruption of the structures of demand and supply of products in the agricultural production chain ((FAO), 2020; Sharma et al., 2020). At the initial stage of the pandemic, the balance of demand and supply of agricultural products was disturbed. The established strong order to protect the population from the disease led to the disruption of economic relations between entities in the chain of production of agricultural products (Hammond et al., 2022).

Risk levels in the production system of agricultural products in Uzbekistan are observed in different forms of farming type (farmers, peasants, estates and agro-firms). There are inconsistencies related to the large scale of production in farmers and agro-firms,

otherways in smallholders, it occurs in economic partners with subjects (Djanibekov & Finger, 2018).

Samarkand region is considered one of the regions that produce the most vegetable products in the republic, and its share in 2020 was 15.6% or 1636.3 thousand tons. Of this, 66.3% of vegetable products are contributed by smallholders. Among vegetable products, tomato is the most cultivated crop, accounting for 31.2% of the total cultivated area.[21] The production and sale of tomatoes by smallholders is somewhat difficult and risky compared to other types of crops. From an objective point of view, such negatives can be distinguished by their small land and the size of the product, the short period of harvesting, the need for special vehicles for the product, the market life is short, and the product price flactuates sharply in different periods of the year.

Unfortunately, today in Uzbekistan, local producers do not have the full opportunity to maintain the product at the level of technical requirements. As a result, at the stages of delivering the product to consumers, the infrastructure facilities are not fully formed (Lombardozzi, 2021; Geoffrey et al., 2014). In most cases, processing companies use their monopoly power to force smallholders to sell their products at low prices (Muratov, 2021). In addition, processing enterprises do not have the opportunity to quickly accept the product during the peak season, they deliberately do not fulfill the terms of the contractual agreements between the entities in order to reduce prices. The long-term transport and storage of tomatoes in transport seriously damages its quality. Unfortunately, in such cases, smallholders are forced to sell the product at a low price, fearing that the product will become unusable.

The article aims to assess and reduce the level of risks associated with infrastructure, financial, natural and environmental, farm management and political changes among entities in the smallholder tomato supply chain (STSC). Based on this, the following questions were answered in order to determine the causes of risks in STPC and to apply measures aimed at mitigationg the level of them: What risk factors affect the cooperation between entities in the tomato production chain? What measures can be treated to mitigate the affects of the high-risk factors? In search of answers to these questions, we identified STSC risks from the existing literature of review, empirical methods were chosen for analysis, data was collected from subjects in the STSC in Samarkand region based on a questionnaire, and a three-stage-scenario experiment was conducted.

In the next part, STSC risks are classified according to their sources, then next section presents the methodology outlining the motivation and fuzziness related to evaluating STSC risks, as well as conducts of materials. The obtained results and their discussion are highlited in the last section.

STSC and its risks classification

In Uzbekistan, smallholders are interconnected in a systematic sequence according to the order of integration between subjects in STSC. It is divided into separate blocks according to the mechanism of participation in the system, they can be divided into the following sections (Fugure 1).

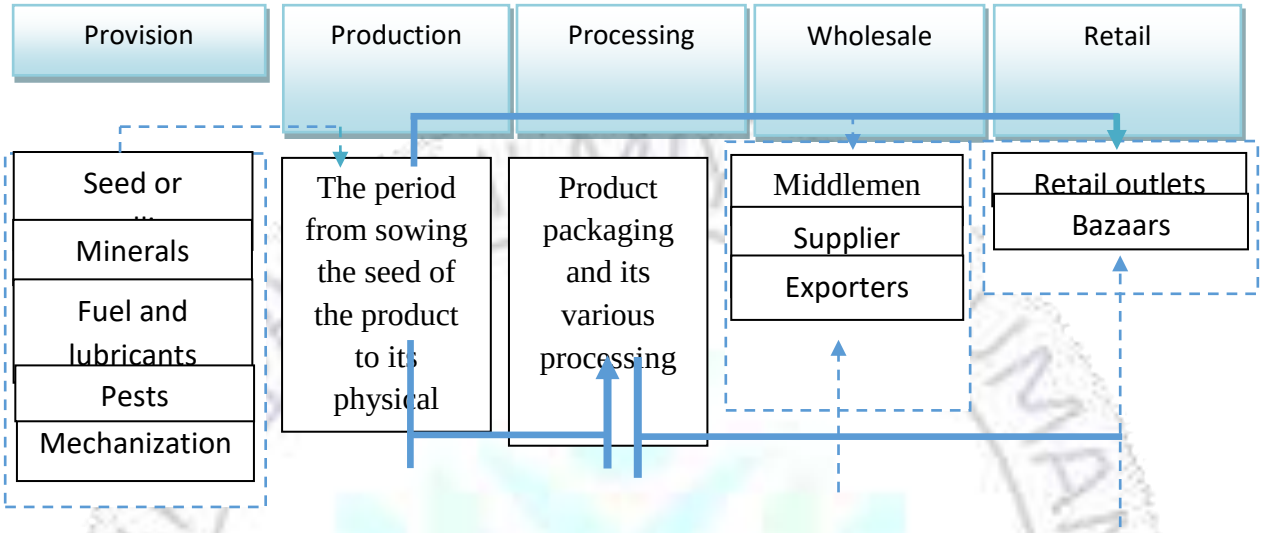
The supply block includes a set of activities for the supply of raw materials for production (seeds/seedlings, fertilizers, fuel and lubricants, chemicals, machinery, etc.). This block directly affects the quantity and quality of the produced products and serves to reduce the excess costs and risks of smallholders (Otsuka et al., 2016). Suppliers of raw materials are divided into groups of buyers and non-buyers of the product. It is more profitable for the smallholder to supply raw materials by suppliers who are buyers of the product, i.e. with customers who have formal (by signing a contract) cooperation (Otsuka et al., 2016; Otsuka et al., 2016; Hernández et al., 2015). In this case, the quality of raw materials is guaranteed,

[21] Statistical department of Samarkand province of Uzbekistan. www.samstat.uz

assistance is provided regarding the technology of its use, and the control mechanism is strengthened. The main participants in the supply block may be:

- smallholders themselves;
- Customers (buyers): processing enterprises; retail outlets; meddlemen; exporters;
- “Томорқа хизмати” LLC, and etc;

In STSC, vertical integration is directly linked to the production unit through the supply of resources.



Fugure 1. STSC in Uzbekistan. The structure of STSC in smallholder is based on the scientific proposals of Michael Porter, who introduced the "production chain" to science in 1985 (Porter, 2011).

The production block includes the production of tomatoes for family consumption and income by smallholders during the summer seasons. According to the Law of the Republic of Uzbekistan on “*dehkan*” farming, that farms produce and sell agricultural products together with family members on owned or leased land.[22] “*Tomorka*” - households are entities that produce agricultural products for family needs or for sale on the market on the plot of land allocated to them.[23] Therefore, they carry out production activities on the land areas seperated to them or on leased land based on legally defined activities, and they supply the resources (seeds, fertilizers, equipment, labor) directly on the farm itself.

Their product sales channels cover the direct or indirect sale of agricultural and household products for consumption or processing. If processing enterprises, outlet stores, bazaars and various social institutions (cantens and restaurants, hospitals, hotels, kindergarten, etc.) are included in the channels of direct sale of the product, middlemens in indirect sales can be included.

In the processing block, the product prepares and readiness to eat - washed, sliced, cut, peeled, trimmed or otherwise prepared in a way that makes it convenient for consumers. Product storage warehouses (refrigerators) safely store vegetable products grown for the population in the winter and spring seasons and provide them for the population`s consumption. Currently, the government is taking a number of measures to increase the warehouses number.

In the wholesale block, middlemen, supplier distributors and exporters are the main player. In Uzbekistan, the number of middlemen in the tomato production chain is

[22] Law of the Republic of Uzbekistan dated April 1, 2021 No. O`RQ-680 "On Dehkan Farms"

[23] Law of the Republic of Uzbekistan dated April 1, 2021 No. O`RQ-681 "On Tomorka Farms"

significantly high. In STSC, they buy the product from the smallholder to the main consumer or buyer (processing companies or retailer). Today, they have become the main buyers of smallholders. It is positive that they serve to deliver the product to the consumers, hovewer, the fact that thay buy the product cheaply and sell it at a high price causes the price of the product to rise. Supplier distributors and exporters work in an official form in the product production chain. It provides guaranteed market and price for producer. Unfortunately, there are very few of them today. Especially since the level of risk in delivering tomatoes to consumers is high, they are less involved in the tomato production chain.

