DIAMOND OPEN ACCESS · ISSN 2819-6252 (ONLINE)
CIMEGS-SEJ
Socio-Economic Journal
journal homepage: journal.cimeg.ca

VOLUME 2
ISSUE 2
YEAR 2026

RESEARCH ARTICLE

Reported Adoption of Precision Agriculture and Organic Practices among Fruit Growers in Tissemsilt Province, Algeria

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ARTICLE INFO

Article history
Received 23 April 2026
Revised 5 May 2026
Accepted 2 September 2026
Published 1 October 2026

Keywords
Precision agriculture
Organic practices
Fruit growers
Adoption
Water access
Tissemsilt
Algeria

JEL classification
Q12, Q16, O33

ABSTRACT

Background: This study examines knowledge, reported practices and perceived barriers relating to precision agriculture (PA) and organic farming (OF) among fruit growers in Tissemsilt Province, Algeria. It distinguishes the use of particular practices from independently verified adoption or organic certification.

Methods: Fieldwork took place from 14 September 2025 to 21 January 2026. A purposive sample of 128 growers in eight communes completed a face-to-face questionnaire. Two institutional leaders participated in semi-structured interviews. The analysis combines descriptive survey indicators, an exploratory logistic model of reported organic practices and thematic interpretation of the institutional interviews.

Results: Reported familiarity with PA was 7.8%, reported use of a PA tool or practice was 4.7%, and intention to adopt was 35%. For OF, familiarity was reported at 80%, use of organic methods at 34%, intention at 90% and certification at approximately 1%. Cooperative membership and the extension-services measure had positive coefficients in the exploratory organic-practice model. Water scarcity was the most frequently reported barrier, at 94%. These indicators describe the selected sample; practices, certification and environmental outcomes were not independently verified.

Conclusions: The findings suggest a need to consider water access, usable advice and the costs of participation together. They do not establish that water infrastructure must precede every technical improvement or that a particular subsidy, extension method or label will improve adoption. Clear practice definitions, complete measurement documentation and follow-up data would strengthen further assessment.

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Cite this article: Difallah, A., Bencherif, S., & Zoubeidi, M. (2026). Reported Adoption of Precision Agriculture and Organic Practices among Fruit Growers in Tissemsilt Province, Algeria. *CIMEGS-SEJ*, *2*(2), 22–28. https://doi.org/10.68808/pyx5rf37

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1. Introduction

Precision agriculture uses information about variation in crops, soils or field conditions to support management decisions. It includes a range of technologies and practices, so the adoption of one tool should not be confused with the use of an integrated system. Lowenberg-DeBoer

and Erickson (2019) show why definitions matter when comparing adoption, and Say et al. (2018) review differences among technologies and settings.

Organic farming concerns a defined production system, while certification provides assurance against specified standards. The use of manure or the avoidance of some synthetic inputs does not by itself demonstrate compliance with an organic standard. The organic agriculture yearbook distinguishes production, operators and markets within this wider context (Willer et al., 2020). In this study, OF practice refers to respondents' reports, unless certification is explicitly mentioned.

The study asks how participating fruit growers in Tissemsilt understand PA and OF, which practices they report using, and which constraints they consider important. Adoption decisions involve knowledge, the fit of a technology with the farm and the support available. Aubert et al. (2012) examine expertise and compatibility in Canadian farms, while Tey and Brindal (2012) review factors associated with PA adoption. Their findings provide a basis for enquiry rather than a prediction about every grower in Tissemsilt.

Research on organic adoption also considers farmers' aims and policy conditions. Kallas et al. (2010), for example, examine adoption decisions in Catalonian vineyards. Berkes (2012) offers a perspective on knowledge developed through relationships with the environment. These sources help frame questions about local practices; neither traditional knowledge nor low input expenditure is sufficient evidence of organic compliance.

We examine reported knowledge and use, perceived barriers and accounts of institutional support. The survey provides descriptive evidence from a purposive sample, supplemented by an exploratory model of reported organic practices. It does not evaluate the causal effects of extension services, credit or water infrastructure.

