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Revegetation of Cleared Sites at the Soubré Hydroelectric Dam (Southwestern Côte d'Ivoire) Using the Cover Crop *Arachis repens* Handro

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Abstract

The aim of this study was to restore the vegetation cover of land stripped during the construction of the Soubré hydroelectric dam through the use of *Arachis repens* cover crops. The method used to install the cover crop was the cutting technique. The cuttings were transplanted by burying two nodes in the soil. The study was conducted on flat and upland surfaces. On each surface, three 100 m^2 (10 m × 10 m) plots of *Arachis repens* ground cover were established, each containing five 1 m^2 observation plots. Measurements were taken in each plot on ten identified plants. The cover crop *Arachis repens* on flat and upland surfaces provided soil protection and reduced erosion on the dam's stripped sites. Analyses have shown that cover plant growth on flat surfaces is better than on upland surfaces after three months of transplanting. However, from the fourth to the thirteenth month, the growth and development of the cover plants are statistically identical on both surfaces. *Arachis repens* therefore appears to be a relevant and sustainable option for revegetating degraded land and ecologically rehabilitating disturbed environments. It could be used nationwide in development projects, particularly on mining and road sites or in areas highly susceptible to erosion.

Keywords

Revegetation, Cover Crop, *Arachis repens*, Stripped Sites, Côte d'Ivoire

1. Introduction

In the most remote areas, where industry does not appear to pose a real threat of air pollution, another type of problem has been identified: deforestation and soil degradation. In Côte d'Ivoire, certain infrastructure construction projects implemented by the state are actively contributing to deforestation and soil degradation. This was the case with the construction of a hydroelectric dam in the town of Soubré in 2013. While only 54% of the Ivorian population had access to electricity, part of this population lived without electricity [1]. The dam was therefore built with the aim of increasing access to electricity for the population, but also to reduce the high cost of this resource. Following the resulting damage, the government committed to restoring heavily degraded areas and minimizing the environmental impact of such projects in the future [2] [3]. Indeed, the rehabilitation or construction of a hydroelectric dam remains a factor in the advanced degradation of flora and soil. The implementation of such works requires the acquisition and displacement of large masses of earth, causing erosion and limiting people's access to arable land [3]. While traditional methods such as riprap and synthetic geotextiles have been used to curb erosion and sedimentation along hydroelectric dams [4], these approaches can cause further degradation and contribute to pollution and habitat loss [5]. Given that nature-based solutions reduce these risks and can facilitate ecosystem restoration, the use of methods such as revegetation may be the best way to address some of the negative impacts of hydroelectric reservoirs. One of the recent strategies implemented by the government aimed at ecological compensation through the practice of agroforestry.

However, the nutrient-poor soil has led to slow growth of the tree species planted as part of the reforestation program [6]. It was therefore necessary to consider revegetation with plants more suited to the substrate before undertaking any reforestation project. To this end, the legume *Arachis repens* was tested as a cover crop on the stripped sites of the Soubré hydroelectric dam. According to Husson [7], Boka [8] [9], Kouadio [10], *A. repens* produces high biomass and organic matter on the soil surface, providing good ground cover and combating erosion, and inducing more diverse and intense biological activity in the soil. It could therefore enable the revegetation of sites that have been stripped bare for agricultural purposes. The objective of this study is to contribute to the restoration of vegetation cover on stripped land through the use of cover crops.

2. Materials and Methods

2.1. Study Site

This study was conducted at the Soubré dam (**Figure 1**) stripping site in southwestern Côte d'Ivoire in the Nawa region, located between 6˚12' and 7˚08' west longitude and 5˚19' and 6˚34' north latitude. The climate is humid sub-equatorial, characterized by two rainy seasons (April-June and September-November) and two dry seasons (July-August and December-March). Under the direct influence of the Atlantic Ocean and relatively dense vegetation cover due to the proximity of Taï National Park, average temperatures range between 24˚C and 27˚C.