In the retail block, supermarkets and minimarkets are considered as branches of trade services in providing the population with various consumer goods, and in the last 20 years their number has increased dramatically in the country (Porter, 2011). Such trade branches of the modern type are more effective and convenient in implementing economic relations between institutions in the chain of food products than farmers` markets. Bazaars have long been a traditional infrastructure in the food chain, and today they are the main institutions that exchange food products between producer and consumers. Today, their number in the republic is 328, but in the following years, it is planned to transform bazaars into outlet shopping complexes in the form of minimarkets, supermarkets and hypermarkets.

Legal and modern conduct of economic relations between the above-mentioned entities, establishment of parties' agreement, measures to reduce costs and risks are important issues in the country.

As in the production chain of various products, risks in STSC also lead to sudden changes in production, service, decision making of the entities and ultimately the price of the product. The level of risk in the field of agricultural production is higher than in other sector of the economy. Yusupov argues that the field of agricultural production is described as a complex biotechnological and socio-economic system, and the risk level is high as a result of the production process being closely related to natural factors (Юсупов, 2019). Komarek et al., (2020), analyzed the risks that occur in ASC, they found that the risk factors related to production, marketing, institutional, personal and financial processes occur more. Taking this into account, we grouped risks in STSC by sources of formation (Table 1).

In order to determine the strategic directions for reducing and mitigating risks in STSC, it is necessary to determine the directions of risk, sources of formation and links of its influence. Such practice means coordination of economic relations between entities in the system, determination of risk reduction strategy and application of efficiency improvement measures.

Different shocks in ASC emerged as a new factor affecting demand and supply in the chain. Under its influence, the level of risks related to the supply of raw materials, sales, transportation and management have increased (Aday & Aday, 2020).

At the same time, as a result of the instability of the political situation in the regions, the impact points of the risk related to the amount of production, economic cooperation between the parties, opportunities for product realization, and the reduction of incentives for product production were separately recognized.

Table 1

Sources of risk in STSC and its impact

The main directions	Sources of risk	Impact points
Production	Low production volume Low availability of modern production technology Lack of technique Supply interruptions	Trade, transport Production, price, product standard, product quality Product quality, productivity Product quality, productivity
Cooperation	Uncertainty of demand Inadequate information regarding product demand Absence of a clear agreement on the purchase of the product	Distribution, planning Production, harvesting Trust of the parties to each other
Infrastructure	The long distance and bad road infrastructure Not enough transportation for the harvest Conditions in Dakhon markets are not fully formed	Product quality and price Product quality and price Confidence in place of sale at farmers markets
Financial	Lack of financial support The investment is poorly diversified Difficulties in getting a loan Sudden price changes in the market	Production, product quality, raw materials Production, product quality Incentives for production, raw materials Farmers' decision-making
Natural and environmental	Crop destruction by diseases Lack of water for irrigation Random precipitation	Productivity, product quality, price Production Production
Management	Decision making in production Quality control in production Planning Producer experience	Production, harvesting, processing, sale Production, product quality, cooperation Production, price, cooperation, implementation Production, productivity, product quality, cooperation
Political changes	Political instability Restrictions on trade	Production, cooperation, realization Production, cooperation, realization, incentive to production

Material and methods

In the study of the problem, small, medium and large organizational entities in vertical integration in STSC were covered. At the initial stage, suppliers of input resources - agro-vet pharmacies, seed and technical supply farms, suppliers of fuel and lubricants, “Tomorqa xizmati” LLC and customer organizations; the production organizations - households, smallholders and smallholders producing products by renting land; product processing - product packaging and processing enterprises; wholesale trade - product sellers, supply distributors and exporters; in retail trade - retail shops, catering establishments and social houses were involved. Data were collected

directly from respondents in the Samarkand region in January-March 2021, and an three-staged-experiment was conducted.

In this study, we used non-traditional methods of risk assessment of economic integration relations between entities in STSC, based on the data collected on the basis of a questionnaire from the entities listed above. This method was used for the first time to assess the impact of risks in the production chain in Uzbekistan using the Fuzzy Linguistic Quantifier Order Weighted Aggregation (FLQOWA) model.

When assessing the impact of risks, unlike other analysis methods, it takes into account the subjective characteristics of the problem under study, evaluates risks in specific coefficients is used in the analysis of all life problems in decision-making, and provides opportunities for mutual comparison. Taking into account the existence of a number of additional features listed above, this method of analysis was used.

A number of modern economic analysis methods were used to determine the result of the impact of risks. These methods include mathematical and multi-criteria decision making.

Most of the analyzes carried out in this direction mainly included studies in two directions. One of them is related to the acceptance of opinions based on the knowledge of experts, and the other is based on information from the past period. In this study, we used the FLQOWA model by combining the above two types of methods. This approach provides a new approach to assessing the impact of various risks on economic cooperation between entities in STSC in Uzbekistan. According to Rohit Sharma et al., this model is adopted to obtain qualitative information of decision-making entities regarding their relationship between various evaluation criteria (Sharma et al., 2020). Therefore, when performing the analysis, it is appropriate to consider each factor separately, along with the levels of data collected from each respondent (Zadeh, 1975).

Table 2

Notations used in the assessment of risks in STSC

Notations	Description
P	*Index used for organisations, where* $p = (1,2,3 \ldots., s)$*;*
Q	*Index used for organisational risk factors, where* $q = (1,2,3 \ldots., t)$*;*
a_{pq}	*Input data of 'q^{th}' organisational risk factors of 'p^{th}' organisation;*
b_{pq}	*Normalised input data of 'q^{th}' organisational risk factors of 'p^{th}' organisation;*
a_{q}^{min}	*Minimisation value of 'p^{th}' organisation among all 'q^{th}' organisational risk factors* $\{a_{1q}, a_{2q}, \ldots\ldots\ldots, a_{sq}\}$*;*
a_{q}^{max}	*Maximisation value of 'p^{th}' organisation among all 'q^{th}' organisational risk factors* $\{a_{1q}, a_{2q}, \ldots\ldots\ldots, a_{sq}\}$*;*
w_q	*Aggregation weighted vector W of 'q^{th}' organisational risk factors;*
w_{q}^{*}	*Maximal entropy aggregation weighted vector W*;*
OR_p	*Organisation risk score (p)*

In carrying out the analysis, the initially collected data were divided into appropriate groups and separated into vague linguistic quanta and collected according to their order. In the last step, the respondents' answers were evaluated in a weighted summation order for each alternative. The symbols used in the risk assessment in STSC are presented in Table 2.

The stages and conditions of the analysis were carried out in the following sequence (Sharma et al., 2020):

1. Set of organizations $O_p = \{O_1, O_2, O_3, \ldots\ldots, O_s\}$ be a set of s organisations, where p = (1, 2, 3, ..., s);

2. Risk factors of the organizations (ORFs) [i.e. $\{ORF_1, ORF_2, ORFF_3, \ldots\ldots, ORF_t\}$, where $q = (1, 2, 3, \ldots ., t)$];

3. Construct a multiple factor matrix $A = [a_{pq}]$ based on 'experts' inputs for different risks faced by their organization;

4. Convert the multiple factor matrix $A = [a_{pq}]$ into a fuzzy multiple factor matrix $B = [b_{pq}]$ using the fuzzy membership function as shown in Equation (1) and Equation (2)

For the maximisation factor,

$$[b_{\mathrm{pq}}] = \frac{a_{pq} - a_q^{min}}{a_q^{max} - a_q^{min}} \quad (1)$$

where, $p = 1,2,3,\ldots s;\ q = 1,2,3,\ldots . t$

For the minimisation factor;

$$[b_{\mathrm{pq}}] = \frac{a_{pq}^{max} - a_{pq}}{a_q^{max} - a_q^{min}} \quad (2)$$

where, $p = 1,2,3,\ldots s;\ q = 1,2,3,\ldots . t$

$$a_q^{max} = max\,\{a_{1q}, a_{2q}, \ldots\ldots\ldots a_{sq}\}$$

$$a_q^{min} = min\,\{a_{1q}, a_{2q}, \ldots\ldots\ldots a_{sq}\}$$

5. Computation of aggregation weighted vector (W):

$$W_q = Q\left(\frac{q}{t}\right) - Q\left(\frac{q-1}{t}\right), \quad (3)$$

where, $q = 1,2,3,\ldots .,n$

$$Q(r) = \{\frac{r-0,5}{r-0,5} \text{ if, } 0,5 \leq \mathrm{r} \leq 1,\ a, b, r \in [0,1], \quad (4)$$

6. Aggregation of the weight vector by the following formula to optimize the order of fuzzy linguistic quantiles and using entropy to constrain the optimization problem.

