Farmers' perceptions of soil degradation and the efficacy of anti-erosion structures in orchards in western Burkina Faso

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1 ABSTRACT

Mango production is of considerable socio-economic importance. It contributes to food security and is a major source of foreign currency income. Despite these assets, soil degradation in mango orchards is a threat to mango production. This study aims is to contribute to the recovery of degraded soil in mango orchards in order to optimise yields. The study was carried out in three localities (Banfora, Tiéfora and Bérégadougou) in the Cascades region on a random sample of 100 producers. The survey was carried out by direct administration of a questionnaire. The results show different levels of perception of soil degradation in mango orchards. For example, 80% of farmers said that they had perceived soil degradation in terms of rainwater run-off and the appearance of gullies, 50% of farmers perceived it in terms of reduced yields and 20% of farmers described it in terms of the morphology of the fruit, which was becoming smaller and smaller. To combat this scourge, 100% of the mango farmers surveyed built bunds of beaten earth, 90% used manure and ploughing, and 20% used agroforestry and filter bunds. In terms of the positive impact of the improvements made, 80% of farmers mentioned the soil restoration effect, 60% said that yields had increased and 15% said that groundwater had been recharged. Despite all this, chemical pesticide treatments are the most widely used by farmers. In view of the results obtained, it would be necessary to adopt these different soil recovery techniques to optimise mango production in orchards.

2 INTRODUCTION

Fruit production in general, and mango production in particular, is of considerable socio-economic importance (PAFASP, 2011). According to Ouédraogo (2011), orchards account for 58% of plantations and 55.20% of fruit producers in our country. This production have an important role in the national economy, with an average production of 300,000 tonnes of mangoes per year (UNPM-B, 2020). It also contributes to the food security of populations in production areas. The mango industry generates more than 15 billion FCFA a year for the country's economy (APROMAB, 2020) and is a major source of foreign currency. Despite its strengths, production difficulties linked to the progressive degradation of the soil exist. The soil is subject to rainwater run-off and drought. One study estimates that around 11% of the country's soil is considered to be much degraded and 34% moderately degraded (SNRCRS 2019). In addition, water and wind erosion in the study area has often led to the abandonment of arable soil. This is a daily problem to be solved in mango orchards. The search for suitable techniques for restoring, conserving and recovering the productive potential of the soil is therefore a constant concern. The fight against this phenomenon involves implementing the agro-ecological intensification approach. This study was initiated to help reverse this trend towards degradation, with a view to improving orchard productivity, preserving the environment and practicing sustainable, resilient agriculture. One of the approaches chosen, with the participation of producers, is the development of anti-erosion sites and the use of compost in mango orchards.

3 MATERIALS AND METHODOLOGY

3.1 Choice of study site: This study was carried out in three localities (Banfora, Tiéfora and Bérégadougou) in the Cascades region (Figure 1). The climate in the study area is south Sudanian (Fontes and Guinko, 1995). Generally, the amount of water collected varies between 775.4 mm and 1278.3 mm, with an average of 1074.01 mm per year. Average annual temperatures range from 17 to 36°C and are relatively mild, with a temperature range of 19°C. The soils in our study area are of the leached tropical ferruginous type. According to the summary of ORSTOM work by Fontes and Guinko (1995), these soils are variable in texture, generally tending to be sandy in the surface horizons and clayey in the deeper horizons (> 40 cm). They have an imperfect water regime due to poor physical properties (porosity and permeability). These soils are unable to retain enough cations (Mg2+, Ca2+, Fe2+) that can be absorbed by plants. These cations help to strengthen plant cell walls by stopping parasitic infections. Ultimately, these shallow, compact soils with a sandy or silty texture contribute to heavy run-off.