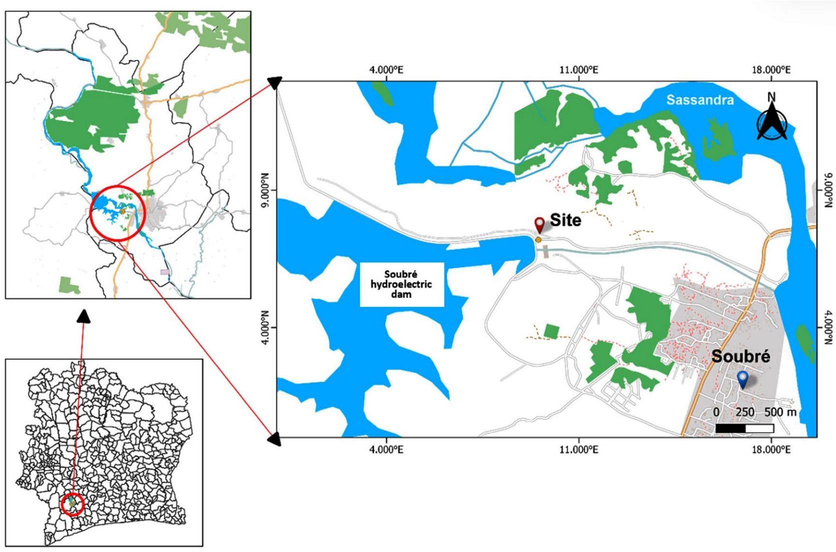


Figure 1. Location of the study site.

2.2. Plant Material

The plant material used in the study consists of the cover crop *Arachis repens* (**Figure 2**). It was chosen primarily as a cover crop because of the thick, prostrate growth of its stolons and strong taproots. It is a leguminous plant with characteristics that enable it to adapt to different soil conditions, fix atmospheric nitrogen, and add organic matter to the soil. It is also a very effective plant for combating erosion [7].

Figure 2. *Arachis repens* collected and used as plant material.

2.3. Methods

2.3.1. Selection and Preparation of the Experimental Plot

The experimental plot for the trial was selected from the site of the stripping work carried out during the construction of the Soubré hydroelectric dam, which left large areas of bare earth. Two types of plots were selected: steeply upland surfaces (>5%) and relatively flat surfaces (<5%). The pH of the plot measured using the glass electrode method [11] was acid around 5 whatever the soil surface type. This stripped site reveals a ferralitic subsoil with a sandy-clay texture and a B horizon rich in iron (lateritic). Each plot had a basic area of 100 m^2, where staking and hole digging were carried out after watering, at intervals of 30 cm × 30 cm across the entire surface of the plot. The holes, approximately 5 cm deep, were made using machetes, dabas, and stakes (**Figure 3**).

Figure 3. Preparation of the experimental plot.

2.3.2. Collection of the Cover Plant and Preparation of Cuttings

The cover plant was collected by carefully removing it from its substrate so that the roots were obtained in fairly good condition. It was then moistened. The plants were transported to the study site, where the stems were cut into cuttings using scissors so that each cutting had at least five nodes. The cuttings were moistened and immediately transplanted.

2.3.3. Transplanting Cuttings and Maintenance

The cuttings were transplanted individually into holes that had been dug beforehand. The cuttings were planted with two nodes in the soil, positioned close together to ensure faster ground cover. Maintenance consisted of watering the transplanted cuttings with a water jet, using a motor pump to deliver water to the plot, then watering cans to water the transplanted cuttings. Watering was done twice a day, in the morning before sunrise and in the evening after sunset for two weeks.

2.3.4. Experimental Design

The experimental design consisted of three simple blocks, each comprising an upland and a flat surface. Each surface had an area of 100 m^2 (10 m × 10 m). Five subplots were set up within each surface, diagonally and in the center. Each subplot with an area of 1.5 m^2 contained 12 plants among which 10 plants were selected for growth measurements and observations.

2.3.5. Data Collection

Data collection focused on the recovery rate of cover plants, the number of branches, internodes, and the length and coverage of cover plants. Surveys were conducted over thirteen months, starting one month after the cuttings were transplanted and continuing at three-month intervals. The recovery rate of cover plants was calculated based on the ratio of the number of cuttings that have recovered growth to the number of cuttings transplanted. The branches emitted by each individual were determined by counting. The number of internodes was also determined by counting. The length of the aerial axis was measured at the apical end of the main stems using a tape measure. During plant growth, the vegetation cover rate (area occupied by a species or vegetation if projected onto the soil surface) was estimated at regular intervals (every 3 months) starting from the first month after the vegetation cover was established [10].

