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A Study of the Cereal Benches Based System for Protection of Soil in Algerian Oued Mellegue Tebessa Dry Lands

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Abstract: The study was intended to mitigate the destructive after-effects of erosion, where runoff water erodes the arable layers through the increased transport of soil particles. The study was conducted in Ain Zerga across 40 plots, covering an area of 405 hectares, during 2023 and 2024, with a focus on the dimensional evaluation of cereal beds. The evaluation mainly focused (a) on the durability of the structure, including the measurement of settlement, which indicates distribution and strength of resistance to climatic hazards, and (b) proportional sustainability and the interbank aspects. The height of benches, at 0.481± 0.086 m, and the length of 82.583 ± 24.203 m were influenced by height differences and the intensity of water flows. The retention of runoff water was influenced by the slope toward the natural spillway. Furthermore, the destructive intensity of the runoff, amplified by the sharp increase in altitude, was confirmed by statistically significant differences in the length, height, and number of cracks between the study sites (p-value = 0.000). The number of cracks per breach at the Gastel site (4.25 units) and Kef Mebdoua (3.917 units) was higher compared to Ain Zerga, Berket Frass, Ouled Mebarek, and Zlassde, where the number ranged from 0.750 to 1.583 units. The statistical significance in the number of cracks ($p<0.001$) signified that variation in cracks between the locations was due to the topographic steep slopes on site. The non-significant difference in width suggests that the observed differences could be due to the phenomenon of compaction following the annual infiltration of water on the ridges of cereal bench, plus the act of trampling constantly exercised by sheep and cattle herds when passing to the paths. This work proposed in this article is an attempt to structure a chain of impact analysis of risks and vulnerability of intensity via the sustainability of cereal bench carried out in the Tebessa region.

Key words: Bench, conservation, height difference, erosion impacts, forests

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Climate change affects ecosystems in various ways, with a major concern being the disruption of the earth's hydrological cycle (Giorgi *et al.,* 2019). This disruption alters precipitation patterns, impacting agriculture and human and animal health (Shah, 2022; Thanh, 2023). Changes in precipitation patterns, increased rainfall intensity, and temperature fluctuations affect the hydrological cycle, leading to increased evapotranspiration, reduced soil moisture, and altered seasonal distribution of precipitation (Nasri *et al.,* 2003; Krim and Hassani, 2023; Messaoudi *et al.,* 2024). These changes have a ripple effect on the soil biosphere, which plays a crucial role in transforming terrestrial ecosystems (Attarod *et al.,* 2023). The relationship between soil erodibility and precipitation is critical, with increased attention focused on the rainfall-soil relationship and its erosive effects (Lee and Hsu, 2021). When soil erosion rates exceed threshold limits, it is necessary to monitor erosional rates and off-site impacts, combining engineering and alternative measures like buffer strips and retention ponds. Water erosion, a global environmental problem, hampers sustainability and is linked to runoff, exacerbated by farming practices that prevent optimal water penetration into the soil (Boardman and Vandaele, 2022). The Cereal Benches Based System is a soil conservation method used in Algerian Oued Mellegue Tebessa dry lands, where raised platforms are constructed to reduce soil erosion and promote sustainable agriculture. The benches are planted with cereal crops, helping to increase water infiltration, trap sediments and nutrients, and reduce soil loss. This approach enhances soil fertility and structure, leading to improved crop yields and environmentally friendly farming practices preserves water resources for farmers and breeders in fragile biotopes (Gonzalez-Velazquez and Castro-Ruizde, 2022). This research papers highlights the importance of anti-erosion development and multi-level governance on agricultural land, emphasizing the resistance, impact, and sustainability of Cereal Benches as a solution.

Materials and Methods

Location of the study area

The Tebessa is the capital city of Tebessa Province in north-eastern Algeria, near the border with Tunisia. It is situated in the north-east of the Tebessa area, the commune of Ain Zerga at 35°24′19″ N, 8°06′59″ E and 800 m altitude covering an area of 29,600 ha. The average annual rainfall of the regions is 250 ± 37 mm. The study site is located in the Oued Mellegue cereal-growing catchment area, to the north-east of Tebessa, bordering on the Hydra region, governorate of Talla (Tunisia). In this