It is advisable to use the following formula to aggregate the weighted vector:

$$(W) = \frac{1}{t-1} \sum_{q-1}^{t} (t-1) w_q \quad (5)$$

Logarithmization when using entropy gives maximum use of weighted vector aggregation:

$$(W) = -\sum_{q-1}^{t} w_q\, ln\ w_q \quad (6)$$

We use the following formula to calculate the risks of organizations based on the system:

$$(W) = \frac{1}{t-1} \sum_{q-1}^{t} (t-q) w_q, \qquad \sum_{q-1}^{t} w_q, \quad w_q = \in [0,1] \quad (7)$$

where, $q = 1,2,3,\ldots, t$

Based on the above formulas, we use the FLQOWA model formula as follows:

$$\sum_{t-1}^{t} \left(\frac{t-q}{t-1} - (W)\right) h^{t-q} = 0$$

$$(W) = \frac{1}{t-1} \sum_{q-1}^{t} (t-q) \frac{h^{t-q}}{\sum_{q=1}^{t} h^{t-q}} \quad (8)$$

$$w_q^* = \frac{h^{t-q}}{\sum_{q=1}^{t} h^{t-q}} \quad (9)$$

where, $q = 1,2,3,\ldots, t$

7. It is appropriate to use the following formula to calculate the levels of risk affecting the relationships between entities in STSC:

$$\mathrm{TP}_p = \left[w_q^* * b_{pq}\right] \quad (10)$$

Inconsistencies in economic relations between entities in STSC prevent mutual integration. We evaluated the impact of risks on the economic integration between subjects in STSC separately for each block using the research method that includes the above-mentioned stages. Below, the results of the analysis are presented and interpreted separately.

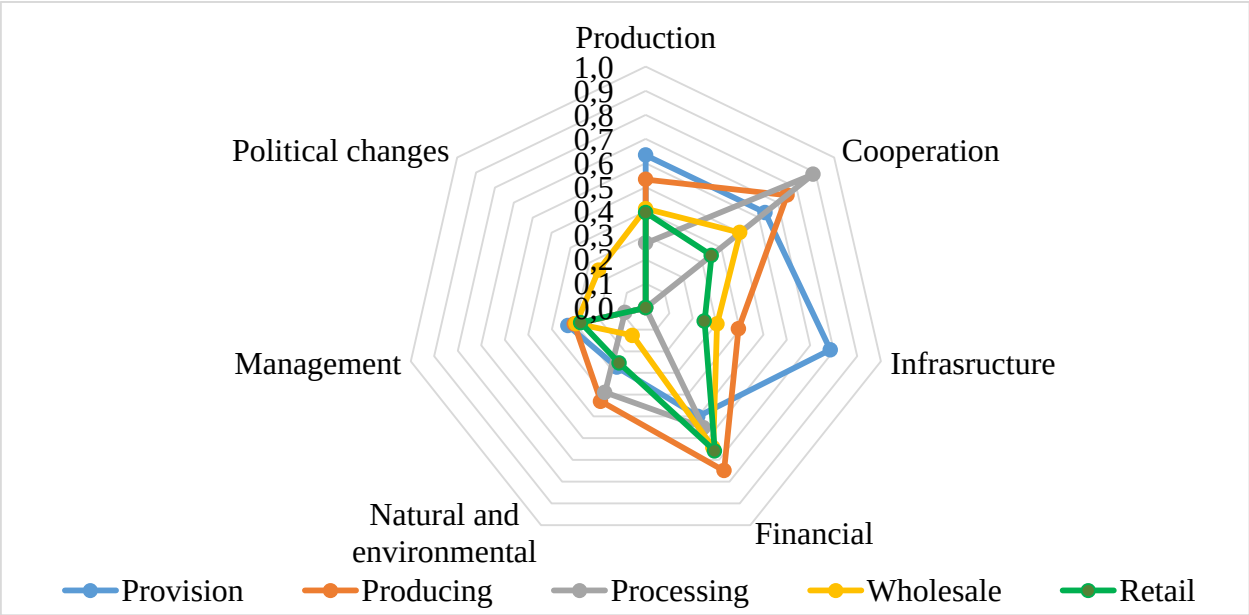
Results

Assessment of risk levels of supply organizations in STSC. A total of 7 grouped main factors, which include factors that negatively affect the economic integration cooperation of the supply organizations with smallholders: infrastructure, capacity of producers, and the level of risk associated with procurment and services, gave an above average result. That is, due to inconsistencies such as long distances in the delivery of input resources and services by suppliers, deficiencies in the road infrastructure, insufficient formation of conditions in special transport and bazaars, the risk level is 0.8; due to the small amount of production in smallholders, the lack of access to modern production technology and interruptions in cooperation caused the risk level is 0.6; and the type and quantity of working capital due to the uncertainty of the demand and the lack of a clear agreement on the purchase of the product the risk level is equal 0.6 (Figure 2). In addition, the risk levels of the financial issues of the supplier organizations are equal to 0.5, which showed that the impact levels of inconsistencies related to the lack of financial support and market prices fluctuations in this sector are high.

Assessment of production-related risk levels in STSC. In tomato production, the financial support of smallholder, their economic integration with buyers, and the risk levels associated with production have been shown to be high. In particular, the level of risk arising in financial matters for farmers is equal to 0.75, from which the risk of lack of supply and financial support during the production period is high. In addition, it was determined that the price of the product in the market changes sharply in different years, which has a negative impact on their decision-making.

We found that the risk level of cooperation with buyers for farmers was 0.75. 43.6% of this risk level was caused by the lack of a specific agreement on the purchase of products. At the same time, 35.2% was due to the lack of accurate information related to product demand, and another 22.1% was due to other risk factors.

For smallholders, the low production volume, difficulties in using modern technologies, lack of equipment and supply interruptions caused the risk to increase by 0.5. Deficiencies in the infrastructure were also assessed as increasing the risk level by 39.4% in the implementation of economic cooperation with entities in STSC.



2-figure. Assessment of the level of risk in economic relations between entities in STSC in Samarkand. (The highest risk level is equal to 1 coefficient).

Assessment of risk levels of processing enterprises in STSC. It was found that the activity of other buyers competing for tomato processing enterprises can increase the risk level by 0.9 in their decision to cooperate with farmers. For them, the level of risk associated with financial matters also showed that they could have a significant negative impact on their cooperation. Of course, processing kompanies can also be suppliers input resources for tomato producers. Financial inadequacies, operating a system of payment of product money in advance in the form of prepayment also mean financial risks for them.

It should be recognized that low production of smallholders, low availability of modern technologies and other similar factors for processing enterprises have a low level of risk in cooperation with smalholders. But the negative effects of biological and environmental factors have shown to increase the risk level by 0.4.

Assessment of risk levels of wholesaler in STSC. 33.0% indicated the lack of support from various financial institutions and 43.5% difficulty in using credit opportunities as the cause of the risk. As can be seen from the figures, we can see that even for wholesale trade organizations, the level of risk has increased due to the influence of other buyers competing in STSC.

Assessment of risk levels of retailer in STSC. Retail trade organizations are one of the main blocks that serve to deliver agricultural products to the table of the population. It was found that the main risk in economic cooperation with farmers is financial relations. If we look at the analysis data, we can see that the level of risk associated with financial issues is equal to 0.7. It is shown that the origin of the level of risk in financial relations is caused by the lack of advance payments and input resources, as well as the sharp changes in the price of agricultural products in the market. At the same time, it was found that the level of risk in the economic relationship of this type of entities with farmers is somewhat higher. 46.5% of the increase in risk was caused by the lack of specific equipment, 32.2% by supply interruptions, and 21.3% by the lack of modern production technologies for smallholder.

In STSC, the level of risk in economic relations between subjects showed that the part related to financial issues is high. At the same time, there are high levels of risk arising from production, supply, infrastructure and financial issues in cooperation between supplier organizations and

smallholders. In conclusion, it should be mentioned that it is appropriate to consider ways to eliminate high risk factors related to buyers, financial issues, infrastructure and production when smallholders implement economic cooperation with entities in STSC.