2.3.6. Analysis of Data

The data obtained were entered using EXCEL version 2016 and analyzed using XLSTAT 2016 software. To study the effects of surface type on the recovery and growth of cover crops, a one-way analysis of variance was performed. In cases of significant differences, Tukey's test was used at a 5% probability threshold to identify homogeneous groups.

3. Results

3.1. Recovery Rate of Cover Plants

The analysis of variance shows a significant difference between the recovery rates of the cover plant *Arachis repens* depending on the surface area of the stripped site ($p < 0.05$). The highest recovery rate was obtained on the flat plot, with 90.67%, while the lowest was recorded on upland surface, with 75.67% (**Table 1**). **Figure 4** illustrates that the recovery of cuttings transplanted on flat surface is higher than that obtained on upland area.

Table 1. Recovery rate of the cover crop *A. repens* according to soil surface.

Soil surfaces	Recovery rate (%)
Upland	75.67 a
Flat	90.67 b
F	4.92
p	0.027

Values assigned the different letter are statistically different at the $\alpha = 0.05$ threshold according to Tukey's test. F: Tukey's value; p: probability.

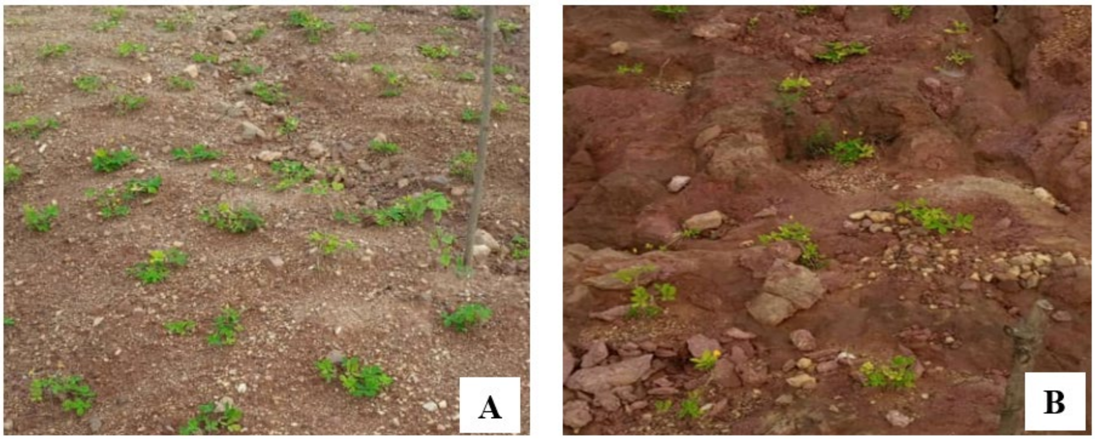
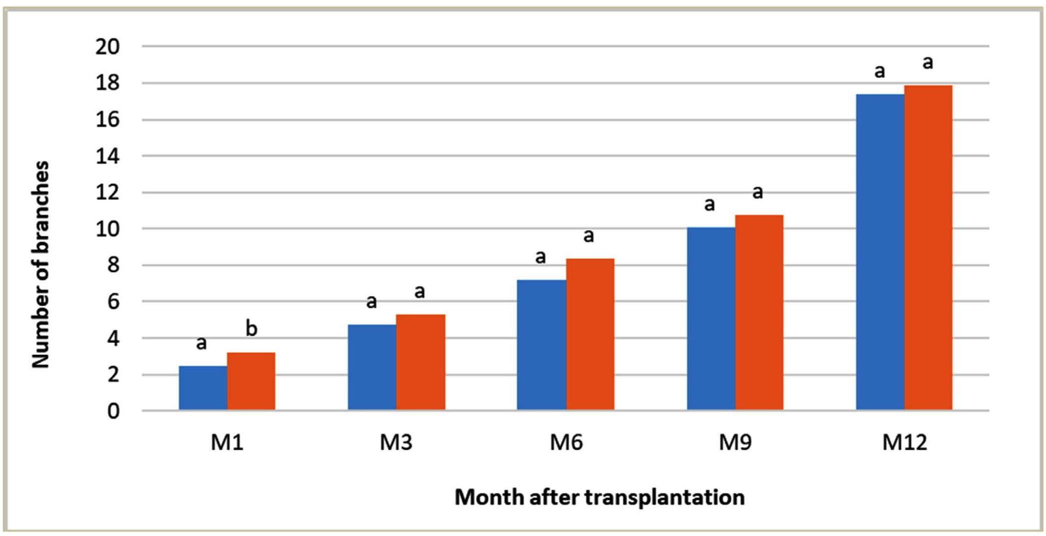


