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FARM-LEVEL SIGNIFICANCE AND ECONOMIC EFFICIENCY OF THE INTERCROPPING TECHNOLOGY OF MAIZE, MUNG BEAN AND WHITE BEAN

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Abstract
When recommending any agricultural technology for implementation in production, its economic feasibility must be substantiated alongside its biological and agroecological effectiveness. If a technology achieves high yields only by causing excessive production costs, its wider adoption in farm practice will be limited. Therefore, the actual effectiveness of a technology should be assessed comprehensively, taking into account the quantity of produce obtained per unit of land, its value and quality indicators, the resources used, and the resulting economic outcomes.

Keywords: Maize, mung bean, white bean, intercropping, soil, efficiency.



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Annotatsiya

Qishloq xo‘jaligida qo‘llaniladigan har qanday agrotexnologiyani ishlab chiqarishga tavsiya etishda uning biologik va agroekologik samaradorligi bilan bir qatorda iqtisodiy jihatdan maqbulligi ham asoslanishi lozim. Chunki yuqori hosil beradigan texnologiya ishlab chiqarish xarajatlarining haddan tashqari ortishi hisobiga shakllangan bo‘lsa, uni xo‘jalik amaliyotiga keng joriy etish imkoniyati cheklanadi. Shu sababli texnologiyaning haqiqiy samaradorligi maydon birligidan olingan mahsulot miqdori, uning qiymati va sifat ko‘rsatkichlari bilan birga sarflangan resurslar hamda iqtisodiy natijalar asosida kompleks baholanishi zarur.

Kalit so‘zlar. Makkajo‘xori, mosh, oq loviya, qo‘shib ekish, tuproq, samaradorlik.

Forage-crop production efficiency is characterized by indicators such as total green-mass yield per hectare, production costs, gross output value, conditional net income, unit production cost, and profitability. Economic assessment is particularly important when cereals and legumes are grown together. Growing two or three components in the same field may require additional expenditure on seed, crop care, and harvesting; however, an increase in total output per unit area can offset these additional costs.

Accordingly, economic efficiency in this study was assessed at two levels. First, the estimated economic performance of the treatments was compared using yields obtained in the field experiment and technological costs. Second, the practical economic efficiency of the research findings under production conditions was assessed on the basis of official certificates issued by the relevant organizations in 2026.

This approach makes it possible to assess separately the scientific results obtained in field experiments and the practical results achieved under production conditions. Therefore, the terms “calculated results under experimental conditions” and “confirmed results under production conditions” were used separately in the subsequent economic analyses.

The economic calculations included costs associated with seed, mineral fertilizers, land preparation, sowing and crop care, irrigation, harvesting, and other technological operations. To compare the experimental treatments, an estimated price of UZS 400,000 per tonne was assigned to maize green mass and UZS 500,000 per tonne to mung bean and white bean green mass. For intercropping treatments, gross output value was calculated by multiplying the yield of each component by its respective estimated price and summing the resulting values.

Production costs and calculated economic efficiency of intercropping treatments.

In assessing the economic efficiency of the intercropping treatments, production costs per hectare were analysed first. These costs included seed, mineral fertilizers and agronomic operations, irrigation and crop care, and harvesting.

The dissertation presents the composition of these costs and their totals in this form.

According to the table, total production costs in the sole-maize treatment amounted to UZS 8,590 thousand per hectare. The corresponding figures were UZS 9,290 thousand/ha for maize + mung bean, UZS 9,650 thousand/ha for maize + white bean, and UZS 10,280 thousand/ha for the three-component treatment.

In the three-component treatment, total expenditure per hectare was UZS 1,690 thousand, or 19.7%, higher than in sole maize. This increase was mainly due to additional costs for seed, crop care, and harvesting.

Table-1 Production costs under sole cropping and intercropping treatments, thousand UZS/ha

Treatments	Seed	Fertilizers and agronomy	Irrigation and crop care	Harvesting	Total costs
Maize (sole cropping)	920	3850	2140	1680	8590
Mung bean (sole cropping)	760	2980	1760	1320	6820
White bean (sole cropping)	810	3140	1820	1390	7160
Maize + mung bean	1180	4020	2280	1810	9290
Maize + white bean	1240	4170	2360	1880	9650
Maize + mung bean + white bean	1460	4380	2480	1960	10280

Table-2 Calculated economic indicators of sole cropping and intercropping treatments based on field experiment results

Treatments	Green-mass yield, t/ha	Gross output value, thousand UZS/ha	Total costs, ming so‘m/ga	Conditional net income, thousand UZS/ha
Maize (sole cropping)	42,6	17040	8590	8450
Mung bean (sole cropping)	18,4	9200	6820	2380
White bean (sole cropping)	20,1	10050	7160	2890
Maize + mung bean	50,4	21320	9290	12030
Maize + white bean	52,2	22160	9650	12510
Maize + mung bean + white bean	55,4	23910	10280	13630

However, higher expenditure per hectare does not necessarily mean that a technology is economically inefficient. The decisive factors in evaluating economic efficiency are the total quantity and value of the output obtained in return for the expenditure. The three-component treatment produced a total green-mass yield of 55.4 t/ha.

