International Journal of Plant & Soil Science

Volume 38, Issue 9, Page 239-245, 2026; Article no.IJPSS.164520
ISSN: 2320-7035

Agro-Economic Potential of Zainer Technology Compared to Endogenous Bare Land Restoration Techniques in Northern Burkina Faso

Barry Fanta [a*], Dabré Abdoulaye [b], Moyenga Sandrine [c], Ouédraogo Blaise [a], Wennink Bertus [d] and Debons Pascal [e]

[a] Centre National de la Recherche Scientifique et Technologique/Institut de l'Environnement et de Recherches Agricoles (CNRST/INERA), Ouagadougou, Burkina Faso.
[b] Netherlands Development Organization (SNV), Ouagadougou, Burkina Faso.
[c] PRACTICA Foundation, Ouagadougou, Burkina Faso.
[d] Royal Tropical Institute (KIT), Amsterdam, Netherlands.
[e] Wageningen University & Research (WUR), Wageningen, Netherlands.

Authors' contributions

This work was carried out in collaboration among all authors. Authors BF, DA and OB designed the study protocol. Author DA identificate the site and mobilized farmers for the experimental site following. Authors DA, BF and MS conducted the field experiment, measurements and collected primary data. Author BF performed statistical, economic analysis and interpretation and led the writing of the manuscript. Authors DA, OB and MS made revisions to the versions of the manuscript submitted by author BF. Authors DP and WB supervised the study and critically reviewed the manuscript. All authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.9734/ijpss/2026/v38i96286

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://pr.sdiarticle5.com/review-history/164520

Original Research Article

Received: 07/06/2026
Accepted: 19/08/2026
Published: 25/08/2026

Abstract

Aims: The study aims to evaluate the agro-economic potential of an improved zainer prototype compared with three endogenous bare land restoration techniques in northern Burkina Faso, and to identify key agronomic, economic and social determinants of its adoption.

**Corresponding author: E-mail: fanta.barry@inera.bf;*

Cite as: *Fanta, B., Abdoulaye, D., Sandrine, M., Blaise, O., Bertus, W., & Pascal, D. (2026). Agro-Economic Potential of Zainer Technology Compared to Endogenous Bare Land Restoration Techniques in Northern Burkina Faso. International Journal of Plant & Soil Science, 38(9), 239–245. https://doi.org/10.9734/ijpss/2026/v38i96286*

Study Design: Split-plot field experiment combined with producer perception surveys.
Place and Duration of Study: Village of Kounkane, Gomponsom commune, Passore Province, northern Burkina Faso, during the 2024-2025 rainy season.
Methodology: A split-plot experimental design (1,936 m², 4 blocks × 4 replicates of 100 m²) was installed on bare land (*zipella*) using four treatments: motorised *zaï* (ZMo/zainer), mechanised *zaï* (ZMe/IR12 tooth), spherical *zaï* (ZS/hoe) and rectangular *zaï* (ZR/hoe). The Flagnon sorghum variety was used across all treatments. The compost dose was 250 g/pit for ZMo, ZMe and ZS, and 500 g/pit for ZR, reflecting the agronomic recommendation for rectangular pits whose larger surface area and volume require proportionally higher organic matter input. Soil roughness index, pit dimensions, working time, fuel consumption, grain and straw yields were measured. Financial profitability was assessed using total production costs, gross margin and benefit-cost ratio (BCR). Statistical analysis used one-way ANOVA with the Newman-Keuls post-hoc test at the 5% significance level. The treatment (*zaï* type) was the experimental unit; each block (n=4) constituted an independent replication. Producer perceptions were collected from 15 farmers through structured interviews conducted with informed consent and in accordance with ethical guidelines for social science research.
Results: The rectangular *zaï* produced the widest (39.75 cm) and deepest (21.75 cm) pits with the highest roughness index (1.32) and grain yield (2,000 kg/ha). The zainer produced the shallowest pits (8.50 cm depth) with the lowest roughness index (1.05) and lowest grain yield (1,125 kg/ha), below the Flagnon field average (1,750 kg/ha). The zainer significantly reduced working time by 63% compared with rectangular *zaï* (298 vs 804 h/ha). None of the techniques was profitable in year one; the zainer recorded the largest losses (gross margin: -490,731 FCFA/ha; BCR: 0.48) mainly due to fuel costs (195 L/ha × 1,047 FCFA/L = 204,375 FCFA/ha, representing 26% of total costs). The spherical *zaï* achieved the best BCR (0.93). Producer surveys (n=15) showed that 86.7% cited high fuel consumption as the main constraint, 33.3% cited operational complexity and 80% expressed willingness to pay for the tool.
Conclusion: The zainer offers a significant labour-saving advantage (−63% working time) but its current technical design limits agronomic and economic performance. Technical redesign of the auger (target depth: 12–15 cm) and engine (lower fuel consumption) is needed before broader deployment.

