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Model For Improving The Mechanism Of Financial Sustainability Of Uzbekistan's Agricultural Sector: Integration Of Crediting, Insurance, And Subsidization Based On A Risk-Oriented Approach

[1] Saidnabiyev Saidalo Saidaliyevich

[1] International Center for Strategic Development and Research in the Field of Food and Agriculture, Independent Researcher, Uzbekistan

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Abstract

In the context of high volatility in agricultural product prices, climatic and water-related risks, seasonal cash flow gaps, and a limited collateral base, the financial sustainability of Uzbekistan's agricultural sector becomes a key prerequisite for ensuring food security and sustainable regional growth. The purpose of this article is to develop a risk-oriented model for improving the mechanism of financial sustainability of the agricultural sector based on the integration of three interrelated instruments: crediting, insurance, and subsidization.

Keywords: Financial sustainability, agricultural sector of Uzbekistan, risk-oriented approach, agricultural crediting, agricultural insurance, government subsidies, integrated support model, seasonal liquidity, stress testing, debt burden management, climate risks, risk segmentation.

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1. Introduction

The financial sustainability of Uzbekistan's agricultural sector is shaped under conditions in which traditional financing instruments face a "dual uncertainty." On the one hand, this uncertainty arises from the production-climatic and biological nature of the agricultural cycle; on the other hand, it is driven by market volatility in prices, logistics costs, and access to credit resources. For most agricultural producers, seasonal cash flow gaps, mismatches between the duration of the production cycle and debt repayment schedules, sensitivity to yield and water-availability shocks, and a limited collateral base are typical. As a result, financial sustainability acquires a systemic character: the problem goes beyond the solvency of individual farms and becomes a task of coordinating credit, insurance, and budgetary policies within a unified risk management architecture.

2. Methodology

The methodological framework of the study is based on a combination of the systems approach, risk-oriented management, and financial analysis tools adapted to the

seasonal nature of agricultural production.

Theoretical and Conceptual Framework. With regard to financial sustainability, the study relies on the corporate finance tradition of analyzing liquidity, solvency, and capital stability (structure of financing sources, debt burden, and the capacity to service obligations), complemented by concepts of financial constraints and credit risk, in which access to financing depends on information asymmetry and the quality of collateral. In terms of risk management, the research applies integrated risk management approaches in agriculture, where the key elements include risk identification, risk measurement, the selection of risk transfer and mitigation instruments, and the assessment of residual risk.

The financial sustainability of the agricultural sector in Uzbekistan can be interpreted as the ability of agricultural producers and the sector as a whole to maintain the continuity of the production cycle, fulfill debt obligations, and preserve investment capacity under the impact of both typical and extreme shocks (yield, price, water availability, diseases, and logistics). The key specificity lies in the seasonal structure of cash flows: the bulk of costs is incurred prior to the sale of the harvest, while revenues are concentrated within a short period following harvesting and marketing.

Risks in agricultural production should be rationally distributed across three layers, as each layer requires a different financial instrument.

The first layer consists of frequent, relatively small losses (local deviations in yields, minor supply disruptions, and short-term price fluctuations). It is economically more efficient to manage these risks through self-insurance mechanisms, improved technological practices, liquidity reserves, and flexible credit repayment schedules.

The second layer comprises moderate losses of medium frequency (significant yield reductions at the district level, disease outbreaks, and noticeable price downturns). In this case, insurance instruments (classical or index-based) are most appropriate, along with credit covenants that automatically adjust repayment schedules upon the occurrence of an insured event.

The third layer consists of catastrophic losses (droughts/extreme heat, major floods, large-scale epizootics), in which the private insurance market—without reinsurance and government support—either fails to provide coverage or makes insurance premiums unaffordable. At this layer, the role of the state is to organize catastrophic reinsurance or a dedicated fund and to ensure predictable rules for budgetary participation, so as not to replace insurance ex post with ad hoc compensations.

Table 1. Risk Matrix of the Agricultural Sector for Risk-Oriented Design of Instruments (Credit–Insurance–Subsidy)

Risk Group	Typical manifestations	Channel of Financial Impact	**Preferred Management Instrument**	**Key Data for Monitoring**
Climatic and Water-Related	drought, water scarcity, heat/frost, flooding	yield reduction → revenue decline; increased irrigation costs	index-based / multi-risk insurance; catastrophic reinsurance; subsidies for water-saving technologies	precipitation, temperature, NDVI / satellite indices, water withdrawal, zonal yields
Production and Biological	pests, plant and animal diseases, soil degradation	cost escalation, crop losses, livestock losses	livestock/crop insurance; preventive subsidies; credit for biosecurity and equipment	veterinary and phytosanitary data, livestock mortality, field

				treatment records
Price and Market	price declines, contract disruptions, export volatility	decline in margins and working capital	commodity and contract schemes, forward contracts, turnover-based credit limits; subsidies for storage and logistics	selling prices, inventory levels, contract structure
Financial (Liquidity/Debt)	seasonal cash flow gaps, interest rate increases, payment arrears	inability to service debt, penalties, restructuring	"seasonal" credit repayment schedules; DSCR covenants; premium/interest subsidies; guarantee instruments	monthly cash flow, DSCR, D/E, arrears
Operational and Logistical	storage losses, supply disruptions, fuel shortages	increase in costs, losses in quality and volume	property and business interruption insurance; infrastructure financing; subsidies for cold-chain development	storage losses, downtime, transport routes
Institutional/Regulatory	regulatory changes, administrative delays	growth of transaction costs, failure to meet deadlines	standardization of procedures, digitalization, "one-stop shop" mechanisms	application processing times, rejection rates, data completeness