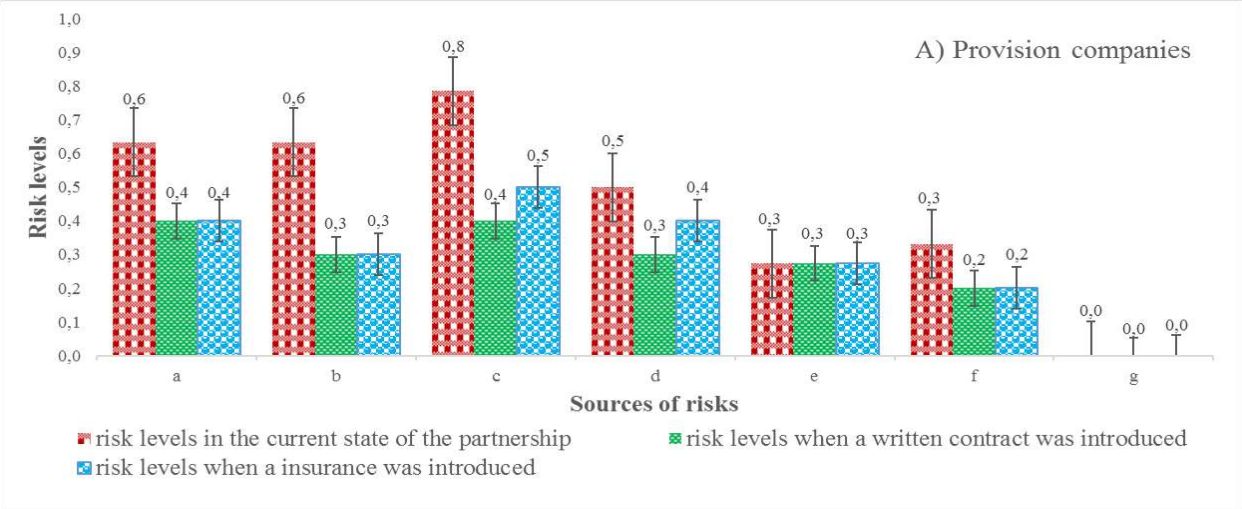
Risk mitigation in STSC

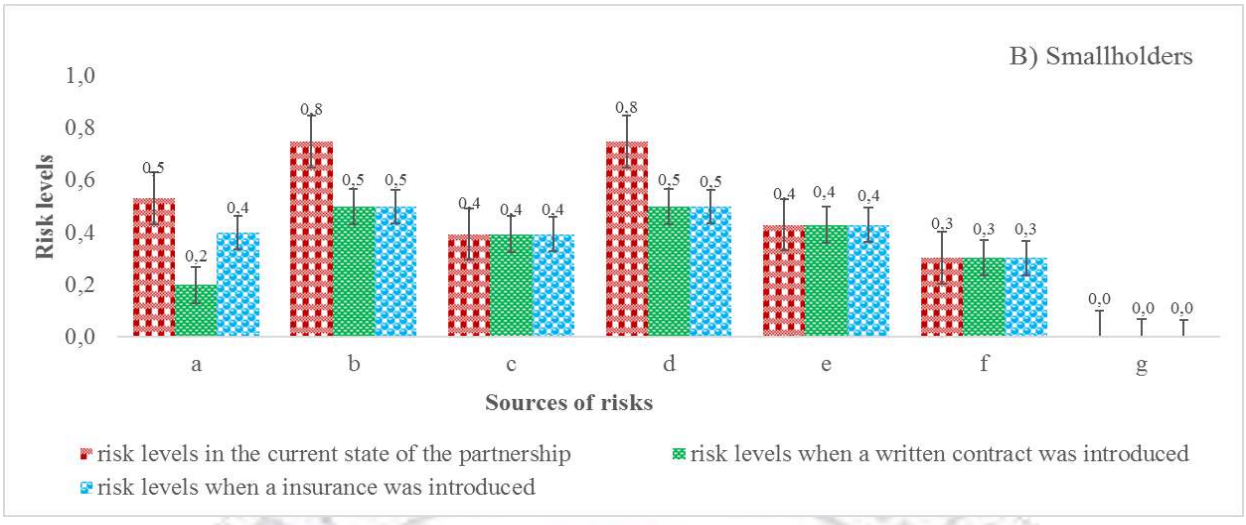
The tomato production chain by smallholders covers all value-added activities from the initial stages of production to consumption. Since this supply chain is important for producing constant, cheap, high-quality and sufficient consumer products for consumers, it is important to ensure that the cooperation between the entities in this system works smoothly and efficiently during the transitional economy. However, due to several inconsistencies and high risks in the system, it is very difficult to keep it running smoothly.

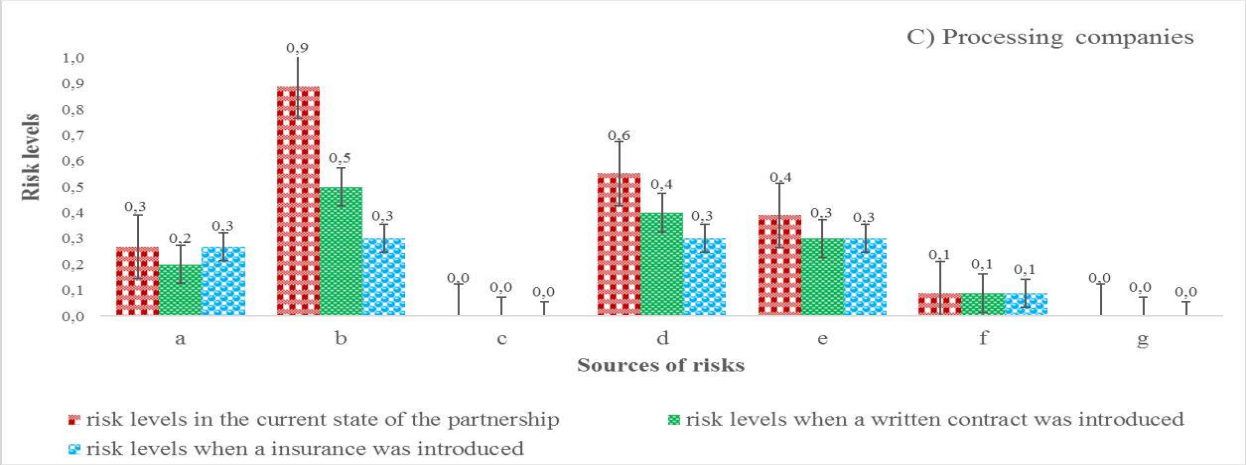
In order to determine strategic directions for reducing and eliminating risks in STSC, it is necessary to determine the directions of risk, sources of formation and links of its influence. Such practice means coordination of economic relations between entities in the system, determination of risk reduction strategy and application of efficiency improvement measures.

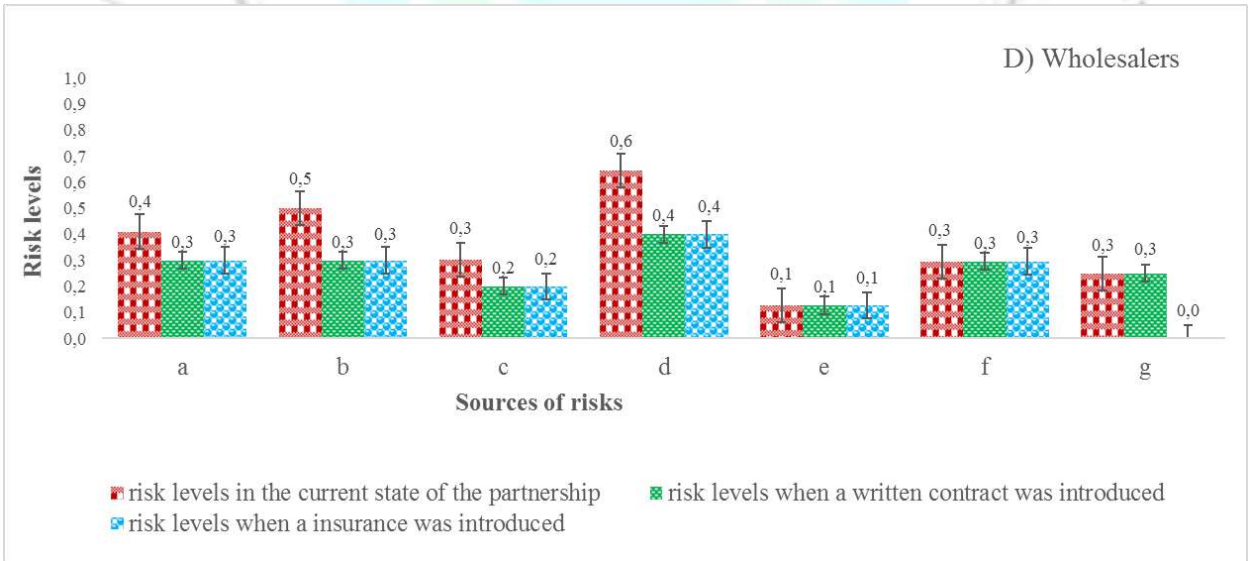
Based on this practice, as measures to reduce the risks affecting cooperation, with the participation of representatives of "Provision companies", "Smallholder", "Processing companies", "Wholesalers" and "Retailers" in the main blocks of STSC a three-staged-scenario experiment was conducted. In the first stage of the experiment, "collaboration without guarantee" (current condion), in the second stage, "Written contracts" and in the third stage, "Insurance" were introduced. The results obtained at each stage were separated and analyzed using the FLQOWA model. The results of the analysis are presented in parts A, B, C, D, E of Figure 2.