For intercropping treatments, gross output value was calculated separately for each component. For maize + mung bean, with yields of 38.8 t/ha of maize and 11.6 t/ha of mung bean, the calculation was:

38.8 × 400 + 11.6 × 500 = UZS 21,320 thousand/ha.

38,8 × 400 + 11,6 × 500 = 21320 ming so‘m/ga.

For maize + white bean:

39.4 × 400 + 12.8 × 500 = UZS 22,160 thousand/ha.

39,4 × 400 + 12,8 × 500 = 22160 ming so‘m/ga.

In the three-component treatment, total expenditure per hectare was UZS 1,690 thousand, or 19.7%, higher than in sole maize. This increase was mainly due to additional costs for seed, crop care, and harvesting.

37,9 × 400 + 9,4 × 500 + 8,1 × 500 = 23910 ming so‘m/ga.

Conditional net income was calculated by subtracting total production costs per hectare from the gross output value.

Conditional net income was UZS 8,450 thousand/ha in sole maize, UZS 12,030 thousand/ha in maize + mung bean, UZS 12,510 thousand/ha in maize + white bean, and UZS 13,630 thousand/ha in the three-component treatment. The research results likewise report conditional net income of UZS 13,630 thousand/ha for the three-component treatment.

In the three-component treatment, total expenditure per hectare was UZS 1,690 thousand, or 19.7%, higher than in sole maize. This increase was mainly due to additional costs for seed, crop care, and harvesting.

These economic indicators were calculated to compare treatments using the yields obtained in the field experiment and the adopted estimated prices. They may differ from official economic results under production conditions.

Table-3 Cost of one tonne of green mass under sole cropping and intercropping treatments

Treatments	Total costs, ming so‘m/ga	Yield, t/ha	Cost per tonne of product, thousand UZS/t
Maize (sole cropping)	8590	42,6	201,6
Mung bean (sole cropping)	6820	18,4	370,7
White bean (sole cropping)	7160	20,1	356,2
Maize + mung bean	9290	50,4	184,3
Maize + white bean	9650	52,2	184,9
Maize + mung bean + white bean	10280	55,4	185,6

The cost per tonne of green mass was calculated as the ratio of total expenditure per hectare to the total green-mass yield obtained. The corresponding values were calculated as UZS 201.6, 370.7, 356.2, 184.3, 184.9, and 185.6 thousand per tonne.

In sole maize, the cost per tonne of green mass was UZS 201.6 thousand/t, whereas in the intercropping treatments it ranged from UZS 184.3 to 185.6 thousand/t. The lowest cost, UZS 184.3 thousand/t, was recorded in maize + mung bean.

In the three-component treatment, total expenditure per hectare was UZS 1,690 thousand, or 19.7%, higher than in sole maize. This increase was mainly due to additional costs for seed, crop care, and harvesting.

Thus, although total expenditure per hectare increased to some extent under intercropping, the higher total biomass yield reduced the cost per unit of product. In the experimental calculations, the three-component treatment performed best in terms of conditional net income, while maize + mung bean performed best in terms of cost per tonne of green mass.

Profitability of intercropping technology, resource use, and production efficiency. Profitability is one of the key indicators of the economic efficiency of an agrotechnology and expresses the ratio of conditional net income to total production costs.

The profitability rate was calculated using the following formula:

$R = (D / X) \times 100,$

where R is the profitability rate (%); D is conditional net income (thousand UZS/ha); and X is total production costs (thousand UZS/ha).

Table-4 Calculated profitability indicators of the treatments based on field experiment results

Treatments	Total costs, ming so‘m/ga	Gross output value, thousand UZS/ha	Conditional net income, thousand UZS/ha	Profitability, %
Maize (sof ekish)	8590	17040	8450	98,4
Mung bean (sole cropping)	6820	9200	2380	34,9
White bean (sole cropping)	7160	10050	2890	40,4
Maize + mung bean	9290	21320	12030	129,5
Maize + white bean	9650	22160	12510	129,6
Maize + mung bean + white bean	10280	23910	13630	132,6

The highest calculated profitability in the experiment was recorded for maize + mung bean + white bean, at 132.6%. Profitability was 129.5% for maize + mung bean and 129.6% for maize + white bean.