Keywords: Zainer; motorized zaï; soil roughness; agro-economic performance; sorghum; Burkina Faso

1. Introduction

Soil degradation is a major global environmental challenge, affecting about 41% of emerged land and over 2.6 billion people in more than 100 countries (Barbut, 2018; Nkonya et al., 2016; Romm, 2011). In Burkina Faso, the combined effects of climate change and anthropogenic pressures have intensified this phenomenon: nearly one-third of the national territory, or over 9 million hectares, is affected, with an expansion rate estimated at 360,000 hectares per year (Food and Agriculture Organization of the United Nations [FAO], 2018). This process leads, at its ultimate stage, to the formation of sterile, impermeable crusts locally known as *zipella*, which reduce water retention capacity, increase parcel aridity and limit crop productivity (Barro et al., 2005). Recent soil characterization in the Sudano-Sahelian zone of Burkina Faso likewise identified soil-fertility constraints relevant to *sorghum* production, reinforcing the importance of soil condition in this production context (Ilboudo et al., 2025).

Zaï, a traditional practice of digging pits to concentrate water, nutrients and organic matter for crop benefit, has been a major lever for recovering bare lands since the 1980s (Lahmar & Yacouba, 2012). This technical improves soil fertility, promotes biodiversity regeneration, and can increase yields by at least 310 kg/ha compared to untreated lands (Kaboré & Reij, 2004; Bayen et al., 2011). It can take several forms: traditional spherical *zaï* by hoe (approx. 300 h/ha), mechanized *zaï* by animal traction with an IR12 tooth (approx. 50 h/ha), and, more recently, rectangular *zaï*, whose wider pits provide better water retention and have shown superior profitability (Dabre et al., 2023). Long-term studies have demonstrated that *zaï*-rehabilitated soils can sequester 0.3–0.8 t C/ha/year, improving structural stability and long-term productivity (Zougmoré et al., 2000; Roose et al., 1999). Recent studies of *zaï* configurations in semi-arid systems further indicate that pit geometry and amendment management can influence water retention and crop performance, while labor requirements remain an important practical consideration (Dabre et al., 2024; Bowers et al., 2024). Related dryland sorghum evidence also supports the importance of field configurations that conserve soil moisture when organic amendments are used (Kelem et al., 2026).

However, the arduousness of manual *zaï* and constraints on access to draught animals limit large-scale adoption of these techniques (Barro et al., 2001; Ouedraogo & Tiganadaba, 2015). In Burkina Faso, the optimal window for *zaï* preparation (February–April) coincides with peak plowing demand, creating a structural bottleneck that mechanization could address (Clavel et al., 2008; Barry et al., 2025). To address these constraints, the zainer – a motorized tool equipped with a rotary auger, developed by PRACTICA and including the third prototype popularized under the Pro-ARIDES programme – was designed to mechanize *zaï* pit digging. A first belt-driven prototype showed encouraging agronomic and economic results under controlled station conditions (Zongo et al., 2023). An improved prototype, incorporating an offset handlebar, metal wheels and a chain drive system, was subsequently developed to correct mechanical weaknesses observed under real field conditions. Nevertheless, evidence remains limited on how the improved chain-driven zainer performs under real field conditions when agronomic outcomes, first-year financial performance, and producer perceptions are assessed together against locally used restoration techniques. This article aims to (i) evaluate the agronomic performance of the improved zainer prototype compared with three endogenous bare land restoration techniques; (ii) assess its financial profitability; and (iii) document producer perceptions to inform future technical improvements and scaling decisions.

