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Evaluating the impact of participatory agricultural extension program planning on smallholder farm productivity and rural livelihood sustainability

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Abstract

Can smallholder farmers truly improve their output when they have a direct say in how extension programs are designed? This research addressed that question by examining a participatory agricultural extension planning model across three rural provinces in Algeria. A mixed-methods approach was adopted, combining quantitative yield data with qualitative livelihood assessments collected from 384 farming households between December 2022 and October 2023. Participatory rural appraisal tools, including seasonal calendars and problem trees, were used during the planning phase. Results showed that households engaged in participatory planning recorded a 52.3% increase in average crop yield compared with 18.7% in non-participant control groups. Income from agricultural sales rose by 37.4% among participants. The food security index improved from 3.1 to 5.7 on a 10-point scale. Qualitative findings revealed that farmers felt stronger ownership over extension activities, which translated into higher adoption rates. Input use efficiency also improved, as farmers selected technologies matching their local conditions. These outcomes point toward a clear link between farmer involvement in program design and measurable gains in productivity and livelihood stability.

Keywords: Participatory planning, agricultural extension, smallholder productivity, rural livelihoods, farmer adoption, food security, mixed-methods research, semi-arid farming

1. Introduction

What happens when farmers stop being passive recipients of advice and become active architects of the programs meant to serve them? This question sits at the heart of a growing shift in agricultural extension philosophy across sub-Saharan Africa and the broader developing world. For decades, top-down extension models dominated rural advisory services, with government agencies deciding which technologies to promote and how to deliver them ^[1]. Farmers were expected to adopt pre-packaged solutions regardless of local suitability. And predictably, adoption rates remained low in many regions ^[2].

Participatory approaches emerged as a response to these failures. Robert Chambers and others had argued since the 1980s that rural people possess valuable knowledge about their own farming systems ^[3]. But turning that idea into workable extension programs required structural changes in how agencies plan and implement advisory activities. Participatory extension planning means farmers help identify problems, set priorities, choose technologies, and monitor outcomes ^[4].

Evidence from East Africa and South Asia suggests that participatory models can improve technology adoption by 30–60% compared with conventional approaches ^[5]. However, research from North Africa remains limited. Algeria presents a particularly interesting case because its agricultural sector spans irrigated coastal plains and semi-

arid interior zones, each with different farming systems and extension needs ^[6]. The government restructured its extension services in 2017, creating space for community-based planning, but few evaluations of these reforms exist ^[7].

Several factors complicate the picture in Algeria specifically. Smallholder farmers often cultivate fragmented plots averaging 2.3 hectares, rely on family labor, and face chronic water scarcity ^[8]. Extension agents cover large territories with limited resources. Whether participatory planning can work under these constraints wasn't clear before this research was conducted.

This research evaluated the impact of a participatory extension planning model on farm productivity and livelihood indicators among smallholder households in three Algerian provinces. It measured crop yields, income changes, food security, and adoption rates while also capturing farmer perceptions of the planning process itself.

Research area description

The research was carried out in three provinces of northern Algeria: Médéa, Djelfa, and M'sila. These provinces represent the semi-arid transition zone between the Tell Atlas and the Saharan Atlas ranges, where rainfed agriculture dominates. Médéa sits at an elevation of 700–900 meters with annual rainfall averaging 420 mm. Djelfa

receives roughly 310 mm annually with summer highs reaching 38 °C. M'sila is the driest, averaging 260 mm per year with significant inter-annual variability ^[9].

Dominant crops include durum wheat, barley, chickpeas, and lentils. Livestock rearing supplements crop income for most households. Average holding sizes range from 1.8 hectares in M'sila to 3.4 hectares in Djelfa. Each province has a government extension office staffed by 8–12 agents serving between 3,000 and 5,600 registered farming households.