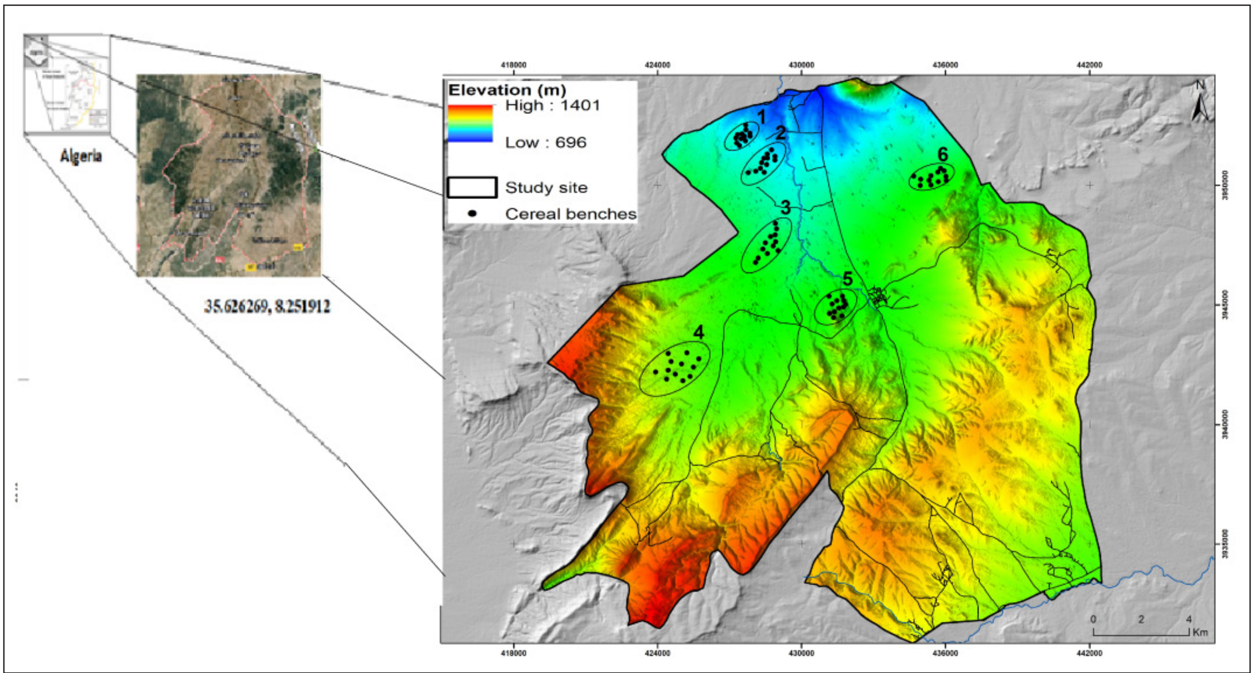

Fig. 1. Geographical location of the study region (Ain zerga/Tebessa).

Table 1. Descriptive statistics studied on benches (Quantitative data)

Variable	Observations	Minimum	Maximum	Mean	Std deviation
Length of benches (m)	72	25.000	124.00	82.583	24.203
Width of benches (m)	72	0.750	1.600	1.057	0.149
Height of benches (m)	72	0.350	0.680	0.481	0.086
Cracks in the benches	72	0.000	8.000	2.181	1.621

region, the cultivated land is characterized by a rugged relief, with 25 to 30% of its surface area sloping at a rate of over 15%, with fairly fragile ridges, accentuating erosion and acting as a deterrent to agricultural development. Cereals account for over 80% of cultivated land.

Study framework and methodology

The Oued Mellegue basin extends over 29600 ha to the east of the town of Tebessa and is located to the north of the large Oued Mellegue Ain Zerga catchment area. Most of the hydrographic network drains are tertiary (Eocene, Pliocene) and quaternary terrain.

The catchment is moderately hilly, with altitudes varying between 800 and 1900 m at sea level.

Altitudes are highest in the north and lowest in the south. The mountainous terrain in the south and extreme northeast defines very steep slopes in excess of 35%. Gentler slopes, as low as 5%, cover less than 30% of the northern basin, near the lowlands. Random sampling on 40 plots treated with water and soil conservation work (WSCW), with 70 cereal bench at the standard 200m length of cereal benches ha^{-1}, the equivalent of 81,000 m length, with a surface area of around 405 ha divided into 6 areas, for 72 observations (Table 1). The methodology of the work consisted of several field trips to water and soil conservation structures (wscs), carried out on the site known as Ain Zerga (Fig. 1) during a survey carried out in 2016. Carried out in the Ain ZERGA area, on six different sites namely (Kef Mebdoua (1080 m), Berket Frass (565 m), Zlass (510 m), Ain Zerga (620 m), Ouled Mebarek (520), Gastel (1150 m); The study aims to measure completed cereal bench works, the average total length of 82.583 ± 24.203 m; the average width of 1.057 ± 0.149 m; the average height of 0.481 ± 0.086 m and the number of cracks of 2.181 ± 1.621 Unit. Focused and concentrating on three axes:

