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Article

State Incentive Adjusted For Payment Terms And A Water-Saving Cropping Structure: The Case Of Sunflower (Section "Agricultural economics")

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Abstract: The article proposes a minimum-incentive formula that links the state incentive paid to sunflower growers to the payment term in the purchase contract. In the household-farm sample (income/cost = 0.962), break-even requires an incentive of 4.0% of the price (on-time payment), 5.7% (30 days) and 9.1% (90 days); each 30-day delay raises the required incentive by about 1.7 percentage points. Under water scarcity, yield falls almost proportionally to water supply, and in a survey in Bukhara and Navoi provinces the water-saving priority was associated with income stability.

Keywords: state incentive, payment term, minimum incentive, water saving, sunflower.

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1. Introduction

Resolution No. 438 of the Cabinet of Ministers of 14 July 2025 sets four rules for oilseeds: rotation of oilseeds on up to 5% of irrigated land, no more than two years of an oilseed on one field, green manure after sunflower monitored by satellite images, and purchase contracts through the "Agroportal" information system [1]. The resolution does not specify the incentive paid per hectare or per tonne; it refers only to preferential credit and instructs the Ministry of Agriculture to prepare a proposal on additional support[2]. The rules exist, but the content of the incentive is not yet defined. The size of an incentive also depends on the payment term: when money arrives late, the real value of the price falls and the incentive may not offset the loss. Water scarcity is the main climate risk for irrigated sunflower, and farmers choose the cropping structure according to their own priorities. The aim of the article is to propose a formula that calculates the incentive together with the payment term and to present findings on the cropping structure under a water constraint and on the range of scenarios for import substitution[3].

In 2023 Türkiye paid 1 TL/kg for sunflower, about 9–10% of the Thrace price of 10,500 TL/t. Kazakhstan paid 22,000 tenge (about USD 48) per tonne of seed delivered to a domestic processor, financed by a 20% export duty on seed. The role of payment terms was shown for Nepalese sugarcane growers: payment delay had a significant negative effect on output, while the minimum purchase price and subsidy became insignificant under delay. A meta-analysis of contract farming estimated the mean income effect at 38%, but publication bias may inflate it; reviews note that conclusions are often unreliable because of methodological limits [4]. Setting an incentive apart from the payment term may therefore cancel its effect, yet Uzbekistan has no simple criterion that calculates this link. Studies in Uzbekistan have examined the options and constraints of crop diversification and second-crop production in the Ferghana Valley in relation to the state order. For irrigation, field evidence for repeat sunflower after winter wheat in Tashkent province (27.1 c/ha with 2,435 m^3/ha) is available, but it does not show how farmers choose between water-saving and cash-income cropping structures[5].

2. Research methodology

The incentive (share π of the price) must cover the cost in present value: $R(1 + \pi)/(1 + rt/365) \geq 1$, where R is the revenue-to-cost ratio without incentive and delay, r is the farmer's alternative annual rate and t is the payment delay in days. The minimum break-even incentive follows:

$$\pi^* = \frac{1+r\,t/365}{R} - 1 \qquad (1)$$

Yield loss under water deficit was estimated with the FAO yield–water relationship [10]:

$$1 - \frac{Y_a}{Y_m} = K_y\left(1 - \frac{ET_a}{ET_m}\right) \qquad (2)$$

where Y_a and Y_m are actual and maximum yield; ET_a and ET_m are actual and maximum evapotranspiration; K_y is the yield response factor (0.95 for sunflower over the whole season). For R we used the ratio of total income to total cost of household farms in 2015–2024 from the National Statistics Committee (0.962) and the US NDSU cost budget (1.053); r = 20% is conditional. The water baseline is a repeat-crop trial in Tashkent province (2,435 m³/ha, 27.1 c/ha). Farmer priorities come from a survey in the irrigation command area of Bukhara and Navoi provinces, which together gave 7.2% of the national sunflower area and 17.2% of output in 2024. The respondents were farm managers and irrigation staff with at least three seasons of sunflower and five years of experience; the target population was about 150 people and the sample 96, drawn by purposive multistage selection. The questionnaire had 35 items. Three alternative cropping structures (cash-income-oriented, water-saving-oriented and an integrated one) were compared by the analytic hierarchy process (AHP), and income-loss risk was modelled with parametric hazard models (Weibull, Gompertz, exponential). Because the output series is short, forecasting methods were checked by rolling one-year-ahead tests (errors measured by MAE, RMSE and MAPE) for 2021–2024.