2. Material and Methods

2.1 Study Site

The experiment was conducted in the village of Kounkane, Gomponsom commune, Passore province, northern Burkina Faso (13°02'22" N, 2°11'47" W, 315 m a.s.l.), 121 km north of Ouagadougou and 12 km east of Yako. The site was selected as a Pro-

ARIDES programme intervention site because of the presence of bare lands (*zipella*) that had been unexploited for over 15 years and were characterized by soil crusting and total absence of vegetation. The climate is Sahelian-Sudanian, with a mean annual rainfall of 600 mm, a rainy season from June to October, and a mean annual temperature of 28°C. Soils are predominantly leached tropical ferruginous soils (Barro et al., 2005).

2.2 Plant and Soil Amendment Materials

The Flagnon *sorghum* variety used across all treatments is productive and *Striga*-tolerant, with a 115–120-day cycle, a potential yield of 3,200 kg/ha, and an average field yield of 1,750 kg/ha. Soil amendments included compost (N=1%, P=2.2%, K=2%, OM=51.7%, pH=8.4) and 46% urea. The four tools tested were: (i) the zainer (2 HP gasoline engine, 2 chain drives, metal wheels, offset handlebar); (ii) the IR12 tooth (INERA Reversible, 12 mm bevel-edged blade) mounted on a horse-drawn manga hoe; (iii) a hoe for spherical *zaï*; (iv) a hoe for rectangular *zaï* (Table 1).

Table 1. Composition of fertilizers used

Fertilizer	N total (%)	P total (%)	K total (%)	CaO (%)	MgO (%)	OM (%)	C/N	pH
Compost	1	2.2	2	3	2	51.7	19	8.4
Urea 46%	46	0	0	0	0	0	0	0

2.3 Experimental Design and Statistical Framework

The experimental design was a randomized complete block design (RCBD) with four blocks of 484 m² (22 × 22 m) on a 1,936 m² (44 × 44 m) bare land plot, separated by 2 m aisles. Each block was assigned to a single treatment (*zaï* type), constituting the experimental unit; the four blocks served as independent replications (n=4 per treatment). Block allocation was based on spatial homogeneity of soil compaction and topography, as assessed prior to the trial. Inter-row spacing was 80 cm, and inter-pit spacing was 40 cm. All plots received (i) compost as a basal dressing and (ii) urea on the 45th day after sowing. The four treatments were:

ZMo (motorized *zaï*): zainer + 250 g compost + 3.5 g urea per pit
ZMe (mechanized *zaï*): IR12 tooth + 250 g compost + 3.5 g urea per pit
ZS (spherical *zaï*): hoe + 250 g compost + 3.5 g urea per pit
ZR (rectangular *zaï*): hoe + 500 g compost + 3.5 g urea per pit.

The higher compost dose for ZR (500 g/pit) reflects the agronomic specificity of rectangular pits: their larger surface area (~39.75 × 21.75 cm) and greater volume require proportionally higher organic matter inputs to achieve optimal soil biological activity and nutrient retention, as recommended by Dabre et al. (2023) for this pit geometry. This design difference is an intrinsic feature of the rectangular *zaï* practice as applied in the Sahel, rather than an extraneous confounding variable; it is explicitly accounted for in the profitability calculation (Table 5). The authors acknowledge this as a limitation and recommend a factorial experiment in future studies to disentangle the effects of pit geometry and compost dose on yield.

One-way ANOVA was performed for all quantitative variables. When significant differences were detected ($P < 0.05$), means were compared using the Newman-Keuls post-hoc test at the 5% significance level. The treatment was the experimental unit; block effects were controlled for in the ANOVA model. Statistical analyses were conducted using SPSS v.25 (descriptive) and Stata v.19 (ANOVA, Newman-Keuls).

2.4 Measurements

2.4.1 Soil Physical Properties and Poquet Dimensions

The soil roughness index was determined by the chain method (Jester & Klik, 2005) with 10 replications per plot: $I = L/L_o$, where L is the actual chain length following soil surface irregularities and Lo its horizontal projection. A higher index indicates greater micro-relief and improved water harvesting capacity. Pit dimensions (depth and diameter/width) were measured on 20 randomly selected pits per block using a tape measure.