Figure 4. Recovery of cuttings on a tray (A) and on a slope (B) one month after cutting.

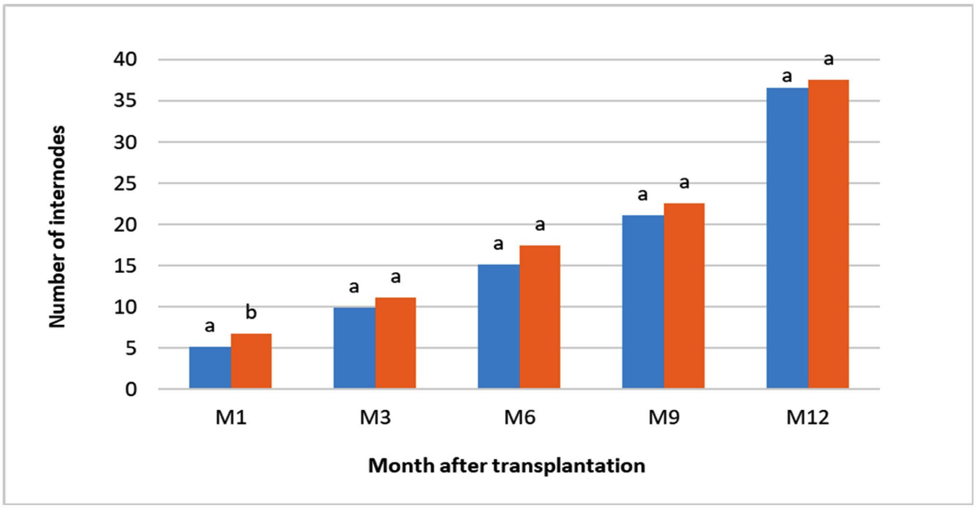
3.2. Number of Branches and Internodes of Cover Crops

The number of branches and internodes of *Arachis repens* gradually increases over the twelve months following transplanting, regardless of the type of soil surface stripped from the Soubré hydroelectric dam (**Figure 5** and **Figure 6**). During the first few months (M1 to M3), vegetative growth remains moderate, with values ranging from 2 to 6 branches and 5 to 11 internodes. At M1, a significant difference is observed between the two conditions, with the flat surface showing the highest numbers of branches and internodes. From M3 onwards, the differences between the surfaces were no longer significant. Both types of surface supported similar and regular growth of the cover plant *A. repens*. At M12, both types of soil surface showed maximum development, with values of around 17 to 18 branches and 37 to 38 internodes.



For a same period, values assigned the different letter are statistically different at the $\alpha = 0.05$ threshold according to Tukey's test. The orange color indicates the flat plots, and the blue color indicates the upland plots.

Figure 5. Number of branches of the cover crop *A. repens* according to soil surface.



For a same period, values assigned the different letter are statistically different at the $\alpha = 0.05$ threshold according to Tukey's test. The orange color indicates the flat plots, and the blue color indicates the upland plots.

Figure 6. Number of internodes of the cover crop *A. repens* according to soil surface.