Source: compiled by the author based on FAO/OECD approaches to agricultural risk management and the principles of risk-oriented financial analysis and supervision (including bank credit risk management practices).

To link crediting, insurance, and subsidization, a unified set of indicators is required that measures sustainability not "on an annual average basis," but with explicit consideration of seasonality and shocks.

The proposed model employs four analytical blocks: liquidity and seasonal cash flow; debt burden; margin sustainability; and the quality of risk management (including insurance coverage and preventive measures).

Table 2. Indicators of the Financial Sustainability of an Agricultural Enterprise in a Risk-Oriented Model (with Practical Thresholds)

Block	Indicator	Definition and Calculation	Interpretation (Benchmarks)

Seasonal Liquidity	Minimum Cash Gap (Min Cash Gap)	minimum value of cumulative monthly cash flow	the closer to zero, the more sustainable; a deep negative value requires a seasonal repayment schedule, liquidity reserves, and/or an insurance linkage
Debt Servicing	DSCR (Debt Service Coverage Ratio)	operating cash flow / debt service payments for the period	>1.2 – sustainable; 1.0–1.2 – borderline; <1.0 – risk of delinquency
Debt Burden	D/E, Debt/EBITDA (adjusted)	debt to equity; debt to operating profit	excessive values increase sensitivity to shocks and require insurance and/or guarantees
Margin and Sustainability	"Shock Margin"	margin under a stress scenario (yield/price/costs)	if the margin turns negative under a moderate shock, risk transfer is needed (insurance and/or preventive subsidies)
Risk Management	Insurance Coverage	share of cultivated areas/livestock covered by insurance; quality of coverage (risks/limits/deductible)	high coverage reduces credit risk and strengthens eligibility for preferential terms
Data and Discipline	Accounting Transparency and Payment History	availability of digital accounting, verifiable reporting, and payment discipline	with high discipline, more favorable credit conditions are possible and a lower share of "compensatory" subsidies is required; priority shifts to preventive support

Source: compiled by the author based on banking financial analysis practices (liquidity, debt burden, DSCR) and international recommendations on agricultural finance and risk management (FAO, World Bank, OECD).

Below is an illustrative stress test (a conditional example) demonstrating why "separate" instruments perform worse than integrated ones.

The example is purely illustrative and is used to provide methodological justification for the proposed model.

Assume a crop-producing farm with annual revenue of 3.0 billion UZS in the baseline scenario.

Variable costs amount to 1.8 billion UZS, fixed costs to 0.6 billion UZS. Annual debt service (interest plus principal) equals 0.45 billion UZS. Thus, the baseline operating cash flow before debt service is 0.6 billion UZS, and the DSCR equals 0.6 / 0.45 = 1.33, indicating a sustainable position.

In the stress scenario, drought reduces yields by 25%, while the selling price declines by 10% (a combined effect of $0.75 \times 0.90 = 0.675$). Variable costs decrease by only 10%, as a significant share of expenses is "rigid" due to costs already incurred. Without insurance and adaptive credit mechanisms, the farm shifts into a cash flow deficit zone.

Table 3. Stress Test of the Financial Sustainability of an Agricultural Enterprise and the Effect of Instrument Integration (Illustrative Example, billion UZS)

Indicator	Baseline	Stress Scenario without Integration	Stress Scenario with Integration (Insurance + Adaptive Credit + Subsidy)
Revenue	3,00	2,03	2,03

Variable costs	1,80	1,62	1,62
Fixed costs	0,60	0,60	0,60
Operating cash flow before debt service	0,60	-0,19	-0,19
Insurance indemnity (payout)	0,00	0,00	0,45
Temporary budget support (interest subsidy / premium subsidy / anti-crisis grant)	0,00	0,00	0,08
Operating cash flow before debt service including insurance/support	0,60	-0,19	0,34
Debt service payments (original schedule)	0,45	0,45	0,45
Debt service payments (adaptive schedule: partial principal deferral)	0,45	0,45	0,30
DSCR (based on the actual repayment schedule)	1,33	-0,43	1,12

Source: Author's calculations based on the seasonal resilience stress testing methodology and the DSCR indicator; scenario and payment parameters are provided as illustrative examples to illustrate the integration mechanism.