2.4.2 Working Time and Fuel Consumption

Total working time per treatment (pit digging, sowing, weeding, harvest, threshing) was measured and extrapolated to the hectare: $Tt = \Sigma(to)$. Fuel consumption was assessed only for the zainer and was calculated as the difference between initial and residual fuel volumes measured with a graduated cylinder for each 100 m² block and then extrapolated to the hectare. The local pump price of gasoline at the time of the trial was 1,047 FCFA/L (confirmed field price, 2024 season), yielding a fuel cost of 195 L/ha × 1,047 FCFA/L = 204,375 FCFA/ha.

2.4.3 Sorghum Yield

Grain and straw yields were determined on the useful area of each block (excluding border rows: net area = 64 m²) and converted to hectare equivalents. After harvest, following drying to approximately 12% moisture content and threshing, grain and straw biomass were weighed separately with a calibrated electronic balance.

2.4.4 Financial Profitability

Total production cost (TC) included input costs (compost, urea, seed, fuel, bags) and plowing costs (based on a local daily wage of 1,500 FCFA/person-day and 8 h/day). Gross value product (GVP) was calculated from yields and prevailing local market prices at harvest (grain: 217 FCFA/kg; straw: 75 FCFA per 4 kg bundle, equivalent to 18.75 FCFA/kg). Gross margin (GM = GVP – TC) and benefit-cost ratio (BCR = GVP/TC) were calculated. A BCR > 1 indicates a profitable activity (Biaou et al., 2016).

2.5 Ethical Statement

Participants were informed of the voluntary nature of their participation and of their right to withdraw at any time without consequences. No personal identifying data were recorded. The field experiment was conducted on land made available by the village community of Kounkane with the agreement of local authorities and the Pro-ARIDES programme coordination.

3. Results and Discussion

3.1 Effect of Technologies on Soil Physical Properties

Statistical analysis (one-way ANOVA with Newman-Keuls post-hoc test, $P < 0.001$) revealed highly significant differences between treatments for all physical variables (Table 2). The rectangular *zaï* (ZR) had the widest (39.75 cm) and deepest (21.75 cm) pits. The zainer (ZMo) produced intermediate-width pits (23.75 cm) but recorded the shallowest depth (8.50 cm), insufficient for effective water and nutrient retention. The mechanized *zaï* (ZMe) produced the narrowest pits (20.50 cm). The roughness index was highest for ZR (1.32) and ZS (1.24), and lowest for ZMo (1.05). A positive correlation was observed between pits depth and soil roughness index.

These results are consistent with Barro et al. (2005), who showed that *zaï* reduces runoff and erosion tenfold. The low pit depth of the zainer (8.50 cm) constitutes its main agronomic limitation; Barry et al. (2025) recommended redesigning the auger to reach a depth of 12–15 cm. The relatively low roughness index of ZMo (1.05) despite its motorized digging reflects the small diameter of pits created by the current auger and the fine texture of ejected soil, which settles back into the pit rather than forming ridges. This confirms that the auger geometry is a priority target for redesign.

Table 2. Effect of treatments on pit dimensions (cm) and roughness index

Treatment	Width/diameter (cm)	Depth (cm)	Roughness index
ZR (rectangular *zaï*)	39.75 a	21.75 a	1.32 a
ZS (spherical *zaï*)	27.00 b	12.50 b	1.24 b
ZMo (zainer)	23.75 c	8.50 c	1.05 b
ZMe (mechanized *zaï*)	20.50 d	12.00 b	1.13 ab
P-value	< 0.001	< 0.001	< 0.001

In the same column, values followed by the same letter are not significantly different (Newman-Keuls, 5%). CORRECTION: Roughness index values were corrected based on source data (Moyenga, 2024): ZR=1.32a, ZS=1.24b, ZMe=1.13ab, ZMo=1.05b. The original submitted manuscript contained an inversion of ZR and ZMo roughness values

3.2 Working Time and Fuel Consumption

Total working time varied highly significantly between techniques ($P < 0.001$) (Table 3). ZR required the most time (804.56 h/ha), followed by ZS (462.70 h/ha), ZMo (298.40 h/ha) and ZMe (100.23 h/ha). The zainer reduced working time by 63% compared with rectangular *zaï*, equivalent to approximately 63 person-days/ha (at 8 h/day). Fuel consumption was 195 L/ha × 1,047 FCFA/L = 204,375 FCFA/ha, the main variable cost item.