3.3. Cover Crop Length and Coverage Rate

The length of the stems and the rate of ground cover by the cover crop *Arachis repens* gradually increased over the twelve months following transplanting, with significant differences between periods but not between soil surface types within the same period (**Table 2**). At M1, the flat surface has a slightly greater stem length (13.91 cm) than those located in the upland area (10.06 cm), although the coverage rates remain statistically similar (11.00% and 8.00%, respectively). From M3 onwards, stem lengths remained higher on flat surface (24.72 cm compared to 21.81 cm in upland areas), while coverage rates evolved in parallel, reaching 19.67% and 17.33%. This trend is confirmed at M6, where vegetative growth reaches 40.34 cm versus 34.48 cm, accompanied by coverage rates of 32.13% and 27.47%. In the ninth month, the differences persist, with 52.75 cm on flat surface compared to 49.16 cm on upland. However, the coverage rates remain statistically indifferent. At M12, *A. repens* reaches its maximum development, with stems measuring 89.22 cm on flat surface and 86.80 cm on upland, accompanied by high coverage rates (71% and 69%). At this stage, no significant differences are observed in either the coverage rate or the length of the plants.

Table 2. Plant length and coverage rate of the cover crop *A. repens according* to soil surface.

Month after transplantation of the cover crop	Soil surfaces	Plant length (cm)	Coverage rate (%)
M1	Flat	13.91 a	11.00 a
	Upland	10.06 a	8.00 a
M3	Flat	24.72 b	19.67 b
	Upland	21.81 b	17.33 b

Continued

M6	Flat	40.34 c	32.13 c
	Upland	34.48 c	27.47 c
M9	Flat	52.75 d	41.93 d
	Upland	49.16 d	39.07 d
M12	Flat	89.22 e	71.00 e
	Upland	86.80 e	69.00 e

For a same period, values assigned the different letter are statistically different at the α = 0.05 threshold according to Tukey's test.

4. Discussion

This study highlighted a significant effect of the type of stripped soil surface on the recovery rate of the cover plant *Arachis repens* ($p < 0.05$), with significantly higher performance on plateau plots. This situation is consistent with empirical and experimental work showing that slope and associated topographic factors (degree and orientation of slope) strongly influence soil water availability, erosion risk, and therefore plant establishment and survival in soil restoration and revegetation contexts [12]. Upland surfaces result in low moisture retention, increased runoff, and soil erosion, which reduces the window for rooting and horizontal spread of stoloniferous legumes such as *A. repens*, which depend on rapid contact with the soil and burial of nodes to establish themselves successfully [13]. Recent literature on conservation and restoration emphasizes combined biological and physical measures for slope stabilization [14].

A steady increase in growth (number of branches and internodes, stem lengths, and coverage rates) of *Arachis repens* was observed at the Soubré hydroelectric site during the 12 months following transplantation. This gradual vegetative development shows a slow initial establishment phase followed by accelerated horizontal expansion, no doubt when nitrogen-fixing root nodules become active. Overall, at the start of the study, *A. repens* performed better on flat surfaces. This finding is thought to be due to water stress induced by upland surface, which delays the activation of stolons and reduces initial vegetative vigor.

However, from the third month after transplanting, the absence of differences between surface types indicates that *A. repens* is able to overcome early establishment difficulties. This convergence is consistent with the property of creeping legumes, whose stolons gradually stabilize the soil, improve moisture distribution, and create more favorable microhabitats over time [7]. Comparable performance on topographies at advanced stages highlights the species' strong adaptive capacity and its suitability for restoring degraded soils, including stripped hydroelectric construction sites. *A. repens* has likely benefited from gradually improved biological nitrogen fixation.

This plant is known to provide 36 to 78 kg N $ha^{-1} \cdot year^{-1}$ in tropical terrestrial cover [15]. Such nitrogen inputs could directly stimulate vegetative growth, as increased nitrogen availability in the soil promotes stolon elongation, branching density, and biomass production, leading to a gradual improvement in soil fertility, particularly in stripped soils that are generally poor in nitrogen after construction work. By accelerating the internal nitrogen cycle and high litter production [15] [16], *A. repens* not only compensates for nutrient-poor conditions, but also actively rebuilds the soil's nutrient and living capital. Although baseline and final soil nutrient data were not measured in this study, the steadily increasing vegetative growth, peaking at stem lengths of 89.22 cm (flat surface) and 86.80 cm (upland surface) at M12, strongly suggests improved nitrogen nutrition with *A. repens.* These limitations of our study should be addressed by long-term monitoring of soil health (organic matter, nitrogen, structural stability, fauna, biological activity) in order to assess the sustainable impact of *A. repens*; by cost-benefit analysis to facilitate large-scale adoption by development projects. In addition, the cover provided by *A. repens* protects soil aggregates from erosion and maintains soil moisture, thereby reducing evaporation and acidification. The long-term root growth of *A. repens* would improve soil aeration, porosity, and infiltration capacity, thereby restoring stripped soils [17]. *A. repens* litter is known to release nutrients (N, P, K, C, and Ca) fairly quickly [18] and to promote good biological activity, thus contributing to the restoration of chemical fertility and soil life from the 12th month after establishment.