The profitability of the three-component treatment was 34.2 percentage points higher than the 98.4% recorded for sole maize. This indicates that, despite higher expenditure per hectare, the treatment generated greater gross output value and conditional net income.

Table-5 Sof va qo‘shib ekish variantlarida resurslardan foydalanish samaradorligi

Treatments	Water use, m^3/ha	Mineral nitrogen, kg/ha	1 t mahsulotga suv sarfi, m^3/t	1 t mahsulotga mineral azot, kg/t	LER
Maize (sof ekish)	4820	220	113,1	5,16	1,00
Mung bean (sole cropping)	3640	90	197,8	4,89	1,00
White bean (sole cropping)	3710	95	184,6	4,73	1,00
Maize + mung bean	4980	180	98,8	3,57	1,54
Maize + white bean	5060	175	96,9	3,35	1,56
Maize + mung bean + white bean	5190	165	93,7	2,98	1,80

These resource-use indicators are reported at the same values in the current version of the dissertation.

Total water use per hectare was slightly higher in the intercropping treatments than in sole maize. Sole maize used 4,820 m³/ha, compared with 5,190 m³/ha in the three-component treatment. However, the opposite trend was observed when calculated per unit of product: water use was 113.1 m³ per tonne of green mass in sole maize and 93.7 m³/t in the three-component treatment.

Consequently, water use per tonne of product in the three-component treatment was 19.4 m³/t, or 17.2%, lower than in sole maize. Therefore, the water-use efficiency of intercropping is more clearly demonstrated by water consumed per unit of product than by total water use per hectare.

A similar pattern was observed for mineral nitrogen. Sole maize received 220 kg N/ha, compared with 165 kg N/ha in the three-component treatment. Per tonne of product, the indicator decreased from 5.16 to 2.98 kg N/t.

However, it would not be appropriate to interpret this difference solely as a direct result of biological nitrogen fixation. Separate research data on the amount of biologically fixed nitrogen and a complete nitrogen balance would be required.

When land-use efficiency was assessed using the LER coefficient, values of 1.54, 1.56, and 1.80 were recorded for maize + mung bean, maize + white bean, and the three-component treatment, respectively. An LER of 1.80 means that, under sole cropping, an estimated 1.80 hectares would be required to produce the component yields obtained from one hectare of intercropping.

Confirmed economic efficiency of intercropping technology under production conditions. To assess the practical significance of the field-experiment results, the intercropping technology was also tested under production conditions. According to official information, research and production trials were conducted on 10.0 ha at the “Komiljon-saxovati” farm and 7.0 ha at the “Topil qizi

Tug‘majon” farm in Yangiyo‘l District, Tashkent Region, and on 2.5 ha at the experimental station of the Institute of Genetics and Plant Experimental Biology in Zangiota District, covering 19.5 ha in total.

In production trials in Zangiota District, the maize + mung bean treatment yielded 44.9 t/ha of green mass and 12.3 t/ha of dry mass, providing an additional 4.4 t/ha of green mass and 2.3 t/ha of dry mass compared with sole maize.

Official data from Yangiyul District and the regional level recorded a total green-mass yield of 55.4 t/ha, dry-matter yield of 14.8 t/ha, and crude-protein yield of 1.98 t/ha for maize + mung bean + white bean.

Economic efficiency was also high under production conditions. According to the official certificate, profitability was 125.3% for maize + mung bean, 128.9% for maize + white bean, and 135.4% for maize + mung bean + white bean.

In the three-component treatment, total expenditure per hectare was UZS 1,690 thousand, or 19.7%, higher than in sole maize. This increase was mainly due to additional costs for seed, crop care, and harvesting.

The difference between the 132.6% profitability calculated in the field experiment and the 135.4% recorded under production conditions is not a contradiction; it reflects differences in the calculation basis and conditions. The 132.6% figure was calculated to compare treatments using field-trial yields, costs, and adopted estimated prices. The 135.4% figure is an economic indicator officially confirmed by the relevant organization on the basis of production results.

In conclusion, the economic advantages of intercropping were confirmed both in the field experiment and under production conditions. In the field experiment, the three-component treatment achieved conditional net income of UZS 13,630 thousand/ha and calculated profitability of 132.6%; under production conditions, conditional net income reached UZS 19,120 thousand/ha and profitability was

135.4%. At the same time, lower water and mineral nitrogen use per unit of product and an LER coefficient of 1.80 indicate that this technology is also advantageous in terms of resource use.

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