The IR12 tooth remained the fastest technique (100.23 h/ha), confirming Clavel et al. (2008). The tillage saving provided by the zainer constitutes a real socio-economic benefit not captured by classical profitability analysis. At the local daily wage of 1,500 FCFA/person-day, the 63 person-days/ha saved represent a time value of 94,500 FCFA/ha — a benefit that, if integrated into profitability models, would narrow the economic gap between the zainer and manual techniques considerably.

Table 3. Working time by treatment

Treatment	Digging time (h/ha)	Total time (h/ha)	Time saved vs ZR
ZMo (zainer)	223.73 b	298.40 c	−63%
ZMe (mechanized *zaï*)	44.58 c	100.23 d	−88%
ZS (spherical *zaï*)	415.41 a	462.70 b	−42%
ZR (rectangular *zaï*)	453.53 a	804.56 a	Reference
P-value	< 0.001	< 0.001	—

3.3 Effect on Sorghum Yield

Grain and straw yields differed highly significantly ($P < 0.001$) (Table 4). ZR generated the highest grain yield (2,000 kg/ha), followed by ZMe (1,925 kg/ha) and ZS (1,687.5 kg/ha). ZMo recorded the lowest grain yield (1,125 kg/ha), below the Flagnon field average (1,750 kg/ha). For straw, ZMe achieved the best result (5,700 kg/ha) compared to 2,475 kg/ha for ZMo. It is important to note that ZR's higher yield reflects the combined effect of its deeper, wider pits and its higher compost input (500 g vs 250 g/pit). This design difference limits direct attribution of ZR's yield advantage to pits geometry alone; future factorial experiments should control for this variable.

The shallow pit depth of the zainer (8.50 cm) partly explains its low yield, as insufficient depth limits water infiltration, nutrient concentration and root establishment on crusted soils. The partial backfilling of ZMo pits after early rains on low-slope plots further contributed to poor performance. Despite this, all treatments produced at least 1,125 kg/ha on previously bare *zipella*, confirming the potential of *zaï* for bare land rehabilitation (Kaboré & Reij, 2004; Bayen et al., 2011). These results are consistent with Zongo et al. (2023) and Dabre et al. (2023), who obtained higher yields under rectangular and spherical *zaï* compared with motorized approaches.

Table 4. Effect of treatments on sorghum (*Flagnon*) grain and straw yields

Treatment	Grain yield (kg/ha)	Straw yield (kg/ha)
ZMo (zainer)	1,125 b	2,475 b
ZMe (mechanized *zaï*)	1,925 a	5,700 a
ZS (spherical *zaï*)	1,687.5 a	4,575 a
ZR (rectangular *zaï*)	2,000 a	5,525 a
Flagnon field average (reference)	1,750	—
P-value	< 0.001	< 0.001

In the same column, values followed by the same letter are not significantly different (Newman-Keuls, 5%). Flagnon field average is provided as a reference benchmark only

3.4 Economic Profitability

None of the treatments was profitable in the first year (Table 5). ZMo recorded the largest losses (−490,731 FCFA/ha; BCR: 0.48), mainly due to high fuel costs (204,375 FCFA/ha, 26% of total costs). ZS achieved the best BCR (0.93), followed by ZMe (0.70), ZR (0.62) and ZMo (0.48). First-year losses are expected under *zaï* on bare land, as profitability typically materializes from the second year of cultivation (Dabre et al., 2023; Clavel et al., 2008). The non-profitability of ZR, despite the highest grain yield, is explained by its higher compost cost (double dose) and very high working time (804 h/ha). The zainer's economic performance could be substantially improved by (i) engine redesign (1.5 HP diesel, estimated fuel savings of 35%); (ii) auger redesign to achieve 12–15 cm pit depth to increase yields; and (iii) adopting a rental service model to eliminate capital acquisition costs for individual producers (Barry et al., 2025).

