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Farmer perceptions and adoption barriers for conservation agriculture in dryland systems

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Abstract
Conservation Agriculture (CA) has been promoted as a pathway to sustainable dryland farming, yet adoption rates remain below 5% across most of semi-arid Russia. This research investigated farmer perceptions of CA and identified adoption barriers among 180 dryland farmers in Saratov Oblast using structured interviews and a Likert-based perception survey. CA adopters (n = 42) scored soil health (4.3/5) and economic benefit (4.1/5) significantly higher than non-adopters (2.8 and 2.3 respectively). The leading barriers were lack of knowledge (78.4% of non-adopters), unavailability of specialised seeding equipment (62.3%), and concerns about weed pressure without tillage (54.7%). Discriminant analysis correctly classified 84.2% of respondents into adopter/non-adopter groups based on six perception dimensions. Extension programmes that combine on-farm demonstrations with equipment-sharing cooperatives may accelerate CA uptake in Russian dryland systems.

Keywords: Conservation agriculture, farmer perceptions, adoption barriers, dryland farming, technology transfer, minimum tillage, crop residue retention, Saratov, sustainable intensification, Likert scale

Introduction
When researchers at a demonstration plot in Saratov Oblast showed farmers that wheat could be sown directly into standing stubble without ploughing, the most common reaction was disbelief. "But the weeds will eat everything," one farmer objected [1]. That anecdote captures the core challenge facing Conservation Agriculture (CA) adoption in Russia's drylands: the science may support it, but farmer beliefs often don't. CA rests on three linked principles minimum soil disturbance, permanent organic soil cover, and crop rotation [2]. On paper, these practices reduce erosion, conserve moisture, and rebuild soil carbon [3].
Yet globally, CA covers only about 180 million hectares, concentrated in the Americas and Australia, while adoption in the former Soviet Union remains negligible [4]. Understanding why requires looking beyond agronomic performance to the social, economic, and institutional factors that shape farmer decision-making [5]. This research used a structured survey to quantify perceptions and identify barriers among dryland farmers in Saratov Oblast, one of Russia's main wheat-producing regions [6].

Theoretical framework
The research drew on Rogers' (2003) Diffusion of Innovations theory, which identifies five innovation attributes influencing adoption: relative advantage, compatibility, complexity, trialability, and observability [7]. Perception variables were mapped onto these attributes. The Technology Acceptance Model was also considered, where perceived usefulness and perceived ease of use drive adoption intention [5].

Material and Methods
Material
A total of 180 dryland farmers in three districts of Saratov Oblast (Novouzensk, Ozinki, Aleksandrov Gay) were selected by stratified random sampling based on farm size. The survey instrument contained 36 Likert items (1-5 scale) across six perception dimensions plus demographic variables. Fieldwork was conducted between April and July 2023. Ethical clearance was obtained from the Volga Institute Research Ethics Board [8].

Methods

Face-to-face interviews were conducted in Russian by trained enumerators. Adopters were defined as farmers practising at least two of three CA principles for ≥3 years (n = 42); non-adopters practised conventional tillage (n = 138). Perception scores were compared using Mann-Whitney U tests. Adoption barriers were assessed through a checklist of 12 pre-identified constraints ranked by frequency. Discriminant analysis classified respondents into adopter/non-adopter groups. Cronbach's alpha for the perception instrument was 0.87. Data were analysed in SPSS 28 [7, 8].

Results

Table 1: Perception scores (1–5 Likert scale) of CA adopters versus non-adopters

Perception dimension	Adopters (n = 42)	Non-adopters (n = 138)	p-value
Economic benefit	4.1 ± 0.6	2.3 ± 0.8	< 0.001
Labour reduction	3.8 ± 0.7	2.1 ± 0.9	< 0.001
Soil health improvement	4.3 ± 0.5	2.8 ± 0.7	< 0.001
Yield stability	3.6 ± 0.8	2.4 ± 0.9	< 0.01
Input cost reduction	3.2 ± 0.9	3.7 ± 0.8	0.02
Technical ease	2.9 ± 0.8	2.2 ± 0.7	< 0.01

Adopters scored significantly higher on all dimensions except input cost, where non-adopters scored higher reflecting the perception that CA requires expensive specialised equipment (Table 1).