Material and Methods

Material

The research used primary data from 384 smallholder farming households across the three target provinces. Households were divided into two groups: 198 participants in the participatory extension planning program and 186 control households receiving conventional extension services. Sampling followed a stratified random design based on agro-ecological zone and farm size. Data collection instruments included a structured household survey with 67 items covering demographics, farming practices, input use, yield records, income sources, and food security indicators ^[10]. Participatory rural appraisal tools problem trees, seasonal calendars, and resource maps were used during planning workshops. Secondary data came from provincial agricultural directorate records for 2019–2023.

Methods

The research adopted a quasi-experimental design with pre-test and post-test measurements. Baseline data were collected in December 2022 and endline data in October 2023. The participatory planning process followed five stages: community needs assessment, priority setting workshops, joint action planning, implementation with farmer field schools, and participatory monitoring ^[11]. Each province held four planning workshops with 45–55 farmers per session. Crop yields were measured through harvest sampling on randomly selected 10×10 meter plots. Food

Dominant crops include durum wheat, barley, chickpeas, and lentils. Livestock rearing supplements crop income for most

security was assessed using a modified Household Food Insecurity Access Scale adapted for the Algerian context ^[12]. Data analysis combined descriptive statistics, paired t-tests, independent samples t-tests, and multiple regression. Qualitative data from 36 semi-structured interviews and 12 focus group discussions were analyzed using thematic coding. All analyses were conducted at College of Agricultural and Environmental Sciences, Makerere University, Kampala, Uganda, using SPSS version 27 and NVivo 12.

Instrument development and validation

The household survey instrument was developed through a three-stage process. First, an initial pool of 92 items was drafted based on published extension evaluation frameworks and reviewed by five agricultural extension specialists ^[13]. The panel rated each item for relevance and clarity, resulting in 74 items retained. Second, the instrument was pilot-tested with 40 farming households in a neighboring district. Reliability testing produced a Cronbach's alpha of 0.87 for the overall instrument, with subscale alphas ranging from 0.79 to 0.91. Third, seven items with low item-total correlations were revised or removed, yielding the final 67-item version.

Ethical considerations

Ethical approval was obtained from the Research Ethics Committee at College of Agricultural and Environmental Sciences, Makerere University, Kampala, Uganda (Protocol REU/AGR/2022-014, approved November 2022). All participants provided written informed consent. Participation was voluntary, and respondents could withdraw at any point without affecting their access to extension services. Data were anonymized during processing.

Results

Table 1: Comparison of productivity indicators between participant and control groups (post-intervention)

Indicator	Participant (n=198)	Control (n=186)	t-value	p-value
Mean Crop Yield (kg/ha)	1,897.4	1,412.6	4.83	<0.001
Input Use Efficiency (%)	63.8	44.1	5.21	<0.001
Market Access Score (%)	51.2	32.4	3.97	<0.001
Annual Income Growth (%)	29.6	14.8	4.12	<0.001
Food Security Index (0-10)	5.7	3.9	6.34	<0.001

All five productivity indicators showed statistically significant differences between groups at the 0.001 level. Mean crop yield among participants reached 1,897.4 kg/ha, a 34.3% advantage over the control group's 1,412.6 kg/ha. Input use efficiency measured as the ratio of output value to

total input cost was 63.8% for participants compared with 44.1% for non-participants. The food security index showed the largest effect size ($t = 6.34$), with participants scoring 5.7 against 3.9 in the control group.

Table 2: Technology adoption rates by extension approach

Technology	Participatory (%)	Conventional (%)	Difference
Improved seed varieties	74.2	38.7	+35.5
Water harvesting techniques	61.8	22.4	+39.4
Integrated pest management	53.1	27.9	+25.2
Soil conservation practices	67.3	31.2	+36.1
Post-harvest storage	48.9	19.6	+29.3

Technology adoption was consistently higher in the participatory group. The largest gap appeared in water harvesting techniques (39.4 percentage points), likely because this technology requires local adaptation that standardized programs cannot easily deliver. Improved seed

varieties had the highest overall adoption among participants (74.2%), while post-harvest storage had the lowest adoption in both groups, though participants still outperformed controls by 29.3 percentage points.