- Real durability of the work in cereal benches on the study site

- Measurement and measurement of the work and compacted earth ridges carried out on 5946 m (6 km) in length, the equivalent of 7.4% of the network,

- Measurements taken on a series of cereal benches carried out on 40 agricultural plots of 405 hectares on an average = 10.12 hectares per agricultural plot on site

Results and Discussion

Typology of benches according to surface water

According to Vietz (2006), the occurrence and distribution of bench's types throughout the watershed is less variable than expected at the watershed scale. The data in Table 1, comprising 72 observations, reveal variability in the sizes of cereal benches. The length of the benches ranges from 25 to 124 m, with an average of 82.58 m and a standard deviation of 24.20, indicating moderate variability. In contrast, the width and height of the benches showed less variability, with average values of 1.06 m and 0.481 m, and standard deviations of 0.149 and 0.086 m, respectively. Furthermore, the severity of cracks observed on the benches varied, with an average of 2.18 ± 1.62 units, indicating that variability in intensity and degree of cracking was influenced by factors such as slope and soil structure, length, width, and height of the benches. These findings were observed by Morris *et al.,* (1992) and, Hassanikhah and Miller (2017) in the field in Australia and Canada and noted that cracks ranged from 0.5 m to 6 m for natural clays, depending on the depth of seasonal suction variations. Overall, these measures highlight the environmental factors influencing the cereal benches, showcasing the variability in their dimensions and cracking severity.

The creative genius of dozens of generations has continued to invent and refine an armory

Table 2. Analysis of differences between modalities (bench length) with a 95% confidence interval / Tukey (HSD)

Modality	Estimated means	Standard error	Lower bound	Upper bound	Groups
Berket Frass	98.083	4.71	89.039	107.127	A
Ain Zerga	98.000	3.91	88.956	107.044	A
Ouled Mebarek	95.583	4.35	86.539	104.627	A
Zlass	91.250	4.38	82.206	100.294	A
Kef Mebdoua	58.167	4.66	49.123	67.211	B
Gastel	54.417	5.04	45.373	63.461	B

Table 3. Analysis of differences Width between modalities with 95% CI/ Tukey (HSD)

Modality	Estimated means	Standard error	Lower bound	Upper bound	Groups
Kef Mebdoua	1.171	0.05	1.088	1.254	A
Berket Frass	1.063	0.04	0.980	1.146	AB
Zlass	1.053	0.06	0.970	1.136	AB
Ain Zerga	1.035	0.03	0.952	1.118	AB
Ouled Mebarek	1.026	0.03	0.943	1.109	AB
Gastel	0.994	0.03	0.911	1.077	B

of techniques for surviving in semi-arid environments. It is, therefore, useful to present an attempt at a typology of bench, taking into account the topography of ecological zones (Table 2)

Proportional durability of benches

Agricultural erosion has resulted in the stripping of humus horizons. But it is ravine erosion, an omnipresent indicator of the abundance of runoff, which is the most dangerous for the regional balance because it accentuates aridity, disfigures mechanizable surfaces and leads to significant movements of earth to the river, an increase in their peak flow, the degradation of the banks, landslides in the concave parts of the rivers (Roose 2002). By taking into consideration the factors like topography of the agricultural land (structure and texture of the layers), the slope of the natural outlets, the dimensional length, height and width the cereal benches can become more sustainable and better adapted to changing environmental and economic conditions. This can help to ensure long-term grain production while preserving natural resources and surrounding ecosystems. The benches of flat surface resist the intensity of the flow at steep slopes

The numbers of agricultural plots between different localities (Fig. 2) were recorded to give an overview of the diversity of agricultural practices and the size of farms at each site. The data showed the distribution of benches on geographical elements or land formations in each locality. For example, Ouled Mebarek has the largest number of benches length (12715.2) m, which indicate higher concentration of

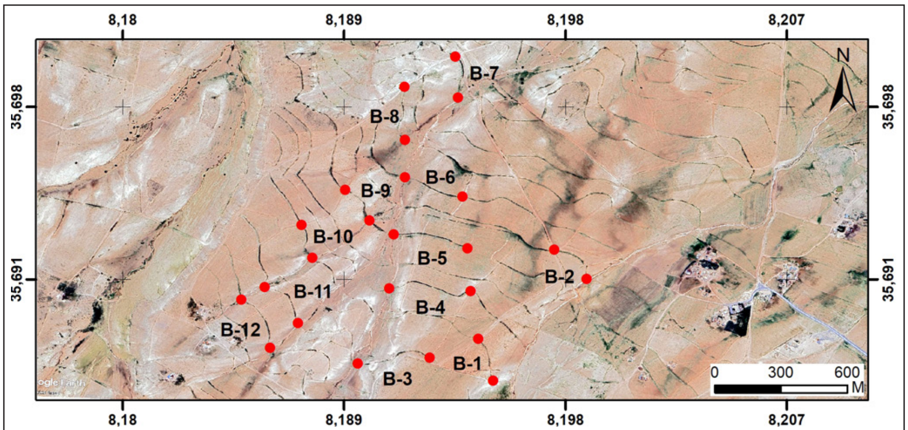

Fig. 2. Spatial distribution of cereal benches in the study region.