Table 5. Comparative economic profitability (FCFA/ha, 2024-2025 season)

Indicator	ZMo (zainer)	ZMe (IR12)	ZS (hoe)	ZR (hoe)
Input costs (FCFA/ha)	721,262 a	707,997 a	425,209 c	777,639 a
Of which Fuel	204,375	0	0	0
Of which compost	300,000	300,000	300,000	600,000
Labor (FCFA/ha)	60,000	48,000	60,000	80,000
Total cost (FCFA/ha)	781,262 b	754,797 b	485,209 c	857,639 a
Grain product (FCFA/ha)	244,125 b	417,725 a	366,187 a	434,000 a
Straw product (FCFA/ha)	46,406 b	106,875 a	85,781 a	103,593 a
Gross product (FCFA/ha)	290,531 b	524,600 a	451,968 a	537,593 a
Gross margin (FCFA/ha)	-490,731 a	-230,197 b	-33,240 c	-320,045 a
Benefit-cost ratio	0.48 c	0.70 b	0.93 a	0.62 b
P-value	< 0.001	—	—	—

Selling prices: grain = 217 FCFA/kg; straw = 75 FCFA/4 kg (= 18.75 FCFA/kg). Fuel cost: 195 L/ha × 1,047 FCFA/L = 204,375 FCFA/ha. Compost cost for ZR: 500 g/pit × 12,500 pits/ha × 50 FCFA/kg (double ZR agronomic dose vs 250 g for other treatments). In the same row, values followed by the same letter are not significantly different at 5%b (Newman-Keuls test)

3.5 Producer Perceptions

Producers expressed genuine interest in the zainer for its time-saving capacity. Based on the structured interviews with 15 producers conducted alongside the field trial, 86.7% cited high fuel consumption as the main constraint; 33.3% considered manipulation to be difficult; 88.75% found pit dimensions too small; 100% recognized the time-saving benefit; and 80% expressed willingness to pay for the tool**.** From an ergonomic perspective, significant vibrations caused bolt loosening and premature wear of the chain drive. Despite these limitations, 80% of producers expressed willingness to pay for the tool, with a preference for collective purchase through cooperatives.

The gap between producers' positive interest (80% willingness to pay) and the tool's current economic non-viability (BCR: 0.48) highlights a critical design-adoption paradox: the labour-saving advantage is highly valued, but the cost structure must be restructured before adoption becomes economically rational for smallholder farmers.

4. Conclusion

This study evaluated the agroeconomic potential of the improved zainer prototype compared with three endogenous bare land restoration techniques on *zipella* in Kounkané village, Gomponsom, Burkina Faso. The key findings are as follows: (i) the zainer significantly reduces working time (−63% vs rectangular *zaï*, equivalent to ~63 person-days/ha); (ii) the zainer produces the shallowest pits (8.50 cm) with the lowest roughness index (1.05) and lowest grain yield (1,125 kg/ha); (iii) no treatment was profitable in year one, with the zainer recording the largest losses (BCR: 0.48); (iv) 80% of producers expressed willingness to pay for the zainer despite current limitations.

These results lead to three recommendations: (a) priority mechanical improvements, i.e., redesigning the auger to achieve a depth of 12 to 15 cm, strengthening the chain transmission, and designing a low-consumption engine; (b) improvements in study design, with future trials using a factorial design to isolate the effects of pit geometry and compost rate, and multi-site, multi-year monitoring to assess long-term carbon dynamics and soil profitability; and (c) conditional scale-up, justified only after technical improvements have been implemented and re-testing has demonstrated acceptable profitability through collective investment or subsidy mechanisms.

5. Limitations of the Study

The following limitations should be considered: (i) The experiment was conducted at a single site during a single season (Kounkané village, 2024-2025); multi-site, multi-year trials are needed to confirm generalizability. (ii) The differential compost dose between ZR (500 g/pit) and the other treatments (250 g) limits direct attribution of yield differences to pit geometry alone; a factorial design is recommended for future studies. (iii) The producer perception survey (n=15) used a non-random sample within the Pro-ARIDES programme area and may not represent all potential zainer users. (iv) The financial profitability analysis does not capture the opportunity cost of saved tillage time, which would partially offset the zainer's economic deficit if integrated into the model.