3. Analysis And Results

Minimum incentive. According to Table 1, in the household-farm sample an incentive of 4.0% of the price suffices when payment is on time, 5.7% is needed at a 30-day delay and 9.1% at 90 days[6].

Table 1. Minimum incentive π^* required for break-even (% of price; r = 20%)

Baseline	*R*	No delay	30 days	60 days	90 days
Household farms	0.962	4.0	5.7	7.4	9.1
Revenue equals cost	1.000	0.0	1.6	3.3	4.9
NDSU budget (USA)	1.053	–5.0	–3.4	–1.9	–0.3

Source: *author's calculation by formula (1) (conditional); a negative value means break-even without any incentive.*

Each 30-day delay raises the required incentive by $r \cdot 30/(365R) \approx 1.7$ percentage points. Table 2 shows the joint effect of the incentive and the delay on the margin: without incentive the household-farm sample loses 3.8% of cost, and a 90-day delay deepens the loss to 8.4%. An incentive of 5% of the price turns the loss into a gain of 1.0% when payment is on time, but at a 30-day delay the result falls to –0.7%. An incentive of about 9.5% (the Turkish level) still yields 3.6% at 30 days, but at 90 days the result is close to zero (0.3%)[7-10].

Table 2. Effect of the incentive and payment delay on the margin (% of cost; *R* = 0.962; *r* = 20%)

Incentive, % of price	No delay	30 days	90 days
0	–3.8	–5.4	–8.4
5.0	1.0	–0.7	–3.8
9.5	5.3	3.6	0.3

Source*: author's calculation (conditional).*

We therefore propose to tie the incentive to the payment term: 6% of the price for payment within 30 days and 7.5% within 60 days. The shorter the term, the cheaper the incentive is for the state.

Financial scale. If the incentive is USD 32–48 per tonne of seed delivered under contract (the Turkish and Kazakh levels), the annual cost for 60 thousand tonnes of seed is USD 1.92–2.88 million. That seed (40% oil yield) gives 24 thousand tonnes of oil, 10.7% of 2025 crude oil imports (225.0 thousand t), worth USD 24.4 million at the import price (USD 1,015/t). This is a gross comparison that ignores processing costs and the seed price, so it is not a net effect. At 20 c/ha, 60 thousand tonnes require about 30 thousand ha, 2.6 times the 2024 area (11.6 thousand ha)[11].

Water scarcity. By formula (2), yield falls almost in proportion to water supply (Table 3). Water productivity hardly changes (1.11–1.14 kg/m³), so spreading water thinly over all fields does not raise total output: it is better to give full water to a smaller area, since sowing, seed and machinery costs depend on area. Under a water limit the unit of decision should be cubic metres, not hectares. This ignores rainfall and soil moisture; the effect of salinity (about 47% of irrigated land in Karakalpakstan) was not assessed for lack of data[12].

Table 3. Effect of water deficit on yield and water productivity (scenario)

ET_a/ET_m, %	Yield loss, %	Yield, c/ha	Water, m³/ha	Productivity, kg/m³
100	0.0	27.1	2,435	1.11
90	9.5	24.5	2,192	1.12
80	19.0	22.0	1,948	1.13
70	28.5	19.4	1,704	1.14

Source: *author's calculation by formula (2); $K_y = 0.95$; baseline from.*

Farmer priorities. In the Bukhara–Navoi survey drought risk was the decisive AHP criterion (weight 0.607), followed by water productivity (0.230); economic profitability had the smallest weight (0.055). The cash-income-oriented structure ranked first overall (0.553), the integrated structure second (0.290) and the water-saving structure third (0.158) (Table 4). The lead of the cash-income structure comes mainly from its high score on the heaviest criterion, drought risk (0.761)[13].

Table 4. AHP priorities of cropping-structure alternatives (96 respondents)

Criterion	Weight	Cash income	Integrated	Water saving
Drought risk	0.607	0.761	0.158	0.082
Water productivity	0.230	0.082	0.761	0.158
Income retention	0.108	0.615	0.066	0.319
Profitability	0.055	0.103	0.216	0.682
Overall priority	1.000	0.553	0.290	0.158

Source: *criterion weights normalised from the goal column of the weighted supermatrix; alternative columns show local priorities.*

The hazard models give a different picture (Table 5). The hazard ratio of the water-saving priority is far below one in all three models: 0.126 (p = 0.012) in the Weibull, 0.105 (p = 0.007) in the Gompertz and 0.239 (p = 0.063) in the exponential model. Irrigation efficiency also lowers the risk (0.971; p = 0.033–0.035), whereas drought risk raises it 1.9–2.4 times but only in the Gompertz model and at the 10% level. The cash-income incentive (0.445–0.485) and the profitability index (1.088–1.138) are insignificant in every model (p > 0.29). The Gompertz model fits best (Akaike information criterion, AIC = 154.9); the exponential model is insignificant overall (p = 0.148), so the conclusion rests on the first two[14].