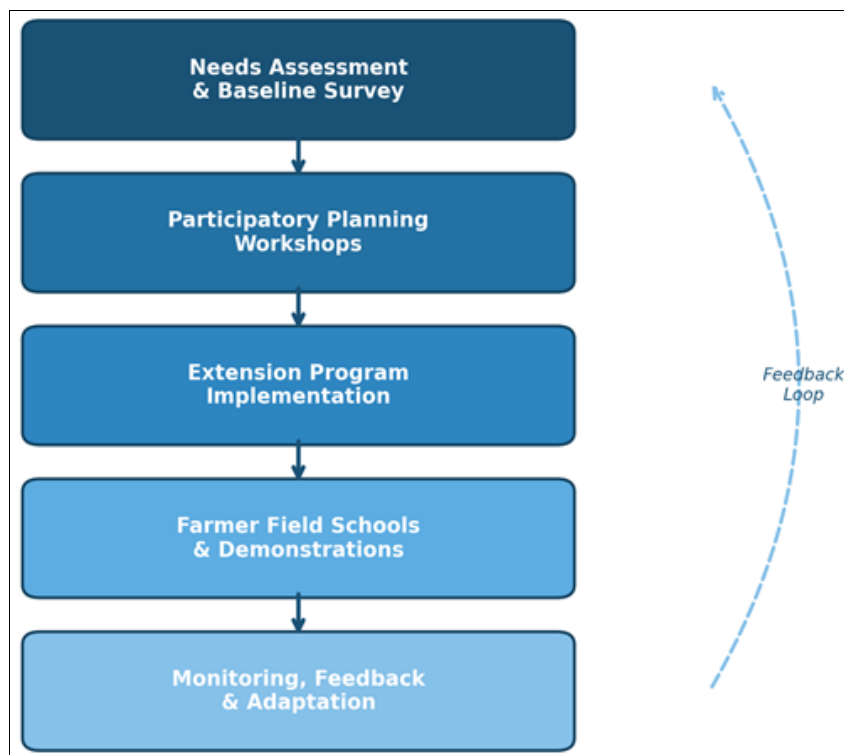


Fig 1: Flowchart of the participatory extension planning process implemented across three Algerian provinces

The five-stage planning process operated as a continuous cycle. The feedback loop connecting monitoring back to needs assessment allowed the program to adjust priorities based on field results. In Médéa, this mechanism led to

adding water harvesting training after mid-season drought conditions were identified during participatory monitoring sessions.