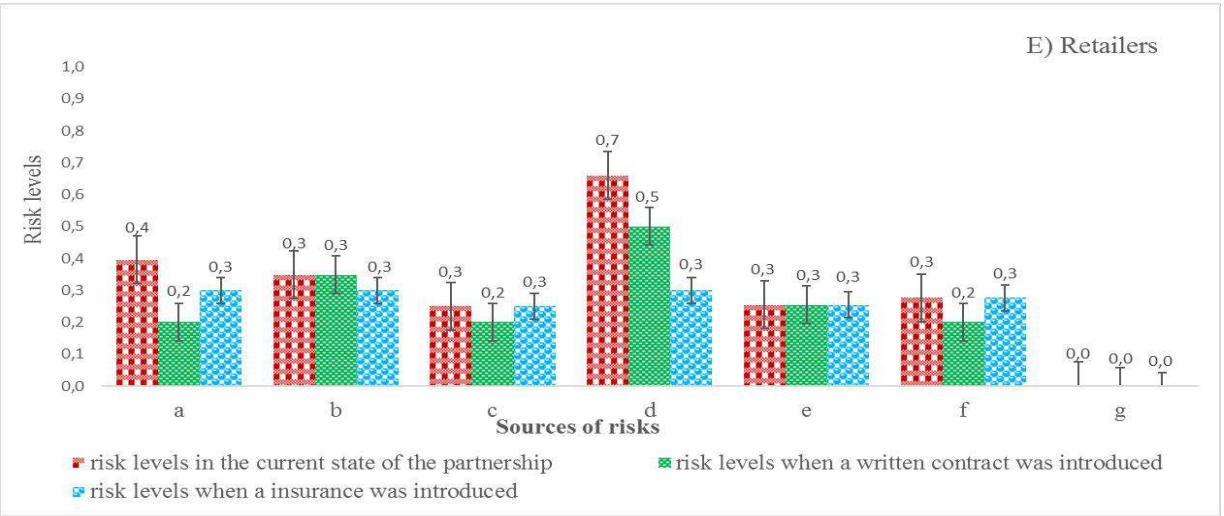
Figure 2. Evaluation of the impact of assurance factors on mitigating the level of risk among subjects in STSC. Sources of occurrence of risk levels: a) Production; b) Cooperation; c) Infrastructure; d) Financial; e) Natural and environment; f) Management; g) Political changes.




B) Smallholders
Risk levels
1,0
0,8
0,6
0,4
0,2
0,0
0,5 0,2 0,4
0,8 0,5 0,5
0,4 0,4 0,4
0,8 0,5 0,5
0,4 0,4 0,4
0,3 0,3 0,3
0,0 0,0 0,0
a b c d e f g
Sources of risks
risk levels in the current state of the partnership
risk levels when a written contract was introduced
risk levels when a insurance was introduced


C) Processing companies
Risk levels
1,0
0,9
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0,0
0,3 0,2 0,3
0,9 0,5 0,3
0,0 0,0 0,0
0,6 0,4 0,3
0,4 0,3 0,3
0,1 0,1 0,1
0,0 0,0 0,0
a b c d e f g
Sources of risks
risk levels in the current state of the partnership
risk levels when a written contract was introduced
risk levels when a insurance was introduced


D) Wholesalers
Risk levels
1,0
0,9
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0,0
0,4 0,3 0,3
0,5 0,3 0,3
0,3 0,2 0,2
0,6 0,4 0,4
0,1 0,1 0,1
0,3 0,3 0,3
0,3 0,3 0,0
a b c d e f g
Sources of risks
risk levels in the current state of the partnership
risk levels when a written contract was introduced
risk levels when a insurance was introduced



The results of the analysis showed that the guarantee factors have a positive effect on cooperation between entities and reduce the impact of risks. When a "written contract" is entroduced, the level of risk decreased in supply organizations on average 0.2-0.4; 0.3 in smallholders; 0.1-0.6 in product processing enterprises; 0.1-0.2 in wholesale trade organizations; and up to 0.1-0.2 in retail organizations. And when "Insurance" is introduced, the level of risk decreased in supply organizations on average 0.1-0.3; 0.1-0.3 in smallholders; 0.1-0.4 in product processing enterprises; 0.1-0.2 in wholesale trade organizations; and in retail trade organizations by 0.1-0.4.

Conclusion

The results of the analysis carried out in this article will help to implement the tasks of doubling the income of smallholders, set in the new development strategy of Uzbekistan for 2022-2026. In the study, the risk levels of various inconsistencies in the establishment of cooperation between farmers and households in ASC with economic partner subjects were determined and ways to reduce it were found. The problem was studied on the example of subjects participating in five blocks in STSC in Samarkand region. In this study, we found the following answer for the question "what risk factors affect the cooperation between subjects in the tomato production chain?". The model results demonstrated that in cooperation between subjects and smallholders the production-related risk levels in product manufacturers and supply organizations are 0.6 and 0.5 coefficients, respectively; 0.5-0.9 coefficient in the cooperation of suppliers, manufacturers, processing enterprises, wholesale trade enterprises; 0.8 coefficient of the level of risk of supply organizations with infrastructure; and it was proved that the level of risk related to financial issues in all blocks is higher than the average by 0.6-0.8. It was concluded that higher than average levels of risk lead to disruption of cooperation between entities.

For the question "What measures can be treated to mitigate the affects of the high-risk factors?" we found the following answer. The level of risk related to relations between subjects, financial issues, infrastructure and production is above then average. The high level of risk has a negative impact on the economic relations between smallholders and partners in ASC. Application "written contract" and "insurance" to collaborative relationships to reduce risk levels has been shown to reduce risks.

The results obtained from this investigation will have a positive effect if policy makers use the applications to increase the economic cooperation between the subjects in STSC.

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BIBLIOGRAPHY THE ROLE OF INNOVATIONS IN THE ACTIVITIES OF TOMORKA FARMS IN SAMARKAND REGION

Sh. Muratov - *Ph.D. student, "*Tashkent Institute *of* Irrigation *and Agricultural Mechanization Engineers" National Research University*

Sh. Hasanov - *Doctor of science in economics, Samarkand branch of Tashkent State Agrarian University, Samarkand, Uzbekistan*

R.Kalandarov - *researcher, Samarkand branch of Tashkent State Agrarian University*

Kh. Pardaev - *PhD student, Samarkand branch of Tashkent State Agrarian University*

F.Saydullayeva - *Ph.D. student, "*Tashkent Institute *of* Irrigation *and Agricultural Mechanization Engineers" National Research University*

Abstract

In this scientific research, the role and importance of using innovations in the income from tomarka farm activities in rural areas is studied. Also, the "The Innovation use index" is developed using factor analysis to assess the impact of the use of innovations on the income from tomorka farm activities. The analysis based on the data of 1428 respondents who took part in a social survey conducted in the rural areas of Samarkand region. The influence of the innovation index on the income from tomarka farm activities is determined to be statistically significant at 1 percent ($p<.01$). Particularly, it is based that, a 1% increase in the index of the use of innovations to increase the income from tomorka farm activities by 32.9%. Based on the results of the analysis, proposals were made to increase income from tomarka farm activities in rural areas and to introduce opportunities for using innovations.

Key words: tomorka farm, non-farm, Innovation use index, factor analysis, VIF test

Introduction. Before the COVID-19 pandemic, there was a focus on ending hunger and malnutrition on Earth by 2030(Banik, 2019). However, the pandemic period had a significant impact on the economic sphere of all countries, including agricultural activities and the food production network. These impacts have led to major changes in storage, processing, delivery, and population consumption which are related with production. As a result, hunger and malnutrition among the population increased from 8.4 percent to 9.9 percent in one year(UNICEF, 2021). In particular, in 2020 compared to 2019, more than 57 million people suffered from famine in Asian countries.