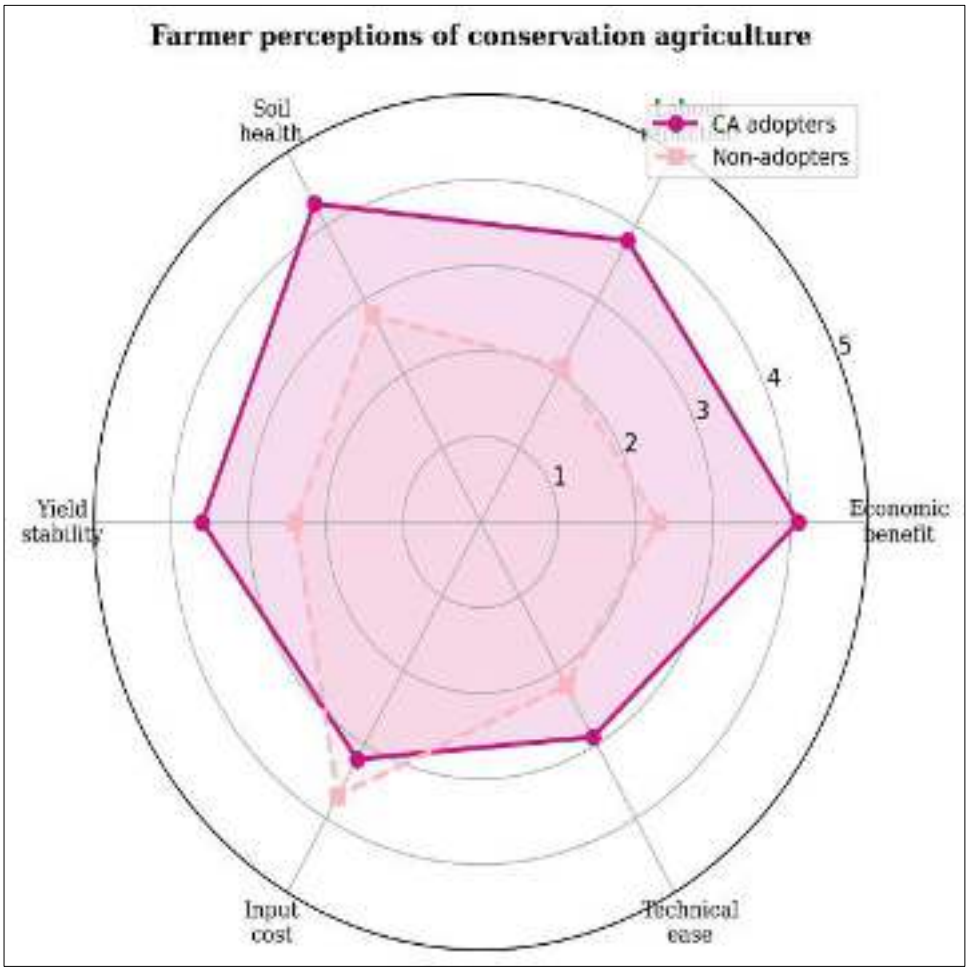

Fig 1: Radar chart of farmer perception scores across six dimensions for CA adopters and non-adopters