Table 5. Hazard ratios for the risk of losing farm income

Factor	Weibull	Gompertz	Exponential
Water-saving priority	0.126**	0.105***	0.239*
Cash-income crop incentive	0.485	0.463	0.445
Profitability index	1.118	1.138	1.088
Drought risk	2.195	2.418*	1.911
Irrigation efficiency	0.971**	0.971**	0.981

Source*: A ratio below one means the factor lowers the risk of income loss; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.*

Read together, respondents put drought risk and cash income first when deciding, yet in the survey data income retention is associated with the water-saving priority and irrigation efficiency, not with the cash-income incentive. Water-saving measures should thus be justified to farmers as a tool of income stability, not as a constraint that cuts income. The survey rests on self-reported assessments, costs were not measured, and the sample is purposive and limited to two provinces[15].

Forecast tests and sensitivity. The output series is short (9 years), volatile (coefficient of variation 26.6%) and without a significant trend (Mann–Kendall test [20], $p = 0.47$). Four simple methods were tested one year ahead for 2021–2024 (Table 6): the last value gave the smallest error (MAE 6,224 t; MAPE 21.8%) and the linear trend the largest (MAE 9,025 t). With only four observations the conclusion is not firm, but errors of 22–30% of output show that working with a single point forecast is unwarranted. As for margins, a 10% yield gain moves the household-farm result from –3.8% to +5.8%, while a 10% fall in yield or price deepens the loss to –13.5%; a loss at baseline is offset by a yield or price rise of about 4% (1/0.962 – 1)[16].

Table 6. Rolling one-year-ahead tests of simple forecasting methods, 2021–2024

Method	MAE, t	RMSE, t	MAPE, %
Last value	6,224	7,770	21.8
Historical mean	7,779	9,091	28.8
Linear trend	9,025	9,101	30.0
Mean of last 3 years	8,143	9,325	29.9

Source: *author's calculation. MAE — mean absolute error; RMSE — root mean squared error; MAPE — mean absolute percentage error.*

Scenarios. Instead of one forecast we propose a scenario range. Historical output ranged from 22.7 to 53.8 thousand tonnes (mean 35.4; last three years 31.0). Thirty thousand ha at 20 c/ha give 60 thousand tonnes, above the 2016 record. Replacing 10, 25 and 50% of 2025 crude oil imports needs 56, 141 and 281 thousand tonnes of seed, or about 28, 70 and 141 thousand ha at 20 c/ha (2.4, 6.1 and 12.1 times the 2024 area; Table 7). The path should therefore be gradual: first up to 20–30 thousand ha, then expansion according to trial results[17-20].

Table 7. Area needed to replace part of crude oil imports (scenario)

Share of 2025 imports replaced, %	Seed, thousand t	Area at 20 c/ha, thousand ha	Multiple of 2024 area
10	56.3	28.1	2.4
25	140.6	70.3	6.1
50	281.3	140.6	12.1

Source: *author's calculation; 2025 crude oil imports 225,010 t; oil yield 40% (conditional).*

Conclusion

Setting the incentive apart from the payment term may cancel its effect: in the household-farm sample break-even requires an incentive of 4.0% of the price (on time) to 9.1% (90 days), and each 30-day delay adds about 1.7 percentage points. Under water scarcity yield falls almost proportionally to water supply, so water should be allocated by cubic metres to a smaller area; in the survey the water-saving priority, unlike the cash-income incentive, was associated with lower income-loss risk. Simple forecasts err by 22–30%, so scenarios are preferable to a point forecast. Recommendations: the Ministry of Agriculture should set the incentive per tonne and link it to the payment term (for example 6% of the price within 30 days and 7.5% within 60 days); contracts should fix a payment term of no more than 30 days; in water-limited areas the sown area should follow the water limit, and water saving should be promoted through extension as a tool of income stability; expansion should be gradual, to 20–30 thousand ha first. Limitations: R and r are conditional, the incentive calculation gives a gross comparison rather than a net effect, and the survey covers two provinces with self-reported data; the calculation should be updated once farm-level cost and price data are collected.

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