2. Methodology

2.1. *Study area*

The research concerns fruit growers in Tissemsilt Province in Algeria. The province includes mountainous and high-plain settings, and the map in Figure 1 provides geographical context. WeatherSpark's city-level description identifies hot, dry summers and cold winters (WeatherSpark, n.d.). It is a local climate summary, rather than a province-wide rainfall normal.

Water access is a central issue in the growers' accounts examined here. Use of drip irrigation is treated as a reported characteristic of the survey sample. It is not presented as an independently verified adoption rate for all farms in the province.

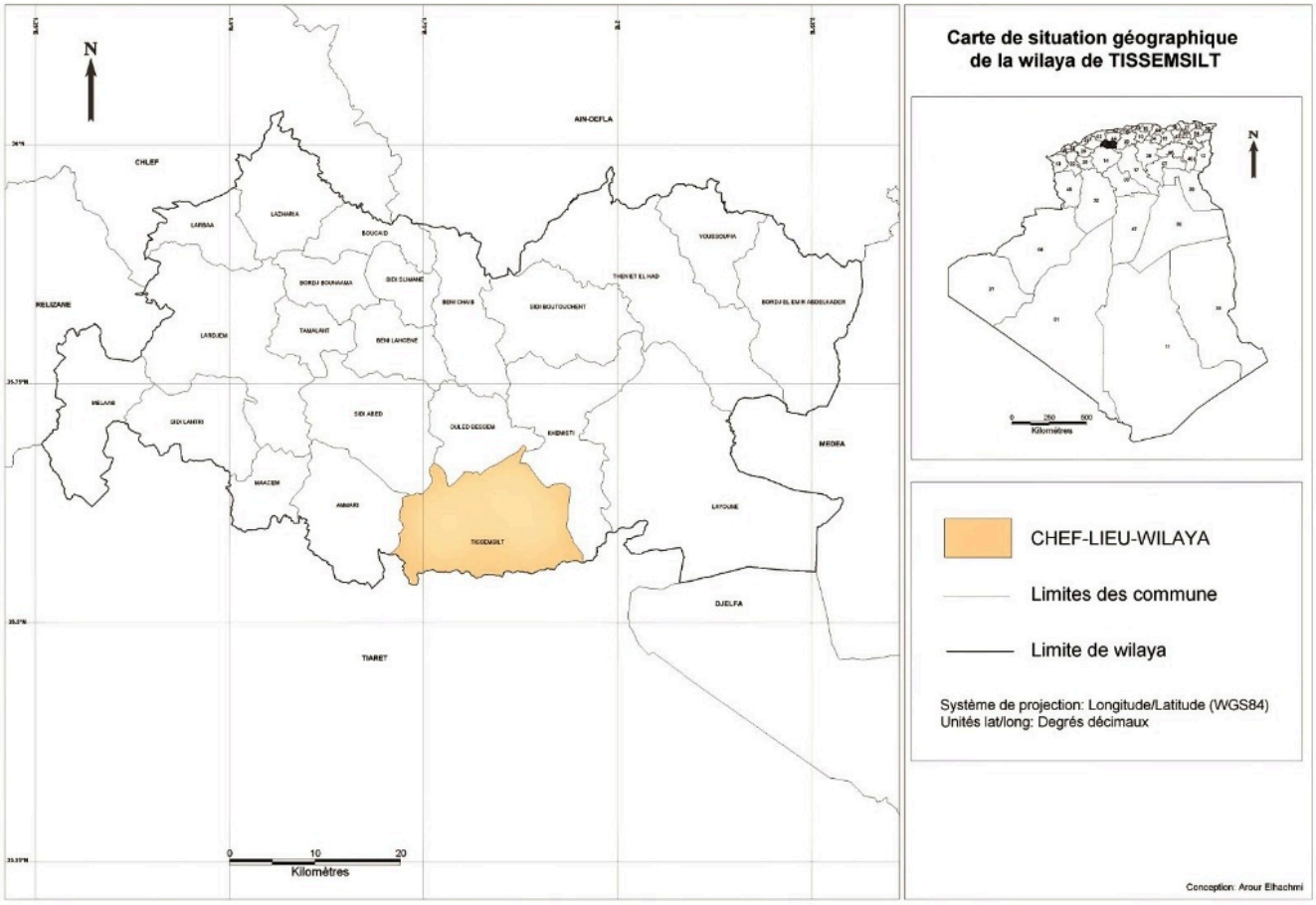


Fig. 1. Geographical context of Tissemsilt Province

Source: Map by Elhachmi Arour (2014). The map provides geographical context and does not identify the eight sampled communes.

2.2. *Sampling and data collection*

Data collection took place from 14 September 2025 to 21 January 2026. The mixed-methods design combined a grower questionnaire with two semi-structured institutional interviews.

2.2.1. Participants

The purposive sample comprised 128 fruit growers in eight communes. Selection targeted growers considered relevant because of their potential interest in, or use of, innovative methods. This approach may favour particular kinds of participants and does not establish statistical representation of the province. The commune-level allocation, recruitment denominator and response rate are not specified.

The institutional interviews involved the Director of Agricultural Services and the President of the Chamber of Agriculture of Tissemsilt. These two leadership perspectives cannot represent all extension staff or institutional actors.

2.2.2. Instruments

The structured questionnaire covered socio-demographic characteristics, farm characteristics, PA knowledge and use, OF knowledge and use, and perceived institutional support. A pilot with ten local growers was used to review terminology and administration. The relationship between the pilot participants and the final sample is not specified. Appendix A presents the questionnaire.

The institutional interview guide addressed support policies, training and extension, perceived barriers and possible responses, and future priorities. Interviews lasted approximately 25 to 30 minutes and were recorded and transcribed for thematic interpretation. Appendix B presents the guide.