Table 4. Analysis of differences between modalities with a 95% confidence intl (Height (m)

Modality	Estimated means	Standard error	Lower bound (95%)	Upper bound (95%)	Groups
Kef Mebdoua	0.559	0.03	0.519	0.599	A
Gastel	0.553	0.02	0.514	0.593	A
Ain Zerga	0.448	0.02	0.409	0.488	B
Berket Frass	0.443	0.02	0.404	0.483	B
Ouled Mebarek	0.441	0.01	0.401	0.481	B
Zlass	0.439	0.01	0.399	0.479	B

agricultural practices in this zone compared to others.

The surface area and the number of plots show the relative size of each place studied. Overall, an overview of the total number of plots, the total surface area covered, and the total number of benches throughout the study was also recorded. These data are crucial for understanding the spatial distribution of the geographical characteristics of the cereal bench by site in order to analyze how they are vary according to the size and number of plots agricultural activity wise in this region compared to others.

The area of agricultural areas was studied from six agricultural sites, note (6 sites, note Kef Mebdoua, Gastel, Ain Zerga, Berket Frass, Ouled Mebarek and Zlass located in the commune of Ain Zerga. Geographical location whose Lambert coordinates are: (35.693693; 8.196010), reflecting the extent of agricultural land use in each locality. By comparing the structural topographic sustainability aspect, the distribution of the number of plots, the area per cereal banks between the different localities (Fig. 3), reflected the extent of agricultural land use of each locality. Comparing, or the distribution and the number of plots, surface area and number of benches among different localities (Fig. 3), help in identifying regional disparities in terms of agricultural activity and agrarian structure. This information help in in-depth understanding of agrarian structure and land use, agricultural activity in each locality which can be useful for agricultural planning, management and development (Albergel and Mansouri, 2000; Albergel *et al.*, 2002).

Impact of erosion on agricultural land

The observed data showed that percentage of breaches increase as the difference in altitude becomes greater. For example, in the "Strong" category, 75% breaches were recorded which were considerably higher than in other categories. The percentages of benches also vary according to the height difference, showing a distribution which might be correlated with the slope or the nature of the terrain (Couper, 1993; Douglas and Couper 1993). It is important to emphasize that the number of cracks observed on cereal banks is closely linked to the altitude, each time the altitude is high the number of damages is persistent, the example on low

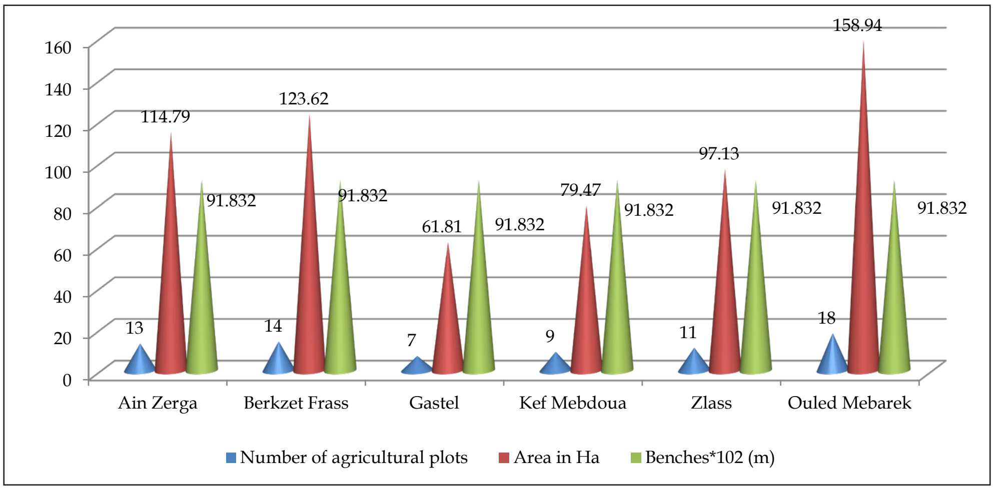

*Fig. 3. Distribution of areas and agricultural plots (**benches**) surveyed.*

altitudes. Example on fifteen banks representing a rate of 16.66% of the work in cereal banks, records a number of cracks of 3 (Nb = 3), or a rate of 20%. On the other hand in the space with accentuated elevation (High), we have a number of 20 works carried out in cereal banks or (22.22%), records 15 cracks (N=15) in manifestation or the equivalent of 75% of the banks on site, from this it is clear that the elevation presents a primordial factor on this physical aspect (Fig. 4); Approved by similar studies by Baccari *et al.*, 2006 identifying the cracking rate of 109 breaches on the 439 cereal banks made in the 24.83% El Gouazine zone in the Tunisian semi-arid land.