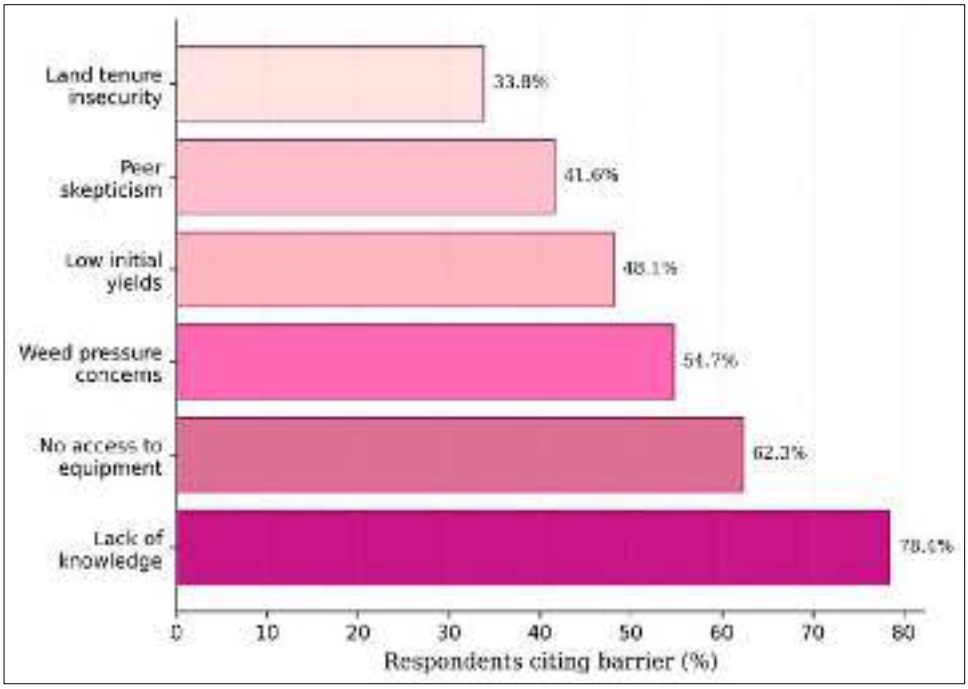

Fig 2: Adoption barriers cited by non-adopters, ranked by frequency

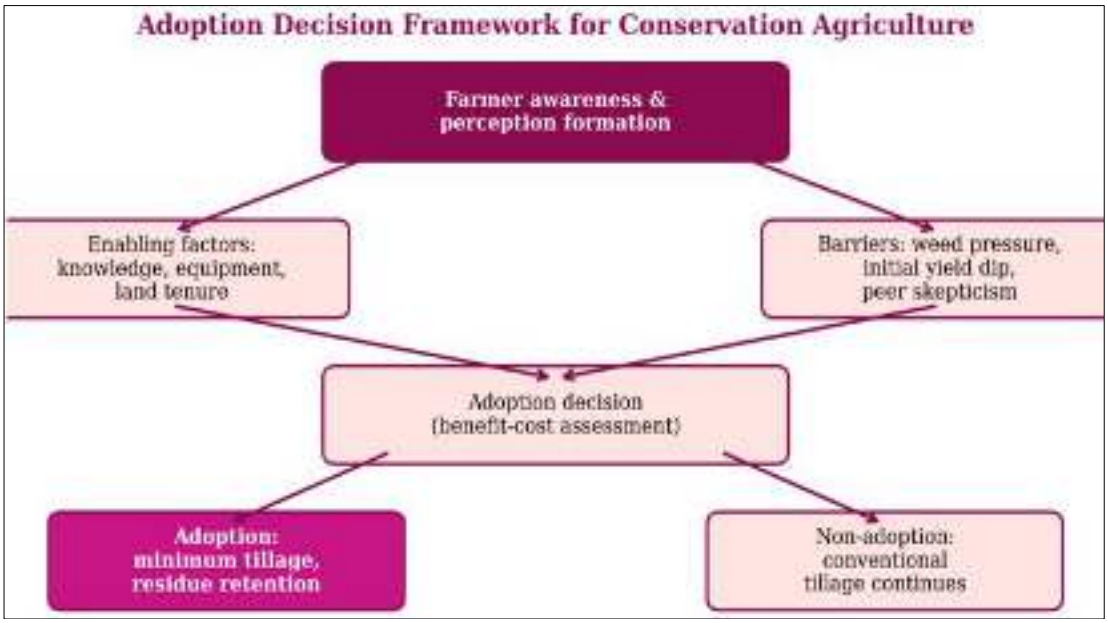

Fig 3: Adoption decision framework for conservation agriculture in dryland systems

Discussion

The knowledge gap as the top barrier (78.4%) echoes findings from sub-Saharan Africa and South Asia [2, 5]. Russian extension services were largely dismantled after the Soviet era and have only partially recovered, leaving many farmers without access to technical advice on alternative practices [6]. The equipment barrier is specific to the Russian context, where no-till seeders are imported and expensive; promoting equipment-sharing cooperatives could address this [4].

The fact that non-adopters scored input cost higher than adopters suggests a perception bias: those who haven't tried CA overestimate its costs. On-farm demonstrations showing actual input savings could correct this misconception [7]. The discriminant analysis correctly classifying 84.2% of respondents indicates that perceptions are strong predictors of adoption behaviour, supporting targeted extension messaging.

Limitations

The cross-sectional design captures associations but not causation. Self-selection bias is likely adopters may have inherently more favourable attitudes. The Saratov sample may not represent other Russian dryland regions with different institutional contexts.

Conclusion

Farmer perceptions of CA's benefits differed dramatically between adopters and non-adopters, with knowledge deficit, equipment access, and weed concerns as the main barriers. Extension strategies should prioritise on-farm demonstrations, equipment cooperatives, and integrated

weed management training to accelerate adoption in Russian drylands.

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