Populations suffering from hunger or malnutrition, with low or no income from their labor, can have a significant impact. Whereas, for the normal growth and development of the population, to live an active and healthy life, it is necessary to provide enough food products(Pelletier *et al.*, 2016). However, 45 percent of the world's population lives in rural areas, and most of them rely on income from agricultural activities. In this regard, diversification of risks in agricultural activities, seasonal income changes and financing of production resources are important for the sustainable development of production efficiency. Also(Müller and Campos, 2021), attracting innovations to the agricultural sector and financial support from the government will have a positive effect on the increase in the quantity and quality of the products obtained from the activity. However, the involvement of innovations in agricultural activities affects the employment of the population in agriculture. In particular, the use of innovations in the labor-intensive work process, which requires a lot of manual labor in agriculture, the implementation of agrotechnical measures, the harvesting of cultivated crops

or the use of resources, has an impact on the reduction of labor costs. The influence of such factors leads to the decision of the population to be engaged in non-farm activities from agricultural activities. While(Hasanov and Sanaev, 2018), the decision to engage in non-farm activities and the income coming from it affects agricultural activities. At the same time, although families grow agricultural products in their household for their own consumption and for the market, in families with a large number of family members, they rely on income from non-farm activities to meet their food and non-food needs(Lanjouw P., 2001).

However, the growth of non-farm sectors in rural areas also affects agricultural activities. That is, according to the results of a scientific study conducted by E. Giannakis and others(Giannakis, Efstratoglou and Antoniades, 2018) in households of the rural area of Cyprus, they found out that there is an inverse relationship between the arable land in farmers' or peasant farms and the probability of participation in non-agricultural activities. Also, according to the results of scientific research by S. Haggblade and others(Haggblade, Hazell and Reardon, 2010), in rural areas, households with less than 0.5 hectares of income from non-agricultural activities make up to 30-90 percent, and households with little or no arable land rely on sources of income from non-agricultural activities. However, agricultural activity includes the production of agricultural products (crops, livestock) in the course of agricultural activities using production factors (natural resources)(Reardon, Berdegué and Escobar, 2001). However, innovations introduced into agricultural activities(Ermakova, 2021) have an impact on the increase in income from activities.

The share of tomarka farms in the production of agricultural products in Uzbekistan is 70.1%, which plays an important role in the country's economy. Today, the number of homesteads is more than 5 million, 1.5 times more than in 2000. The land area used for agriculture in Uzbekistan(*Agricultural statistics*, 2021) is 3686.7 thousand hectares, 13.0% of which is arable land used by homesteads.

Tomarka farming(*Law of the Republic of Uzbekistan. About the farm(tomarka)*, 2021) is a labor activity related to agricultural production on private homestead land plots for family economic activity, cultivation (processing) for sale on the market. Tomorka farming is not considered an entrepreneurial activity; it is not required to be state registered. However, a person may receive the status of a self-employed person in accordance with the legislation on employment. However, 26.9% of the working-age population in Uzbekistan is engaged in agricultural activities, and in 2020, compared to 2017, employment decreased by 3.1%. The decrease in the employment of the population in agricultural activities is related to the decrease in the size of agricultural arable land, which has decreased by 3.3% over the last 4 years. Although it is observed that the agricultural arable land has decreased, the volume of agricultural products and their value have increased over the years (2017-2020). The increase in the volume of agricultural products is related to the attraction of innovations in the field. In particular, in 2017, 66.7 percent of technological innovations were involved in agricultural activities by agricultural entities, and in 2020, this figure was 90.4 percent. Basically, innovations introduced by agricultural subjects are agricultural machinery, technologies related to the implementation of agrotechnical activities, innovative technologies related to crop irrigation. However, the involvement of such innovative technologies in agricultural activities are carried out by farm or agro cluster entities.

However, the owners of farm land in Uzbekistan are small farm subjects that grow agricultural products. It is important to introduce innovations in agricultural activities, which are the use of innovations by the owners of the agricultural land, such as irrigation of crops, fruitful new varieties of fruits and vegetables and potatoes, and cultivation of plant products from cultivated fields in all seasons. Also, the use of livestock with high productivity in livestock farming activities by the landowners can have a positive effect on the increase in the volume of products obtained from the activity.

The purpose of the scientific research work is to make an economic assessment of the impact of the innovations used by the estate owners on the income from the estate business and to make scientifically based proposals.

The scientific research work was based on survey data obtained from 1428 homestead land owners who operate in rural areas of Samarkand region.

1. Material and methods

1.1. Materials

The object of study of the scientific research work is homestead farms operating in the rural areas of the Samarkand region, the center of the Republic of Uzbekistan. Samarkand region is located in the middle part of the Zarafshan river basin and is one of the largest and ancient irrigated regions in Central Asia. There are 14 districts and 2 large cities in Samarkand region. The Zarafshan river divides into two rivers around the city of Samarkand - Akdarya and Karadarya, and merges again near Khatirchi district of Navoi region. (Figure 1).

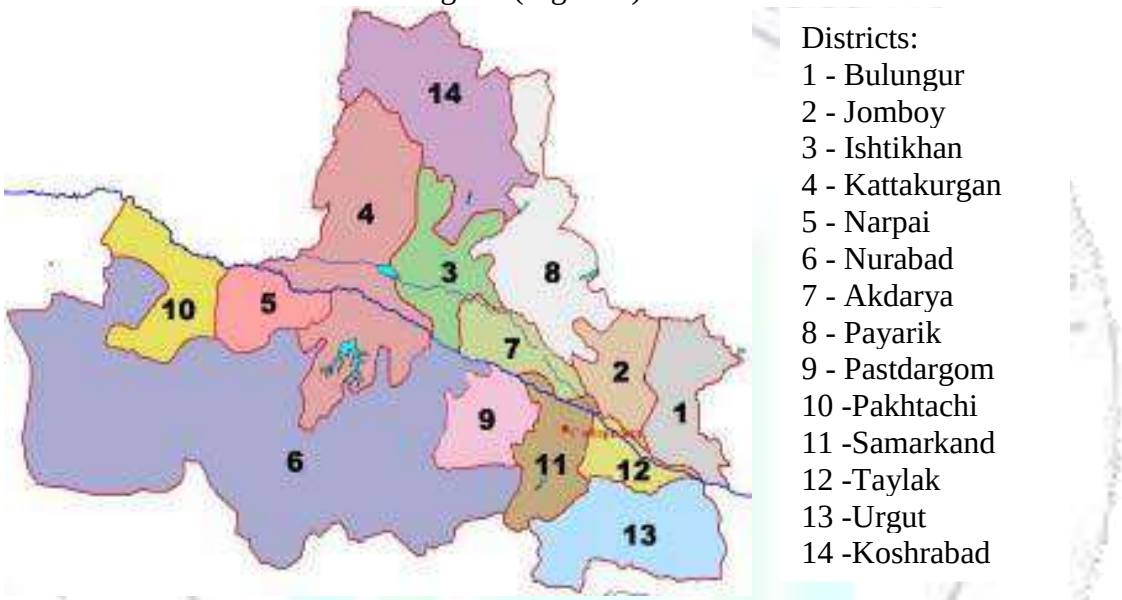

Figure 1. Location map of Samarkand regional districts

Pastdargom, Payarik, Narpai and Kattakurgan districts are the largest districts in the region in terms of the size of irrigated cropland. But, in the region, the cultivation of vegetable products on homestead farms is more due to the contribution of Jomboy, Taylak, Urgut and Samarkand districts.

This valley, located around the Zarafshan River, is 2000-3000 meters above sea level, and in some lowlands it is 980-1400 meters above sea level, and the annual rainfall is 320-360 mm. The climate of the region is sharply continental, the sun shines on about 300 days of the year, summer days are up to 15 hours long. In general, the climate conditions in the territory of the region correspond to the generally accepted soil-climate classification. According to agroclimate, the irrigated area is divided into 2 parts: the larger part of the area corresponds to the region of typical gray soils, and the smaller part corresponds to the region of pale gray soils. Irrigated gray soils are located in the temperate-hot thermal zone, the annual effective temperature is 2140-2300 C0, the length of the vegetation period is 208-212 days.