Grower responses were coded for statistical processing. The instruments describe voluntary participation and confidentiality, and the institutional guide requests permission to record. Institutional roles are identified in the study, so complete anonymity cannot be assumed for those participants.

2.3. *Analysis and interpretation*

Survey records were organised in Microsoft Excel and analysed in IBM SPSS Statistics. Descriptive percentages summarise reported characteristics, knowledge, practices and barriers. Familiarity, a self-rated knowledge score, current use and intention are different measures and are interpreted separately. The available summaries do not give item-level response counts or missing-response procedures; rounded percentages are retained without reconstructing participant counts.

An exploratory binary logistic model examined associations with reported organic practices. The predictors were cooperative membership, an extension-services measure, education level, farm size and age. Education was described as an ordered score, and non-membership was the reference for cooperative membership. The summaries do not fully specify the units or coding of age, farm size and extension. The supplied questionnaire also does not document every model predictor. These limits restrict the substantive interpretation and reproducibility of the coefficients.

The model is described through the reported coefficient tests, odds ratios and confidence intervals. The likelihood-ratio test, Nagelkerke pseudo-R^2, Hosmer-Lemeshow test and apparent classification accuracy are also reported. They do not establish causality, external predictive performance or freedom from overfitting. PA use was rare and sensitive to the adoption definition, so its determinants are not interpreted inferentially here.

The institutional interviews were interpreted through thematic analysis, using Braun and Clarke (2006) as the methodological reference. The procedure described familiarisation, coding, development and review of themes, and interpretation. Themes are used to contextualise the survey rather than estimate their prevalence in the wider farming population.

3. Findings and discussion

3.1. *Participant characteristics*

The survey summaries report 59.4% of growers as older than 45 and 44.5% as having no formal education. These are different characteristics: absence of schooling is not a test of literacy, digital capability or willingness to adopt a technology. Age alone does not establish resistance to innovation.