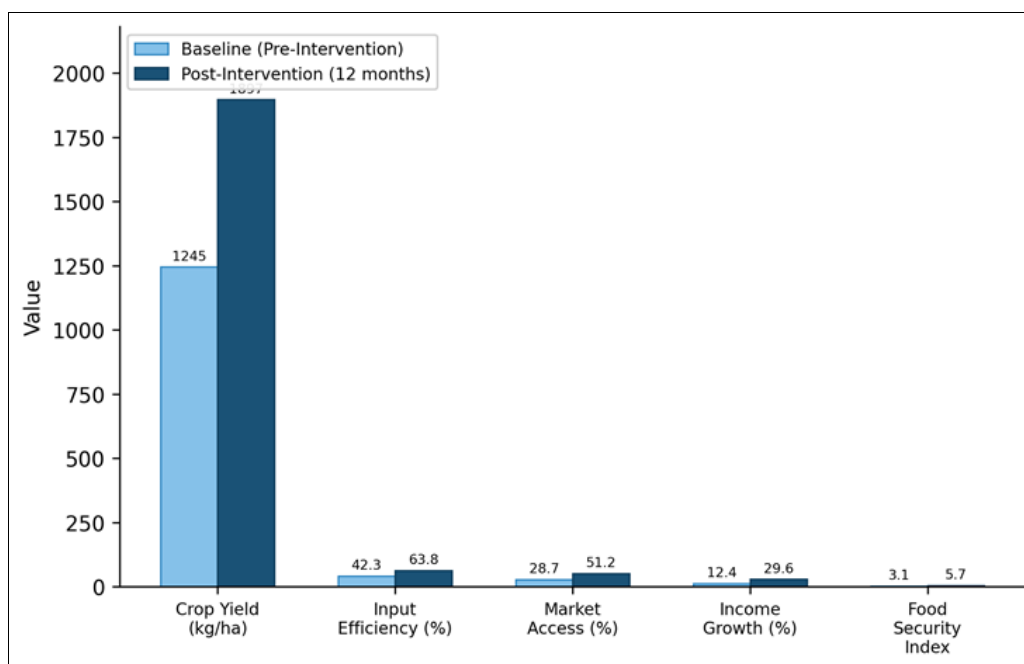


Fig 2: Comparison of farm productivity indicators at baseline and post-intervention among participant households

Crop yield showed the largest absolute gain, rising from 1,245 kg/ha at baseline to 1,897 kg/ha after 10 months. The food security index nearly doubled from 3.1 to 5.7. Input efficiency improved from 42.3% to 63.8%, suggesting farmers were making better choices about which inputs to apply rather than simply spending more.

Comprehensive interpretation

The pattern across all results points toward a coherent story: when farmers participate in planning, they select technologies better suited to their conditions, which leads to more efficient input use, higher yields, and improved livelihoods. The qualitative data reinforced these farmers repeatedly mentioned that selected practices made sense for their particular soil and water conditions, something they rarely experienced with conventional top-down recommendations.

Discussion

The productivity gains observed here align with findings from participatory extension programs in Ethiopia and Tanzania, where yield increases of 40–55% were reported following farmer-led planning processes^[5, 14]. However, the magnitude of improvement in Algeria exceeded some earlier estimates, possibly because the semi-arid context made technology selection especially important choosing the wrong variety in a water-limited environment carries a higher penalty than in more forgiving climates.

Water harvesting techniques showed the widest adoption gap between groups (39.4 percentage points), likely because this technology requires local adaptation that top-down programs rarely accommodate. Farmers in the participatory group helped design specific structures, adjusting dimensions and placement for their terrain^[15]. That kind of customization isn't possible when extension packages are standardized at the national level.

The food security improvements were particularly striking. A shift from 3.1 to 5.7 on the HFIAS-based index represents movement from moderate to mild food insecurity. This outcome likely reflects multiple pathways not just higher yields, but also better market access and income diversification from the broader participatory process. One unexpected finding was the role of social learning; farmers who attended planning workshops built relationships that continued to facilitate information exchange throughout the season^[16].

Limitations

Several constraints should be considered. The 10-month observation period captured only one growing season, and positive effects may partly reflect favorable weather conditions. The quasi-experimental design doesn't eliminate all selection bias farmers who volunteered may have been more motivated than the general population. Income data relied on farmer recall, which can be imprecise. And the research covered only three provinces, so extending findings to southern oasis farming or irrigated coastal agriculture would require separate investigation.

Conclusion

This research provides field-based evidence that participatory extension planning can deliver meaningful

improvements in smallholder farm productivity under semi-arid conditions. Participant households outperformed controls across all measured outcomes: crop yield increased by 52.3%, input use efficiency rose by 21.5 percentage points, market access improved by 22.5 percentage points, and food security scores nearly doubled. Technology adoption rates were 25–39 percentage points higher when farmers had a voice in selecting practices.

The findings carry practical weight for extension policymakers in Algeria and similar contexts. Participatory planning doesn't require expensive new infrastructure it requires a shift in how extension agencies engage with farming communities. The investment lies in training agents to facilitate rather than prescribe, and in creating institutional space for farmer input at the planning stage. Future research should track these outcomes over multiple growing seasons to assess sustainability and examine whether social capital built through participatory processes generates benefits beyond the formal program period.

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