Consent and Ethical Approval

The producer perception survey was conducted in accordance with ethical guidelines for social science research. All 15 producers who participated in the perception survey provided written informed consent before the interview.

Acknowledgements

This research was supported by the Dutch Ministry of Foreign Affairs and Danish cooperation under the Pro-ARIDES programme, implemented by SNV in collaboration with CARE Netherlands, Wageningen University & Research and the Royal Tropical Institute. The authors thank the CNRST/INERA and PRACTICA Foundation field teams, and the producers and local authorities of Kounkané village for their participation.

Declaration of AI Use

This manuscript was prepared through the intellectual contributions of the author(s) to the study design, data analysis, interpretation of results, and scholarly content. Grammarly and ChatGPT were used solely to assist with grammatical refinement and reference formatting during manuscript revision. The author(s) accept full responsibility for the accuracy, integrity, and final content of the manuscript.

Competing Interests

Authors have declared that no competing interests exist.

References

Barbut, M. (2018). La réhabilitation des terres dégradées dans les zones sèches. *Annales des Mines - Responsabilité & environnement, 91*(3), 51–55. https://doi.org/10.3917/re1.091.0051

Barro, A., Zougmoré, R., & Ouédraogo-Zigani, P. (2001). *Réalisation du zaï mécanique en traction animale pour la réhabilitation des terres encroûtées* [Fiche technique]. Institut de l'Environnement et de Recherches Agricoles (INERA).

Barro, A., Zougmoré, R., & Taonda, J.-B. S. (2005). Mécanisation de la technique du zaï manuel en zone semi-aride. *Cahiers Agricultures, 14*(6), 549–559. https://revues.cirad.fr/index.php/cahiers-agricultures/article/view/30550

Barry, F., Dabré, A., Ouédraogo, B., Debons, P., Wennink, B., & Camara, O. (2025). *Le Zainer, un outil pour la récupération des terres dénudées ? Potentiel technico-économique à Gomponsom, Burkina Faso* [Note technique recherche-action]. Pro-ARIDES. https://proarides.org/wp-content/uploads/2025/11/Pro-ARIDES_2025_NT_Burkina_Zainer.pdf

Bayen, P., Traoré, S., Bognounou, F., Kaiser, D., & Thiombiano, A. (2011). Effet du zaï amélioré sur la productivité du sorgho en zone sahélienne. *VertigO - La revue électronique en sciences de l'environnement, 11*(3). https://doi.org/10.4000/vertigo.11497

Biaou, D., Yabi, J. A., Yegbemey, R. N., & Biaou, G. (2016). Performances technique et économique des pratiques culturales de gestion et de conservation de la fertilité des sols en production maraîchère dans la commune de Malanville, Nord Bénin. *International Journal of Innovation and Scientific Research, 21*(1), 201–211. https://ijisr.issr-journals.org/abstract.php?article=IJISR-15-351-02

Bowers, M. J., Kasaine, S., & Schulte, B. A. (2024). Zai pits as a climate-smart agriculture technique in southern Kenya: Maize success is influenced more by manure than depth. *Resources, 13*(9), 120. https://doi.org/10.3390/resources13090120

Clavel, D., Barro, A., Belay, T., Lahmar, R., & Maraux, F. (2008). Changements techniques et dynamique d'innovation agricole en Afrique sahélienne : Le cas du zaï mécanisé au Burkina Faso et de l'introduction d'une cactée en Éthiopie. *VertigO - La revue électronique en sciences de l'environnement, 8*(3). https://doi.org/10.4000/vertigo.7442

Dabré, A., Savadogo, P., Sanou, L., & Nacro, H. B. (2023). Rentabilité économique de différentes longueurs de poquets de zaï rectangulaire sous culture de *Sorghum bicolor* (L.) Moench dans les zones sahéliennes et soudano-sahélienne du Burkina Faso. *International Journal of Biological and Chemical Sciences, 17*(4), 1497–1518. https://doi.org/10.4314/ijbcs.v17i4.17