A social survey was conducted to study the activities of tomorka farms. The survey was conducted from March 10 to August 24, 2021, and a total of 1428 respondents from 14 districts of Samarkand region participated. In this case, a questionnaire was conducted among the landowners located in the district, but not included in the neighborhood of the central city of the district(Saydullaeva, 2021). The agricultural products grown on homesteads in the research object,

especially the crops obtained from plant growing, are grown for the consumption of family members. However, the needs of family members for agricultural products are met at the expense of vegetable, potato, fruit and grape products grown on homesteads. Surplus of consumption of family members is sold for income. However, family members are engaged in agricultural activities, the main income of families is income from agricultural activities. That is, tomorka farm land owners grow commodity products for sale in 1 or 2 types of markets on arable land. Nevertheless, a certain part of the goods is used by the family members to meet the needs of the family. In this process, agricultural products used for sale and for family needs were taken to determine the income from tomorka farm activities. In this case, the agricultural products used for family needs in homesteads, which are vegetables, potatoes, fruit and grape products, were expressed at the market price. According to the approach, when agricultural products are not grown on the cultivated area of the tomorka farm, how many soums will be spent for the needs of family members. In total, the incomes from household activities of 1428 respondents were taken in the value index, and their average income is 14,531 thousand soums

Table 1

Descriptive Statistics of tomorka farms activities

Variable	*Obs*	*Mean*	*Std. Dev.*	*Min*	*Max*
Income	*1428*	*14.531*	*5.458*	*3.3*	*37.5*
Inn_irrigation	*1428*	*344*	*475*	*0*	*1*
Inn_veg_var	*1428*	*548*	*498*	*0*	*1*
Inn_fruit_var	*1428*	*506*	*5*	*0*	*1*
Inn_greenhouse	*1428*	*297*	*457*	*0*	*1*
Inn_ped_cattle	*1428*	*2*	*4*	*0*	*1*
Age	*1428*	*48.1*	*6.87*	*27*	*60*
Male	*1428*	*832*	*374*	*0*	*1*
Education	*1428*	*1.926*	*685*	*1*	*3*
Non-farm	*1428*	*543*	*498*	*0*	*1*
Cropland	*1428*	*7.323*	*2.438*	*3*	*18*
Family_members	*1428*	*5.588*	*1.229*	*2*	*11*
3_year_members	*1428*	*272*	*445*	*0*	*1*
log_Income	*1428*	*2.598*	*413*	*1.194*	*3.624*

Innovations used by tomorka farm land owners, which are the use of modern technologies in crop irrigation, high-yielding varieties of vegetables and fruits, and the presence of closed space and productive livestock in tomorka farms, were taken as dummy variables. In particular, 34.4 percent of 1,428 respondents used modern technologies to irrigate agricultural crops grown on tomorka farms. Also, 54.8% of the respondents used high-yielding vegetable crops in their homesteads, and 50.6% of respondents have high-yielding fruit trees in their homesteads. However, 29.7 percent of homesteads have a closed area and 20.0 percent have productive livestock. The average arable land in homesteads is 7,323 hectares, which can limit the possibility of raising productive livestock breeds. The age, gender, education and number of family members(Pardaev, 2021) of the owners of the estate are important for the change of the income from the tomorka farm activities(Muratov, 2021). However, the average age of the respondents is 48.1 years, and they are at working age. Similarly, 83.2% of the landowners are men, 27.2% of the family members have children under 3 years of age, and the average number of family members in the household is about 6 people. However, 54.3 percent of homestead land owners living in rural areas are mainly engaged in non-farm activities

1.2. Methods

In scientific research, the standard deviation of different values of the independent variable or the variation of the relationship between them causes the problem of heteroskedasticity and multicollinearity(Daoud, 2018). In order to partially eliminate the problem of heteroskedasticity, we introduce a new variable, innovations used by landowners, which use dummy indicators. This new variable represents the index of the use of innovations in household activities of 1428 respondents. Factor analysis(Rummel, 1988) was used to create the index of the use of these innovations.

First, the Kaiser-Meyer-Olkin (KMO=0.568) test(Kaiser, 1974) was conducted to determine the suitability of factor analysis for the variables used in agricultural activities, which represent innovations. In this case, the statistic is a measure of the ratio of variance between variables that may be the total variance. Also, according to the results of Bartlett's test(Bartlett, 1937), H0: the fact that the variables are not related to each other is explained by the condition that p value is less than 10%, 5%, and 1%. According to the result of Barlett's test, the variables representing the use of innovations in agricultural activities are not related (p=0.0000). Determinant of the correlation matrix(Bartlett, 1951) is explained by multicollinearity between variables greater than 0.0000001. However, the multicollinearity between the variables representing the innovations used in gomorka farm activities explains 0.890.

According to the results of the 3 tests conducted, using factor analysis, it is possible to express the innovation use index by means of the variables that represent the use of innovation.

Factor 1 explains 27.5% of the innovations used in homesteads as a variable (Table 2).

Table 2

Value of interpretation of variables in factors

Factor analysis/correlation			Number of obs =	1,428
Method: principal-component factor			Retained factors =	2
Rotation: (unrotated)			Number of params	9
Factor	Eigenvalue	Difference	Proportion	Cumulative
Factor1	1.37979	0.24770	0.2760	0.2760
Factor2	1.13209	0.27211	0.2264	0.5024
Factor3	0.85998	0.04324	0.1720	0.6744
Factor4	0.81674	0.00535	0.1633	0.8377
Factor5	0.81139		0.1623	1.0000

LR test: independent vs. saturated: chi2(10) = 165.75 Prob>chi2 = 0.0000

However, in 5 factors, their eigenvalue is greater than 1(Larsen and Warne, 2010), Factor1 and Factor2 explain the variables expressed in the use of innovations by the landowners. In particular, Factor2 explains 22.6 percent of 5 independent variables.

Existing innovations in the activities of homesteads (Figure 2), which means that fruit trees were planted in homesteads 1 year ago or many years ago, and are present in homesteads for years.

On the other hand, the price of fruit seedlings set in the markets or by the growers of fruitful fruit seedlings shows that the farm is suitable for the consumption of the landowners.

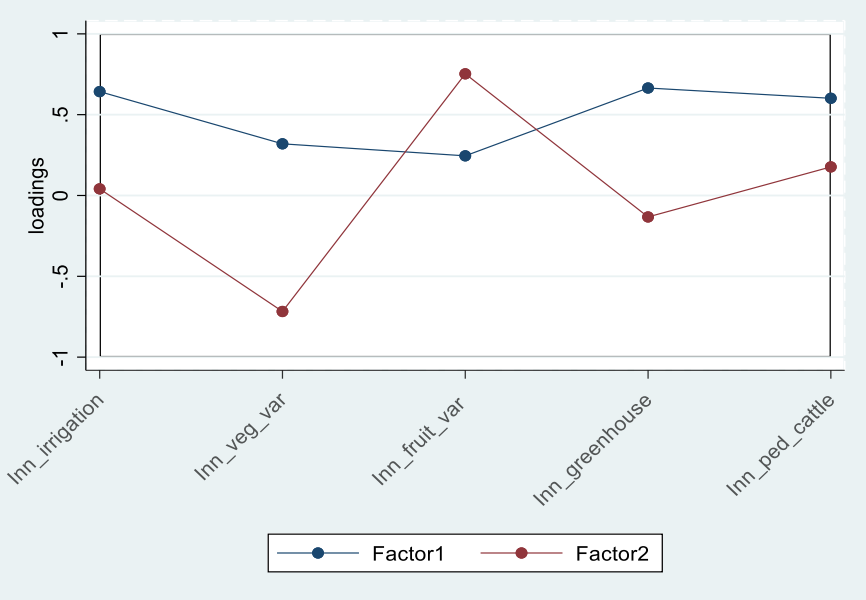

Figure 2. Loadings of variables representing innovations in farm activities

The variables representing innovation were explained by Factor1 and Factor2 and indexed by Bartlett's method(Bartlett, 1937) (Table 3).

Table 3

Descriptive Statistics of Inn_index

Variable	Obs	Mean	Std. Dev.	Min	Max
Inn_index	1,428	.3504802	.2449325	-5.40e-17	1

In this case, according to the statistical description of the index of use of innovations, 1428 estate owners, which represented the innovations used in estates, were indexed between 0 and 1. The average value of the innovation use index is 350, and the standard deviation is 244.

In the object of scientific research, it is expressed that there is a relationship between the income from tomarka farm activity and the index of use of innovations (Figure 3).