Table 1 summarises the reported age, education and irrigation indicators. The reported drip-irrigation share is 64%. Drip equipment may offer a basis for further irrigation management, but its presence alone does not demonstrate PA adoption or measured water savings.

Table 1 Reported profile indicators in the grower sample

Indicator	Reported percentage
Older than 45	59.4%
No formal education	44.5%
Drip irrigation	64%
Gravity irrigation	36%

Source: Study survey, 2025-2026; total sample n = 128. Percentages describe the participating sample.

3.2. *Knowledge and reported use*

PA familiarity was reported at 7.8%, and the mean self-rated knowledge score was 2.1 on the questionnaire's five-point scale. Reported use of a PA tool or practice was 4.7%. Reported examples included mobile-controlled irrigation and occasional soil or water analysis. These reports do not establish the extent to which information was used to manage spatial or temporal variation. They are therefore described as reported use rather than verified system adoption.

Intention to adopt PA was reported at 35%. Intention is not a forecast of uptake or a substitute for observed use. Definitions and the range of technologies matter when comparing these indicators with adoption research (Say et al., 2018; Tey & Brindal, 2012; Lowenberg-DeBoer & Erickson, 2019).

For OF, familiarity was reported at 80%, intention at 90% and current practices at 34%. The practices described included manure use and avoidance of synthetic pesticides. These descriptions do not demonstrate compliance with a complete organic production standard. Approximately 1% of the sample was reported as certified, without independent inspection of certification records.

Table 2 Reported knowledge use and intention indicators

Measure	PA	OF
Familiarity	7.8%	80%
Intention to adopt	35%	90%
Reported current practice	4.7%	34%
Reported certification	Not reported	Approximately 1%

Source: Study survey summaries, 2025-2026; total sample n = 128. Measures are presented separately and are not parts of one percentage distribution. Certification and practice claims were not independently verified.

3.3. *Exploratory associations with reported organic practices*

Table 3 presents the reported logistic coefficients for organic practices. Cooperative membership and the extension-services measure have positive coefficients with $p < .001$. Education, farm size and age do not reach the .05 level in this model. The estimates concern conditional associations within the selected sample, not effects of membership or advisory services.

Table 3 Exploratory logistic model of reported organic practices

Predictor	B	SE	Wald χ^2	p	OR	95% CI for OR
Cooperative membership	1.815	0.549	10.938	< .001	6.144	2.095 to 18.017
Extension services	2.641	0.599	19.455	< .001	14.033	4.339 to 45.384
Education level	-0.132	0.229	0.332	.565	0.877	0.560 to 1.372
Farm size	-0.543	0.394	1.899	.168	0.581	0.268 to 1.258
Age	0.583	0.365	2.541	.111	1.791	0.875 to 3.665

Model summary as reported: n = 128; likelihood-ratio $\chi^2(5) = 68.847$, $p < .001$; Nagelkerke pseudo-$R^2 = .575$; Hosmer-Lemeshow $\chi^2(8) = 4.120$, $p = .846$; apparent classification accuracy = 81.3%. Nagelkerke R^2 is a pseudo-R^2 measure, not a percentage of outcome variance explained. A non-significant Hosmer-Lemeshow result does not prove model validity. Classification accuracy is an in-sample summary, and the classification threshold and an external validation result are not given.

Source: Coefficient summaries reported for the study's SPSS analysis. OR = odds ratio; CI = confidence interval. Estimates refer to the model's coded predictors. The units of age and farm size and the distinction between extension contact and frequency are not fully specified, so their odds ratios are not interpreted per year, hectare or additional visit.

Cooperative members had higher reported odds of organic practice than non-members in the fitted model (OR = 6.144, 95% CI 2.095 to 18.017). The extension measure also has a positive coefficient (OR = 14.033, 95% CI 4.339 to 45.384), but its coding limits interpretation of the contrast. The wide intervals indicate substantial uncertainty. These associations may reflect selection, shared characteristics or other unmeasured influences; the study cannot establish their direction over time.