This helped in understanding the distribution of benches and gaps depending on the height difference, which can have implications in various fields such as soil management, landscape ecology, or land use planning. This is clearly seen in the Kef Mebdoua and Gastel zones, whereas it is less intense in Zlass (Ain Zerga), and Ouled Mebarek, where cracks are minimal. These differences in the existence of brief constant are the outcome of climatic factors triggered by the existence of fairly steep slopes favoring the massive and intense flow of watercourses during the torrential downpours recorded. Non-significant differences were observed for the three micro-zones (Zlass, Ouled Mebarek, and Berket Frass), while the Gastel and Kef Mebdouaa micro-zones showed very significant differences

Variation in length of cereal benches

The analysis of variance (ANOVA) with post hoc Tukey (HSD) for comparing the differences between the modalities (groups), the interpretation based on the information evaluated in table 2. In general, cereals bench on flat or slightly sloping land are often more effective than those on very steep or uneven land. However, proper selection of grain type, soil type, water management, agricultural practices and climatic context can all contribute to determining the best bench length range for a given region. The existing vegetation cover on the ground varies according to the location of the cereal banks, the accumulative power of runoff water and the type of soil, thus playing a vital role in determining the durability and survival of the work carried out along the length of cereal banks. Clayey or shale soils may be more sensitive to changes in altitude and slopes than sandy or silty soils. Water management on agricultural land influences the variation in length amplitude and the agricultural practices used can affect the variation in length. For example, growing cereals in rotation with other crops can help prevent erosion and maintain soil fertility (Remini *et al.*, 2019), which can reduce the need for significant slopes. Regions with higher precipitation affect the number of running benches (Remini, 2019). From the data provided, on the modalities and their corresponding lengths of total cereal bench measured in meters (82.58±24.03) m, at a 95% confidence interval (Table 1), two distinct groups are deduced, those having meters ranging from 90 to 98 meters noted group A. and those distributed over the interval having meters between 54 to 58 meters, noted group B, justified by the type and the nature of slope in unevenness characterized these lands.

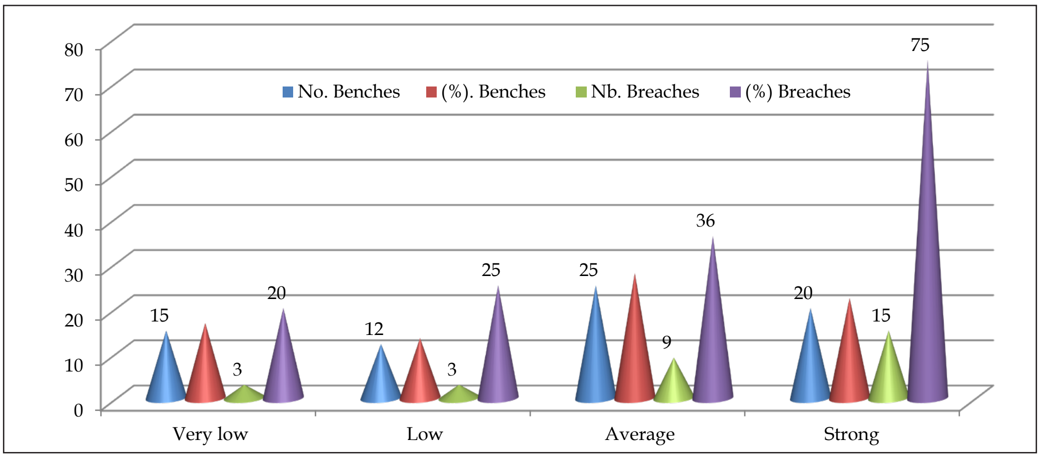

Fig. 4. Physical damage recorded by embankments in study zone.