The stress test's conclusion is fundamental: even with a preferential loan without insurance, a farm remains vulnerable to a weather shock. Conversely, insurance without an adaptive loan schedule may not close the cash flow gap over time. Therefore, integration should be technical, not declarative: an insured event should trigger a change in the loan schedule, and the subsidy should be tied to prevention and insurance coverage, not simply to the issuance of a loan.

Segmentation is necessary to improve targeting and budget efficiency: identical benefits for farms with different risk profiles lead to either budget overspending or underfunding of vulnerable segments. The model proposes 3-4 segments, where criteria are formed according to a matrix: environmental risk (climate/water/market) and management quality (discipline, data, insurance coverage, technology).

Table 4. Package integration of lending, insurance and subsidies by risk segments (risk-oriented design logic)

Segment Profile	Risk and Discipline	Credit (Design)	Insurance (Design)	Subsidization (Design)
A: low risk / high discipline	stable revenue, DSCR consistently above 1.2; digital accounting; diversification	standard interest rate below the market average; seasonal repayment schedule; fast turnover-based credit limit	mandatory basic coverage (cropland/livestock), with an optional index-based add-on	priority is placed not on compensation, but on co-financing preventive measures (irrigation, storage, digitalization)
B: medium risk / medium discipline	DSCR 1.0–1.2; seasonal cash flow gaps; partial transparency	concessional credit subject to mandatory insurance; liquidity covenants;	multi-risk / index-based coverage with an optimal deductible	premium and/or interest subsidies, conditional on risk and discipline criteria (data

		partial guarantee		quality, technologies)
C: high risk / improvement potential	high climate/water risk zone; DSCR frequently below 1.0 without support; weak accounting	limited credit; mandatory adaptive repayment schedule; possible grace period	extended coverage plus a catastrophic layer through reinsurance or a dedicated fund	a higher share of premium subsidies; grants for risk reduction (water-saving measures, resilient varieties), conditional on the digitalization of accounting
D: high risk / low discipline	systemic arrears, lack of data, absence of insurance	**credit only subject to restructuring and approved recovery plans**	insurance is possible only after meeting minimum data standards	subsidies are provided not for compensation, but for "entry conditions" (accounting, auditing, training), followed by a transition to segment C

Source: developed by the author based on the principles of risk-oriented regulation and targeted subsidization practices; the logic of the packages reflects the linkage between financing conditions ↔ insurance protection ↔ risk prevention.

To ensure that the model does not remain merely a "paper-based scheme," an organizational and technological linkage among stakeholders is required.

The key solution is a unified digital profile of the farm (an "agro-financial passport") that includes core financial indicators, a seasonal calendar of costs and revenues, data on cultivated areas or livestock, the geographic risk zone, insurance status, credit discipline history, and a list of risk-mitigation technologies applied. This profile serves as a single "source of truth" for banks, insurers, and subsidy-administering authorities, thereby reducing transaction costs and enhancing transparency.

Next, a trigger rule is introduced: the occurrence of an insured event automatically activates a pre-agreed credit adaptation mechanism (deferral of part of the principal, extension of maturity, rescheduling of payments to the marketing period), while the subsidy switches to a liquidity support and production recovery mode, subject to compliance with financial discipline and verification of damage or the relevant index.

The proposed model should be implemented not as a "single package of measures," but as a managed system with clear and transparent rules: who gains access to concessional credit, under what conditions risks are insured, which subsidies are activated and by which triggers, how financial discipline is measured, and how support parameters change as the risk profile improves or deteriorates.

Within Uzbekistan's institutional framework, elements of such an architecture are already taking shape: the establishment of an Agricultural Insurance Fund has been formalized, the "Agricultural Insurance" information system has been launched, and at the state level there is ongoing discussion of a transition toward a "discipline-for-accessible-credit" model, as well as the reform of subsidies through a specialized payment agency.

3. Conclusion

The conducted study confirms that the financial sustainability of Uzbekistan's agricultural sector is determined to a decisive extent not only by the level of interest rates or the volume of credit, but by the architecture of risk allocation among producers, the financial sector, and the state. The seasonal nature of cash flows, the high dependence of yields on climatic and water-related factors, and price volatility create a

situation in which the "separate" application of instruments (concessional credit in isolation, insurance in isolation, and subsidies in isolation) reduces the effectiveness of each of them: credit increases vulnerability to shocks, insurance without linkage to the credit repayment schedule may fail to cover temporary cash flow gaps, and subsidies without risk segmentation become costly and difficult to manage.

Limitations of the Study and Directions for Further Research.

The limitations of the study are related to the availability and quality of risk statistics (on yields, vulnerability zones, losses, and payout timelines), as well as to the heterogeneity of farms' financial reporting. These constraints define directions for further research, including the calibration of risk-segmentation thresholds by districts and crops, the development of regional stress scenarios (water, climate, and prices), an econometric assessment of the impact of insurance coverage on credit risk, and an evaluation of the budgetary efficiency of "preventive" subsidies compared to ex post compensation mechanisms.

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