The model makes advisory support and cooperative participation relevant topics for further investigation. It does not establish that organic adoption depends exclusively on social capital or that such support causes conversion. Kallas et al. (2010) examine different objectives and policy influences in another production setting, which reinforces the need for context-specific interpretation.

3.4. *Reported barriers and institutional perspectives*

Water scarcity was the most frequently reported barrier, at 94%. The institutional accounts also emphasised uncertainty about irrigation water and the difficulty of planning investment under that uncertainty. These perceptions identify a priority for the participating growers; they do not show that water availability is an absolute prerequisite for every use of sensors or other management tools.

Other reported barriers concern equipment costs and credit, the accessibility of information, technical complexity and market arrangements. Table 4 presents the reported grouped categories and percentages. A combined category does not establish separate prevalence rates for its components. In particular, the literacy-and-language category is a perceived barrier, not a measurement of functional illiteracy.

Table 4 Reported barriers in the grower sample

Reported barrier category	Percentage
Water scarcity	94%
High equipment costs and credit access	78%
Literacy and language barriers	47%
Technical complexity and lack of training	36%
Lack of certified markets or trust	15%

Source: Study survey, 2025-2026; total sample n = 128. Categories are separate indicators and need not sum to 100%. Item-level counts and the coding of the open-ended barrier responses are not detailed.

The institutional themes suggest a need to consider the accessibility of extension information, practical demonstrations and water-management concerns together. They support evaluating how advice is communicated and how growers assess possible investments. Comparisons among delivery methods, collective equipment and subsidies require evidence about costs, uptake and outcomes.

4. Limitations

The purposive sample cannot establish provincial adoption rates. The eight-commune selection and the recruitment of growers considered relevant to innovation may affect the observed profile. Practices, knowledge, certification and barriers are self-reported, and no field audit, price comparison or measurement of water savings is presented. The two institutional interviews provide a narrow leadership perspective.

Measurement documentation also limits interpretation. A consistent mapping between farm-size and educational categories and the questionnaire options is unavailable, and the questionnaire does not document all regression predictors. The coding of extension, farm size and age is incomplete. Item-level denominators, missing responses, recruitment counts and the overlap between the pilot and final sample are unspecified. The exploratory organic-practice model has not been externally validated, and the cross-sectional design cannot establish causal effects or temporal order.

5. Conclusion

The surveyed growers reported limited familiarity with PA and low use of PA tools or practices. Organic methods were reported more often, but these reports do not establish compliance with an organic standard; certification was reported at a much lower level. The exploratory organic-practice model identifies associations involving cooperative membership and extension, subject to the measurement and sampling limits.

Water scarcity was the most frequently reported barrier, alongside costs, accessible information and technical support. A response could combine attention to water reliability and management with practical advice suited to growers' needs. Infrastructure and technology options should be evaluated together, rather than assume a universally effective sequence.

Possible actions include demonstrations in languages participants understand, accessible written and visual material, and trials of shared equipment where demand and costs justify them. A local product label would require clear criteria, credible verification and evidence of market demand; branding alone would not establish organic status or guarantee a price premium. Follow-up research should use explicit adoption definitions, document predictor coding and compare reported practices with field and market evidence.

Consent information: The survey and interview instruments describe voluntary participation and confidentiality. The institutional interview guide requests permission to record.

Declarations

Author Contributions. Conceptualisation and methodology: D.A., B.S. and Z.M.; software, formal analysis, investigation and data curation: D.A.; writing of the original draft, review and editing, supervision and project administration: D.A., B.S. and Z.M.

Funding. This research received no external funding.

Conflicts of Interest. The authors declare no conflicts of interest.

Data Availability Statement. The data presented in this study are available on request from the corresponding author.

Declaration of Generative AI Use. The authors used Google Gemini solely for language editing, grammar correction and proofreading. They reviewed and approved all content and take full responsibility for the accuracy, integrity and final version of the published article.

Acknowledgements. The authors thank the Directorate of Agricultural Services of Tissemsilt, local extension agents and the participating fruit growers for their time and contributions.