From the data (Table 2) it was observed that modalities of Berket Frass, Ain Zerga, Ouled and Mebarek, Zlass (G_A) generally have higher average lengths than the modalities of Kef Mebdoua and Gastel (G_B) because these places are on flat land with a fairly gentle slope. Confidence intervals for G_A modalities are generally wider than those for G_B modalities, indicating greater variability within G_A. Within G_A, Berket Frass and Ain Zerga have similar average seat lengths, while Ouled Mebarek and Zlass have slightly lower average lengths. The two modalities in $\mathbf{G_B}$ (Kef Mebdoua and Gastel) have a significantly lower average length than any modality in G_A, because their confidence intervals do not overlap the confidence interval of any modality in G_A. This is attributed to the existing slope on these places justified by a design of these works as benches on the edge of the forests. These observations suggest that there are significant differences in the length of the Cereal Benches in the two groups, with G_A modalities frequently having a greater length than G_B modalities.

Variation in width of cereal benches

The bead width generally varies between 0.5 and 1.2 m, but this value can vary considerably depending on the factors mentioned above. The variation factor of the bead width also depends on several factors, such as differences in vegetation type, soil, agricultural practice, equipment and climatic context. It is therefore important to consider these factors when planning and managing cereal benches to ensure efficient and sustainable production. The analysis of the differences in width between the modalities with their corresponding confidence intervals bringing the width measurements of the cereal bench of the study region to 95. The analysis of observations based on the required data confirmed that the modalities of G_A (Kef Mebdoua, Berket Frass, Zlass) generally have higher estimated average widths compared to those of G_B (Ain Zerga, Ouled Mebarek, Gastel). The confidence intervals for each modality overlap to some extent width among all modalities, closely followed by Berket Frass and Zlass in G_A, while the site known as Gastel has the lowest estimated average width among all modalities, followed by the Ouled Mebarek and Ain Zerga site in G_B. In summary, there are differences in the estimated average width between the modalities, the sites in G_A having average cereal benches estimated higher than those in G_B. However, there is some overlap in confidence intervals, suggesting potential similarities in width between some modalities (Table 3). Based on these points, the interpretation of data shown between G_A and G_B, there seem to be significant differences in the estimated means for the modalities of Kef Mebdoua, Berket Frass and Zlass from 1.17 to 1.05 m, because the confidence intervals do not overlap between these groups for these modalities. For the other modalities (Ain Zerga, Ouled Mebarek, Gastel), from a variable of (1.03 to 0.99) m the confidence intervals overlap between G_A and, G_B which suggests an absence of significant difference between the estimated means of these groups.

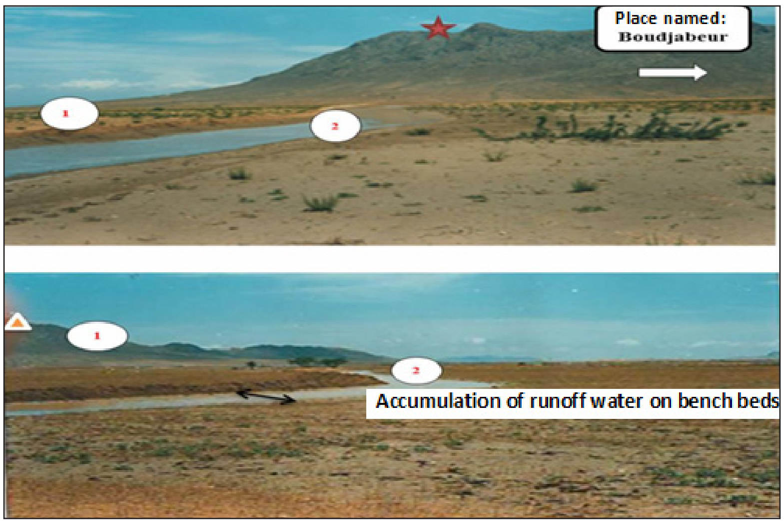

Fig. 5. Distribution of the sample in the study area.

Table 5. Analysis of differences modalities with a 95% CI (Number of cracking)

Modalité	Estimated means	Standard error	Lower bound	Upper bound	Groups
Gastel	4.250	0.39	3.742	4.758	A
Kef Mebdoua	3.917	0.26	3.409	4.425	A
Ain Zerga	1.583	0.19	1.075	2.091	B
Berket Frass	1.333	0.22	0.825	1.841	B
Ouled Mebarek	1.250	0.22	0.742	1.758	B
Zlass	0.750	0.18	0.242	1.258	B

Variation in height of cereal benches

The height of the cereal benches is an important parameter to consider when planning and managing the cereal benches. It varies between 0.60 and 1.20 m depending on the factors mentioned above. It also depends on several other factors, such as differences in grain type, soil, agricultural practice, equipment and climatic factors. Hence, it is important to consider these factors while planning and managing cereal benches. It is also important to note that the bead height can be adjusted based on specific crop requirements, agricultural practices and environmental conditions to maximize productivity and sustainability.