5. Conclusion

The aim of this study was to restore vegetation cover on stripped land at the Soubré hydroelectric dam site in Côte d'Ivoire using the cover crop *Arachis repens*. The results showed that this species effectively tolerates the harsh conditions of stripped soils, with relatively high recovery rates and continuous growth characterized by a steady increase in the number of internodes, branches, stem length, and coverage rate, both on upland surface and on flat surface. These performances confirm the adaptability of *A. repens* and highlight its potential as a tool for ecological restoration on heavily disturbed sites. The results imply scaling up the use of *A. repens* for the rehabilitation of other hydroelectric, mining, or road infrastructure with degraded soils. Its ability to establish itself quickly, stabilize the soil, and gradually improve substrate quality makes it a strategic species for restoration programs. The integration of *A. repens* into sustainable soil management systems could also help reduce erosion, limit silting in reservoirs, and improve the ecological resilience of developed sites. Thus, *Arachis repens* appears to be a promising ecological solution for the restoration of severely disturbed soils, with broad application potential and benefits to be explored further in future research.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Banque Mondiale (2020) Le secret du succès électrique de la Côte d'Ivoire.

https://www.banquemondiale.org/fr/news/feature/2020/07/23/the-secret-to-cote-divoires-electric-success

[2] Deshaies, M. and Kouadio, A. (2019) Les enjeux du développement des énergies renouvelables pour la production d'électricité en Côte d'Ivoire. *Revue Espace Geographique et Societe Marocaine*, **26**, 249-272. https://revues.imist.ma/index.php/EGSM/article/download/15049/8368/37864

[3] Kouadio, Y.J.C., Kouassi, B.K., N'Guessan, O.Y., Tiébré, M.S., Ouattara, D. and Kouakou, E.N. (2020) Disponibilité des plantes utilitaires dans la zone de conservation de biodiversité du barrage hydroélectrique de Soubré, Sud-Ouest, Côte d'Ivoire. *Afrique Science*, **16**, 65-74. https://www.afriquescience.net/admin/post-pdfs/dbf3309d49688ca3558971a15ea65e991728601717.pdf

[4] Aparicio Ardila, M., dos Santos Junior, R., Kobelnik, M., Aparecido Valentin, C., Silva Schliewe, M., Teixeira Coelho, A., *et al.* (2021) Semi-Rigid Erosion Control Techniques with Geotextiles Applied to Reservoir Margins in Hydroelectric Power Plants, Brazil. *Water*, **13**, Article 500. https://doi.org/10.3390/w13040500

[5] da Luz, M., Aparicio Ardila, M., dos Santos Junior, R., Valentin, C., Schliewe, M., Coelho, A., *et al.* (2021) Geomats Used to Control Erosion on Reservoir Margins in Brazilian Hydroelectric Power Plants. *Water*, **13**, Article 1444. https://doi.org/10.3390/w13111444

[6] Sarrailh, J.M. (2002) La revégétalisation des exploitations minières: L'exemple de la Nouvelle-Calédonie. *BOIS & FORETS des Tropiques*, **272**, 21-31. https://revues.cirad.fr/index.php/BFT/article/view/20151

[7] Husson, O., Charpentier, H., Michellon, R., Razanamparany, C., Moussa, N., En-jalric, F., Naudin, K. and Rakotondramanana Séguy, L. (2012) Fiches techniques plantes de couverture: Légumineuses pérennes—Arachis pintoï et *Arachis repens*. *Manuel Pratique du Semis Direct à Madagascar*, **3**, 45-56. https://gsdm-mg.org/wp-content/files/Manuel_SCV_Vol_3_Fiche_technique_GSDM.pdf