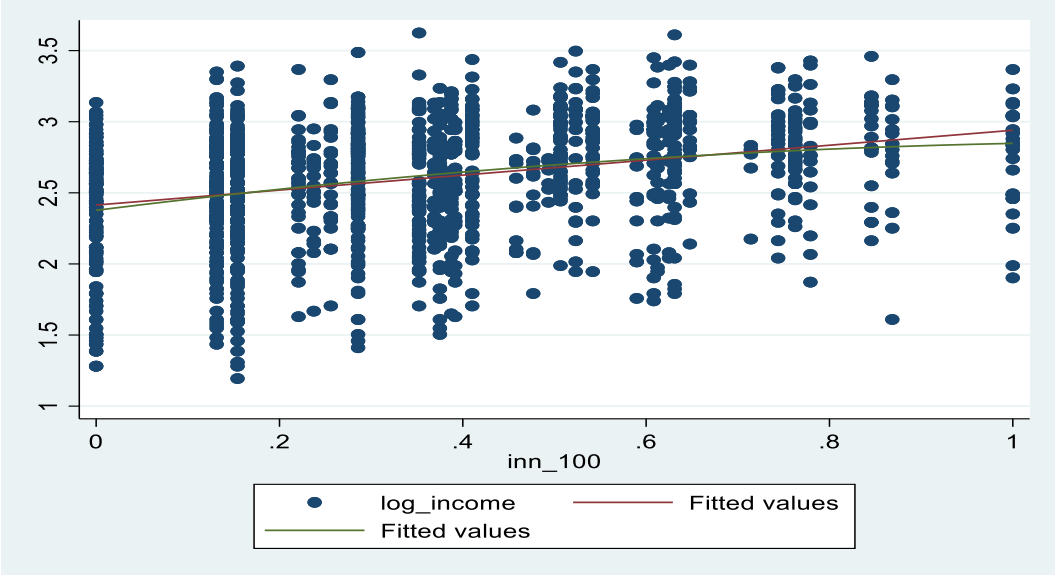

Figure 3. Graphic representation of the relationship between income from tomorka farm activities and the index of use of innovations

In this case, the relationship between the dependent variable, the income from household activities, and the independent variable, the innovation use index, is positive. Innovations introduced into real estate activities, which are variables representing the index of innovation use, have a positive effect on the increase in income from real estate activities.

The presence of variable correlation in the variables indicates multicollinearity, that is, the independent variables are statistically insignificant. When determining such a situation, a diagnostic test was conducted to ensure the robustness of our results (Table 3).

Table 3

Variance inflation factor

Variable	VIF	1/VIF
Income_tf	1.34	.746
Education	1.312	.762
Age	1.17	.855
3_year_members	1.112	.899
Male	1.086	.92
Cropland	1.075	.93
Inn_index	1.048	.954
Family_members	1.016	.984
Mean VIF	1.145	.

VIF (Variance inflation factor) test was conducted for independent variables to determine multicollinearity. The VIF test(Wichers, 1975) is a measure of the amount of multicollinearity in a set of multiple regressor variables. Mathematically, the VIF for a variable in a regression model is the ratio of the total model variance to the variance of the model containing only one independent variable. This ratio is calculated for each independent variable. A high VIF indicates that the dependent independent variable is correlated with other variables in the model. However, according to the VIF test result, its mean value is 1.145, indicating that there is no multicollinearity between the variables.

The results were obtained in the STATA-16 program package using the multivariate linear regression model in the economic evaluation of the influence of independent variables on the income from household activities. The "robust" command was used in the STATA-16 program package in order to strengthen the variables and eliminate multicollinearity when obtaining the results. Here, the marginal effect of the index of use of innovations on the income from household activities was determined.

Results. According to the results of the analysis (Table 4), independent variables explain 50.7 percent of the changes in the dependent variable (R-squared=0.507). The functional equation is statistically significant (Prob > F 0.000) and at least 1 of the independent variables affects the dependent variable. However, the change of the income from tomorka farm activities is influenced by the use of innovation index, tomorka farm area, employment of the owner of the tomorka farm land in non-farm activities, education, gender, age, number of family members and family members under 3 years of age 1 percent (p<.01) is statistically significant. In this case, the influence of independent variables on the dependent variable is statistically significant.

However, the presence of children under the age of 3 in the family members has a negative effect on the increase in income from household activities. That is, the presence of 3-year-old children in the family has a statistical significance of 1 percent (p<.01) on the income from household activities, and it reduces the income from household activities by 7.9 percent. In this case, it is possible to limit the labor costs of family members in the homestead or the expenses spent on the homestead. However, the busyness of working-age family members with raising children up to the age of 3 limits the labor consumption in the cultivation of agricultural products

Table 4

Economic assessment of the impact of variables on the income from farm activities

log_income	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Inn_index	.329	.032	10.23	0	.266	.392	***
Cropland	.083	.003	23.95	0	.076	.09	***
Non-farm	.168	.018	9.20	0	.132	.203	***
Education	.221	.012	18.03	0	.197	.245	***
Male	.083	.022	3.71	0	.039	.127	***
Age	.004	.001	3.22	.001	.002	.006	***
Family_members	.025	.006	4.07	0	.013	.037	***
3_year_members	-.079	.019	-4.17	0	-.116	-.042	***
Constant	.984	.078	12.67	0	.831	1.136	***

Mean dependent var	2.598	SD dependent var	0.413
R-squared	0.507	Number of obs	1428
F-test	168.270	Prob > F	0.000
Akaike crit. (AIC)	532.252	Bayesian crit. (BIC)	579.628

**** p<.01, ** p<.05, * p<.1*

in homesteads. However, sending children older than 3 years to kindergarten, which can have a positive effect on the increase in income from household activities. An increase in cultivated area by 1 hectare in tomorka farms increases the income from the activity by 8.3 percent. However, there

is no possibility to increase the cultivated area due to the limited amount of cultivated land in the regions. However, in order to reduce poverty in the rural areas, to increase the employment of the population and their well-being, the government is allocating 15 hectares of arable land for long-term use, but not exceeding 10 years.

Use of resources, in which the limitation of land resources forces the intensive use of arable land. However, the intensive use of open spaces is related to the innovative technologies involved in the activity. In particular, a 1% increase in the index of the use of innovations by the landowners increases the income from the estate by 32.9%. However, the use of innovations by homestead land owners depends on the level of education and income of family members. In particular, an increase in the level of education of tomorka farm land owners by 1 unit increases the income from tomorka farm activities by 22.1 percent. In this case, it is required to increase the literacy of the landowners in the field of agriculture and livestock.

In homesteads, the employment of the head of the family in non-farm activities increases the income from homestead activities by 16.8%. However, the head of the family's employment in non-farm activities depends on the number of family members. In particular, the limitation of labor costs in farm activities, which the heads of families focus on the income from non-farm activities. However, an increase in the number of family members by 1 person increases the income from tomorka farm activities by 2.5%.

Innovations used in farm activities or the innovation index have a positive effect on the increase in income from tomorka farms (Figure 4).

However, we cannot say that homestead landowners have effectively used innovations such as crop irrigation, high-yielding vegetable and fruit varieties, greenhouses, and productive livestock. Based on the results of the analysis, the innovation use index has a significant impact on the increase in income from household activities. In particular, the relative marginal effect of the index of use of innovations on the income from household activities confirms this.

Figure 4. The relative marginal effect of the index of use of innovations on the income received from household activities

Conclusion and suggestions. In the economy of Uzbekistan, agriculture is important in supplying industry with raw materials, meeting the population's demand for food products, and providing employment for rural residents. In particular, the agricultural products grown in the homestead economy, which, in addition to meeting the demand for food products of the family, are their source of income.

In the economic analysis of the impact of innovation on the income from tomorka farm activities, the data of the rural areas in Samarkand region was analyzed. 1428 respondents or landowners took part in the social survey. The results of the analysis showed that there is an opportunity to increase the income from tomorka farm activities in the rural areas of Samarkand region.

The size of tomorka farm land is important in increasing the income of the residents of rural areas from tomorka farm activities. However, the limited amount of arable land in tomorka farms, the use of innovations in activities is important. In this case, the homestead requires the use of new technologies by the landowners, which include crop irrigation, high-yielding vegetable and fruit varieties, greenhouses, productive livestock and other innovations. However, the effect of the use of innovation index on the income from farm activities is statistically significant at 1 percent ($p<.01$), and an increase in the use of innovation index by 1 percent increases the income from the activity by 32.9 percent. Also, the increase of the income from tomorka farm activities is statistically significant in 1 percent ($p<.01$) of tomorka farm area, occupation of the tomorka farm land owner in non-agricultural activities, education, gender, age, and number of family members. Although the presence of members under 3 years of age in the family household is statistically significant at 1 percent ($p<.01$), it has a negative effect on the increase in income from household activities.

Nowadays, the reforms carried out by the government, which reduce poverty in rural areas and provide long-term arable land to the population, are important for improving the welfare of the population. However, it is necessary to develop a system to support or encourage the use of innovations in homestead tomorka farms and arable land allocated to them for a long time.

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МУНДАРИЖА