Group A (Group$_A$): modalities (Kef Mebdoua, Gastel) often have higher estimated sizes compared to C_B modalities (Ain Zerga, Berket Frass, Ouled Mebarek, Zlass). The confidence intervals for each modality overlap to some extent with the confidence intervals of other

modalities, indicating virtual similarities in terms of height. The Kef Mebdoua site has the highest estimated average size among all modalities, closely followed by Gastel in G_A. The Zlass site has the lowest estimated average size among all modalities, closely followed by Ouled Mebarek, Berket Frass and Ain Zerga in C_B. The estimated averages for the modalities of G_A, (Gastel and Kef Mebdoua), are respectively 4.250 and 3.917, (Fig. 6), while the averages estimated for the modalities of G_B vary from 0.750 to 1.583. In addition, the confidence intervals admit a risk of error of 5% of the average number of cracks for each modality of G_A (Gastel and Kef Mebdoua) do not overlap with the confidence intervals of any modality of G_B (Ain Zerga, Berket Frass, Ouled Mebarek, Zlass). This lack of overlap further reinforces the significant differences between the two groups. From this, it can be concluded that there are significant differences in the average number of cracks between (G_A and, $G_{B)}$.

Globe analysis on external aspects of cereal benches

Based on null hypothesis testing (Table 5) it was observed that the difference is statistically significant at 95% confidence interval. On the basis of the data in Table 2 it was observed that manifestation of two groups G_A (Gastel and Kef Mebdoua) (Table 5) and Group$_B$ (Ain Zerga, Berket Frass, Ouled Mebarek and Zlass) was significant. By studying the threshold intervals of 95% meaning that a risk of error at 5%, there is no overlap between the confidence intervals

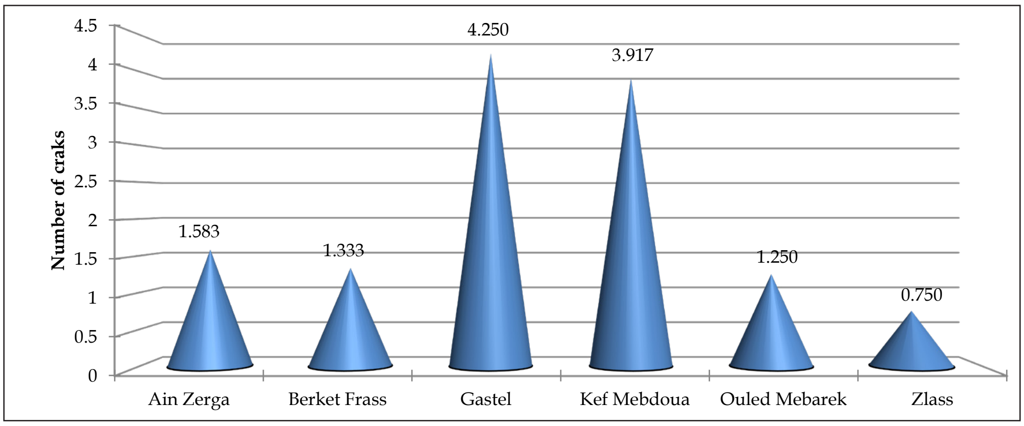

Fig. 6. Amplitude variation in bench cracking in the study region.

Table. 6 Correlation matrix (Pearson (n))

Variables	Length bunches (m)	Width (m)	Height (m)	Cracks number
Length benches (m)	1			
Width (m)	-0.023	1		
Height (m)	-0.493	0.088	1	
Cracks number	-0.615	0.107	0.559	1

Values in bold are different from 0 at a significance level alpha=0.05

Table 7. Variation in coefficient of determination (R^2) of the regression model in size

	Length of benches (m)	Width (m)	Height (m)	Cracking
R^2	0.609	0.139	0.397	0.725
F	20.582	2.136	8.678	34.874
Pr	< 0.001	0.072	< 0.001	< 0.001
Sites	20.582	2.136	8.678	34.874
	< 0.001	0.072	< 0.001	< 0.001

of G_A and that of G_B. This indicates a substantial difference between the two groups in terms of average number of cracks. Furthermore G_A has the ability to have higher cracking values than G_B. However, within each group, no significant difference is observed between the individual modalities. This is supported by the fact that the confidence intervals for each modality within the same group overlap significantly. Logically, although there are constant differences between the overall averages of G_A and G_B, no significant difference is observed between the individual modalities of each group.