[8] Boka, K.N.R., Cherif, M., Kassi, K.F.J.M., Kouame, K.D., Tuo, S., Kouame, K.F., *et al.* (2022) Effects of Two Cover Crops [*Arachis repens* (L.) Handro and *Desmodium adscendens* (SW.) DC.] on the Density of Arbuscular Mycorrhizal Fungi in Soils under Industrial Banana Plantations in Côte d'Ivoire. *European Scientific Journal*, *ESJ*, **18**, 222-239. https://doi.org/10.19044/esj.2022.v18n11p222

[9] Boka, K.N.R. (2025) Effets des plantes de couverture sur la fertilité du sol et les paramètres agrophysiologiques des bananiers en Côte d'Ivoire. Ph.D. Thesis, Faculté de Biosciences, Université Félix Houphouet-Boigny, 273 p.

[10] Kouadio, E.Y.G., Chérif, M., Kouamé, K.F., Kassi, K.F.J.M., Kouamé, K.D., Camara, B., Abo, K. and Dick, A.E. (2022) Growth of Two Cover Crops [*Arachis repens* (L.) and *Desmodium adscendens* (Sw.)] and Effect on Weediness in Industrial Banana Plantations in Southeastern Côte d'Ivoire. *European Journal of Scientific Research*, **161**, 47-62.

[11] AFNOR (Association Française de Normalisation) (1999) Détermination du pH. In: AFNOR, Eds., *Qualité des sols*, Association Française de Normalisation, 339-348.

[12] Zhao, F., Wang, N., Liu, J. and Zhou, Z. (2022) Effects of Vegetation Type and Topography on Vegetation Restoration after Pipeline Construction in the Northern Shaanxi Loess Plateau, China. *Ecological Research*, **38**, 177-187. https://doi.org/10.1111/1440-1703.12360

[13] Delgado, J.A., Barrera Mosquera, V.H., Alwang, J.R., Villacis-Aveiga, A., Cartagena

Ayala, Y.E., Neer, D., Monar, C. and Escudero López, L.O. (2021) Potential Use of Cover Crops for Soil and Water Conservation, Nutrient Management, and Climate Change Adaptation across the Tropics. *Advances in Agronomy*, **165**, 175-247. https://doi.org/10.1016/bs.agron.2020.09.003

[14] Atakoun, A.M., Tovihoudji, P.G., Diogo, R.V.C., Yemadje, P.L., Balarabe, O., Akponikpè, P.B.I., *et al.* (2023) Evaluation of Cover Crop Contributions to Conservation Agriculture in Northern Benin. *Field Crops Research*, **303**, Article ID: 109118. https://doi.org/10.1016/j.fcr.2023.109118

[15] Ngome, A.F. and Mtei, M.K. (2010) Establishment, Biological Nitrogen Fixation and Nutritive Value of *Arachis pintoi* (CIAT 18744) in Western Kenya. *Tropical Grasslands*, **44**, 289-294. https://www.tropicalgrasslands.info/public/journals/4/Historic/Tropical%20Grasslands%20Journal%20archive/PDFs/Vol_44%20%281_2_3_4%29/Vol%2044%20%284%29%20Ngome%20and%20Mtei%20289.pdf

[16] Cook, B.G., Pengelly, B.C., Brown, S.D., Donnelly, J.L., Eagles, D.A., Franco, M.A., Hanson, J., Mullen, B.F., Partridge, I.J., Peters, M. and Schultze-Kraft, R. (2005) Tropical Forages: An Interactive Selection Tool. https://cgspace.cgiar.org/items/f3b5a09f-5630-4fb6-b0ed-f6a1d61539c2

[17] la Mora, B.V., Castillo-Gallegos, E., Jarillo-Rodrguez, J. and Ocaa-Zavalet, E. (2012) Impact of an Introduced Forage Legume and Grazing on Soil Fertility in Native Pastures of the Humid Tropics of Mexico. In: Whalen, J.K., Ed., *Soil Fertility Improvement and Integrated Nutrient Management—A Global Perspective*, InTech, 57-80. https://doi.org/10.5772/28523

[18] Kerridge, P.C. and Hardy, B.E. (1994) Biology and Agronomy of Forage Arachis. CIAT Publication, 209 p.