Dabre, A., Savadogo, P., Sanou, L., & Nacro, H. B. (2024). Sorghum yield using rectangular versus spherical zaï pits and integrated soil fertility management in the Sahelian and Sudano-Sahelian zones of Burkina Faso. *Agricultural Research, 13*, 253–265. https://doi.org/10.1007/s40003-023-00690-7

Food and Agriculture Organization of the United Nations. (2018). *Action contre la désertification [Action against desertification]*. https://www.fao.org/in-action/action-against-desertification/fr

Ilboudo, A., Guébré, D., Ouédraogo, H., Ganeme, A., Zongo, K. F., & Hien, E. (2025). Characterization and evaluation of the agronomic suitability of three soil types for sorghum production in the Sudano-Sahelian zone of Burkina Faso. *Journal of Experimental Agriculture International, 47*(6), 103–118. https://doi.org/10.9734/jeai/2025/v47i63474

Jester, W., & Klik, A. (2005). Soil surface roughness measurement—Methods, applicability, and surface representation. *Catena, 64*(2–3), 174–192. https://doi.org/10.1016/j.catena.2005.08.005

Kaboré, D., & Reij, C. (2004). *The emergence and spreading of an improved traditional soil and water conservation practice in Burkina Faso* (EPTD Discussion Paper No. 114). International Food Policy Research Institute. https://hdl.handle.net/10568/155576

Kelem, A., Tsegay, A., & Gebrekidan, D. (2026). Effect of seedbed type and farmyard manure rates on *Striga* infestation control, soil moisture conservation, and sorghum yield in Western Tigray, Ethiopia. *Journal of Global Agriculture and Ecology, 18*(3), 159–167. https://doi.org/10.56557/jogae/2026/v18i310935

Lahmar, R., & Yacouba, H. (2012). Zaï et potentiel de l'association cultures annuelles-arbustes natifs. In A. Dia & R. Duponnois (Eds.), *La Grande Muraille Verte: Capitalisation des recherches et valorisation des savoirs locaux* (pp. 201–221). IRD Éditions. https://doi.org/10.4000/books.irdeditions.3298

Moyenga, S. (2024). *Analyse de la rentabilité agroéconomique et de la perception des producteurs de la technologie du zainer dans la commune de Gomponsom au Nord du Burkina Faso* [Mémoire de master, Institut Supérieur du Développement Durable, Université Yembila Abdoulaye Toguyeni].

Nkonya, E., Mirzabaev, A., & von Braun, J. (Eds.). (2016). *Economics of land degradation and improvement: A global assessment for sustainable development*. Springer. https://doi.org/10.1007/978-3-319-19168-3

Ouedraogo, S., & Tiganadaba, L. (2015). Adoption of water and soil conservation technologies: Determinant factors in the Central Plateau of Burkina Faso. *Journal of Asian Scientific Research, 5*(2), 96–110. https://doi.org/10.18488/journal.2/2015.5.2/2.2.96.110

Romm, J. (2011). Desertification: The next dust bowl. *Nature, 478*(7370), 450–451. https://doi.org/10.1038/478450a

Roose, E., Kaboré, V., & Guenat, C. (1999). Zai practice: A West African traditional rehabilitation system for semiarid degraded lands, a case study in Burkina Faso. *Arid Soil Research and Rehabilitation, 13*(4), 343–355. https://doi.org/10.1080/089030699263230

Zongo, B., Barro, A., Moyenga, S., & Simporé, S. (2023). Techno-economic performance of motorization for sustainable agricultural water management: Case of zaï practice in the central region of Burkina Faso. *International Journal of Innovation and Applied Studies, 41*(2), 660–669. https://ijias.issr-journals.org/abstract.php?article=IJIAS-23-317-09

Zougmoré, R., Guillobez, S., Kambou, N. F., & Son, G. (2000). Runoff and sorghum performance as affected by the spacing of stone lines in the semiarid Sahelian zone. *Soil and Tillage Research, 56*(3–4), 175–183. https://doi.org/10.1016/S0167-1987(00)00137-9

Peer-review history:
The peer review history for this paper can be accessed here:
https://pr.sdiarticle5.com/review-history/164520