Synthesis of dimensional averages stimulated by sites

The data in Table 6 and 7 showed that the coefficient of determination (r^2) of the regression model predicting the length of benches is 0.61, which indicates that approximately 60.9% of the length variability can be explained by the independent variables. the negative correlation of the variable length of cereal bench with the number of cracks (r^2=0.61) recorded, each time that the length decreases the number of cracks and damages and damage on bench is weak; on the other hand the existence of a positive correlation between the height of the cereal bench and the number of cracks recorded with r^2=0.56. The F statistic is 20.582 with a p value less than 0.0001, which indicates that the regression model is statistically significant. The analysis suggests that there are significant differences in the length of cereal benches across the six sites. The coefficient of determination (R^2) of the regression model predicting width is 0.139, which indicates that approximately 13.9% of the variability in width can be explained by the independent variables. The F statistic is 2.136 with a p-value of 0.072, suggesting that the regression model for width is not statistically significant at the conventional 0.05 significance level. The analysis suggests that there may not be significant differences in width between sites. The coefficient of determination (R^2) of the regression model predicting height is 0.397, which indicates that approximately 39.7% of the variability in height can be explained by the independent variables.

The analysis suggests that there are significant height differences between the sites of existence, as for the number of cracks manifested on section of cereal benches: The coefficient of determination (R^2) of the regression model predicting the number of cracks is 0.725, which indicates that approximately 72.5% of the variability in the number of cracks can be explained by the independent variables. The F statistic is 34.874 with a probability (p) value less than 0.0001, indicating that the regression model is highly statistically significant.

Summary of overall data carried out in the study region

Based on the aggregated data (Table 2), significant differences are observed between the cereal terraces in terms of length, height, and number of cracks. The p-values (Pr < 0.001 for each measure) and the coefficients of variation R^2 (0.609 for length, 0.397 for height, and 0.725 for cracks) indicate these variations (Table 8). Regarding terrace length (in meters), the Kef Mebdoua and Gastel sites show significantly

Table 8. Summary estimated averages by groups of cereal benches

Sites	Length of benches (m)	Width (m)	Height (m)	Cracking
Kef Mebdoua	58.167 b	1.171 a	0.559 a	3.917 a
Berket Frass	98.083 a	1.063 ab	0.443 b	1.333 b
Ain Zerga	98.000 a	1.035 ab	0.448 b	1.583 b
Gastel	54.417 b	0.994 b	0.553 a	4.250 a
Ouled Mebarek	95.583 a	1.026 ab	0.441 b	1.250 b
Zlass	91.250 a	1.053 ab	0.439 b	0.750 b
Pr	0.001	0.072	0.001	0.001

shorter average lengths compared to other sites, marked with a "b". The sites of Berket Frass, Ain Zerga, Ouled Mebarek, and Zlass exhibit higher and more consistent average lengths, marked with an "a". For terrace height, Berket Frass, Ain Zerga, Ouled Mebarek, and Zlass have intermediate average heights, denoted by "ab", while Gastel records the lowest height, marked with a "b". Concerning the extent of cracking, Gastel shows a significantly higher average number of cracks compared to the other sites (Berket Frass, Ain Zerga, Ouled Mebarek, and Zlass), with Pr <0.001 and R^2=0.725

The attenuation phenomenon observed in some areas is related to the topography, with slopes of 10 to 12%. Kef Mebdoua has a greater average width than Gastel, while the other sites (Berket Frass, Ain Zerga, Ouled Mebarek and Zlass) have similar widths. The variation in width between Kef Mebdoua and Gastel is statistically insignificant, probably due to variations in height and the proximity of forests. On the other hand, significant differences are noted in the lengths, heights and numbers of cracks between the sites. Kef Mebdoua has shorter lengths (58 to 167 m) due to its rocky terrain and steep slopes, which helps reduce damage during heavy rains. Conversely, Gastel has a higher number of cracks, due to its position upstream of mountainous terrain.

Conclusion

The analysis of cereal banks in the Oued Mellegue watershed highlights their crucial role in runoff management, particularly during heavy rains, by significantly reducing runoff coefficients. Erosion is more pronounced near forest areas and the banks are more effective on slopes of 5 to 10% than on steeper slopes (12 to 15%), due to human activities. A negative correlation (r^2=0.61) was observed between the length of the banks and the number of cracks: the shorter the length, the fewer cracks recorded. On the other hand, a positive correlation (r^2=0.56′) exists between the height of the banks and the number of cracks, with a high height often a much greater recording of cracks. This observation is linked to dry agriculture. The formation of cracks varies according to the slope, especially in Kef Mebdoua and Gastel. Although cereal terraces are beneficial, their water storage capacity is heterogeneous, presenting risks of failure. It is essential to implement protective measures, such as the introduction of appropriate vegetation, to ensure the sustainability of these anti-erosion structures recommended by FAO.

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