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Appendices

Appendix A Structured farmer questionnaire

Enumerator: _____ Date: _____ Commune: _____

Introduction and informed consent

Hello. We are conducting a study on agricultural practices in fruit arboriculture in Tissemsilt Province. Participation is voluntary and anonymous. The information collected will be used exclusively for scientific research. The interview will last approximately 25 to 30 minutes.

Section 1 Socio-demographic profile

1. Gender

[ ] Male [ ] Female

2. Age group

[ ] <30 years [ ] 30-45 [ ] 46-60 [ ] >60

3. Education level

[ ] None [ ] Primary [ ] Secondary [ ] University

4. Farming experience

[ ] <5 years [ ] 5-10 [ ] 11-20 [ ] >20

Section 2 Farm characteristics

5. Farm size

[ ] <5 ha [ ] 5-10 ha [ ] 11-20 ha [ ] >20 ha

6. Land tenure

[ ] Owner [ ] Tenant [ ] Family land [ ] Other

7. Irrigation system

[ ] Rainfed [ ] Drip [ ] Well/Borehole [ ] Traditional

8. Main fruit crops

_____

9. Number of permanent workers

[ ] 0 [ ] 1-2 [ ] 3-5 [ ] >5

Section 3 Precision agriculture

10. Familiarity with precision agriculture

[ ] Yes [ ] No

11. Knowledge level

[ ] 1 (Low) [ ] 2 [ ] 3 [ ] 4 [ ] 5 (High)

12. Currently using any precision agriculture tool or practice

[ ] Yes [ ] No

13. Main barriers to adopting precision agriculture

_____

Section 4 Organic farming

14. Familiarity with organic farming standards or practices

[ ] Yes [ ] No

15. Knowledge level

[ ] 1 (Low) [ ] 2 [ ] 3 [ ] 4 [ ] 5 (High)

16. Currently applying organic farming practices

[ ] Yes [ ] No

17. Main barriers to adopting organic farming

_____

Section 5 Perceived institutional support

18. Access to agricultural credit

[ ] Yes [ ] No

19. Main source of technical support

[ ] Extension service [ ] Private advisor [ ] Input supplier [ ] Other farmers [ ] Internet [ ] Other

20. Farmer observations and quality assessment

_____

Thank you for your time and your insights.

Appendix B Institutional interview guide

Interviewer: _____ Date: _____ Institution: _____

Introduction and informed consent

Hello. I am conducting a study on the adoption of precision agriculture and organic farming in Tissemsilt. This interview lasts approximately 25 to 30 minutes. Participation is voluntary, and the data will be anonymised. With your permission, this session will be recorded for transcription and thematic analysis.

Permission to record: [ ] Yes [ ] No

Axis 1 National and local support policies

1. Could you please introduce yourself and briefly present your institution?

_____

2. Could you describe the current state of fruit arboriculture in Tissemsilt, including area, production and cropping systems, and assess the evolution of this sector in recent years?

_____

3. Could you also indicate the potential number of fruit growers identified in Tissemsilt?

_____

4. What specific institutional frameworks or subsidy programmes exist to support the transition to high-tech or organic arboriculture in this province?

_____

Axis 2 Training and extension activities

5. How are extension services adapted to the local context, including language and literacy levels, to encourage the adoption of new agricultural practices?

_____

Axis 3 Perceptions of adoption barriers and levers

6. In your view, what are the primary structural and economic barriers preventing fruit growers from adopting precision agriculture or organic certification?

_____

7. What are the key psychological or institutional levers that have successfully motivated pioneer farmers in the region?

_____

Axis 4 Future strategic perspectives

8. What are the priority strategic objectives for your institution over the next five years regarding modernising the fruit sector?

_____

9. Do you have any final recommendations for policy changes at the Ministry of Agriculture to facilitate this transition?

_____

Thank you for your time and expertise. This interview will be transcribed to support the thematic analysis of the research.