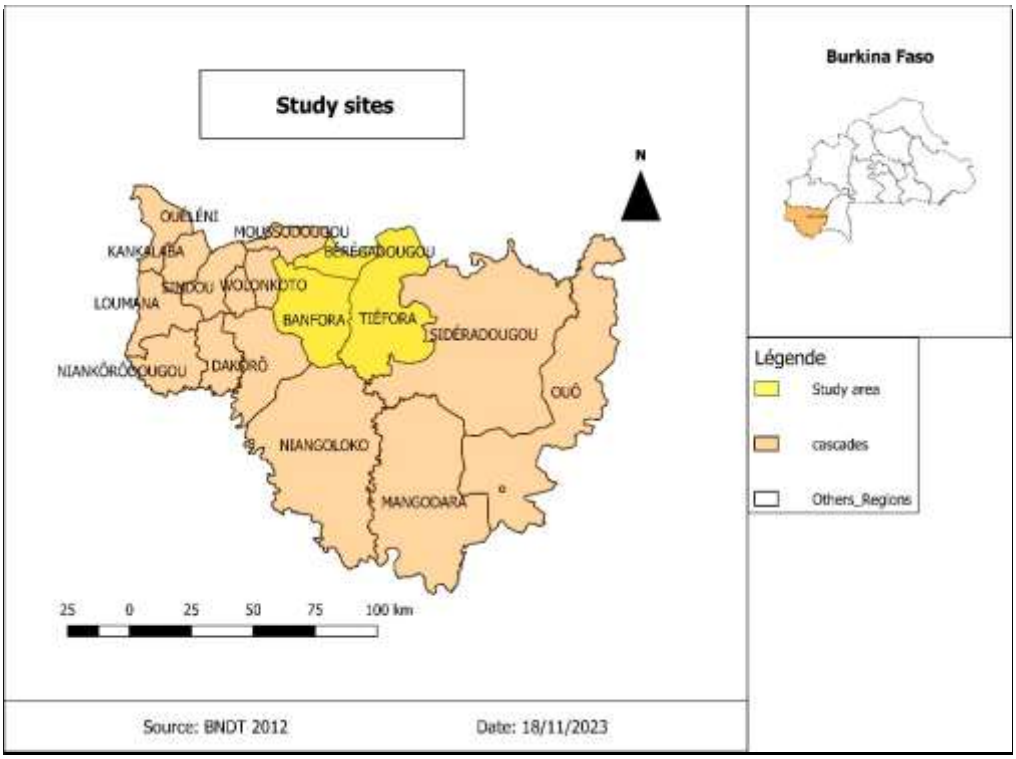

Figure 1: Study area

3.2 Choice of sample: Cent (100) producers were identified for the purposes of the survey. These producers were chosen because they belonged to the mango-producing agricultural areas most affected by soil degradation due to water run-off, and because they were available for the survey.

3.3 Design and administration of the questionnaire: The questionnaire was designed according to the information required (questionnaire presented in the appendix). The information was collected in two phases: an interview phase and a survey phase. The interviews took place with certain officials from the deconcentrated agriculture department and the department representing the mango umbrella organization, whose views were collected. Producer surveys and direct observations were carried out. A sample of 100 people was surveyed and the parameters assessed included: observations and measurements of earth bunds and filter bunds; comparisons of mango tree production in developed and undeveloped areas; production and use of compost/manure, the effects of developments and the difficulties associated with their implementation.

3.4 Data processing and analysis: Sphinx Plus2 software was used to draw up the questionnaire and to analyse data. The data were processed by counting them. The histograms were constructed using Excel 2016, based on data exported from Sphinx Plus2.

4 RESULTS

4.1 Perception of soil degradation in orchards: Figure 2 shows farmers' perceptions of soil degradation. Eighty percent said they perceived soil degradation in terms of rainwater runoff and the disappearance of arable soil (Figure 3-b). 50% of farmers agreed that yields were low and that plant roots were exposed to the soil surface (Figure 3-a). At the end, 20% of farmers described the phenomenon in terms of the morphology of the fruit, which was becoming smaller and smaller.

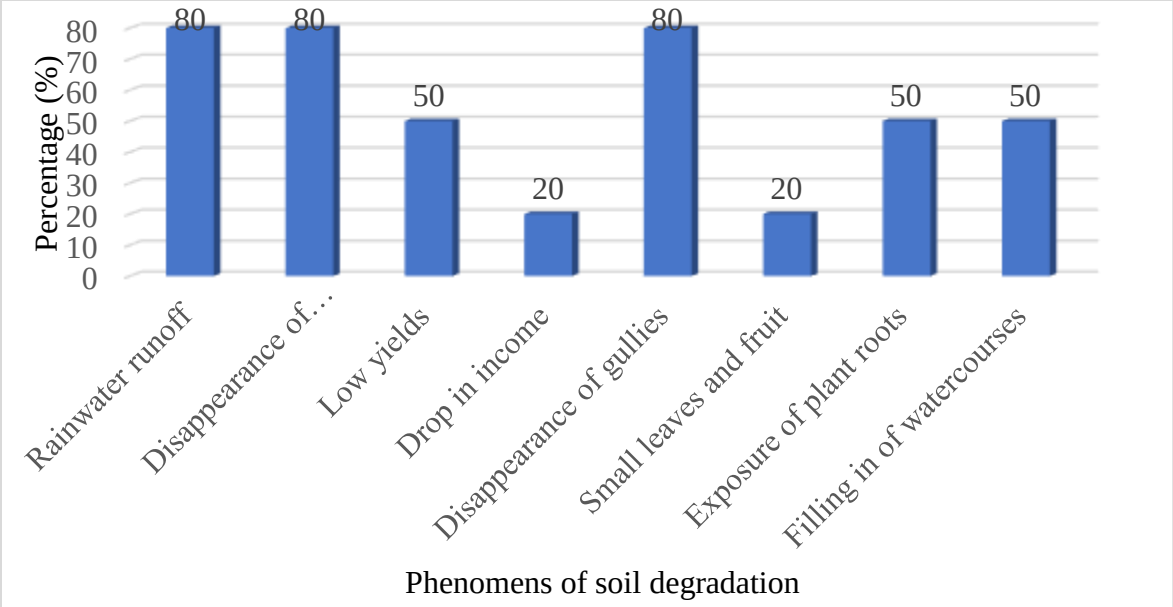

Figure 2: Farmers' perception of degradation.

a) Exposure of mango roots on the soil surface

b) Gully in a mango orchard

Figure 3: Some phenomena of soil degradation.

4.2 Phytosanitary treatments used: Figure 4 shows the phytosanitary treatments used by mango farmers as part of integrated management of the risks of fruit fly infestation and disease control. In all, 80% of farmers mentioned using chemical insecticides against mango pests and diseases. 20% of farmers said they used sex and food baits and plant extracts. However, none of the farmers used natural enemies to treat mango trees against pests.

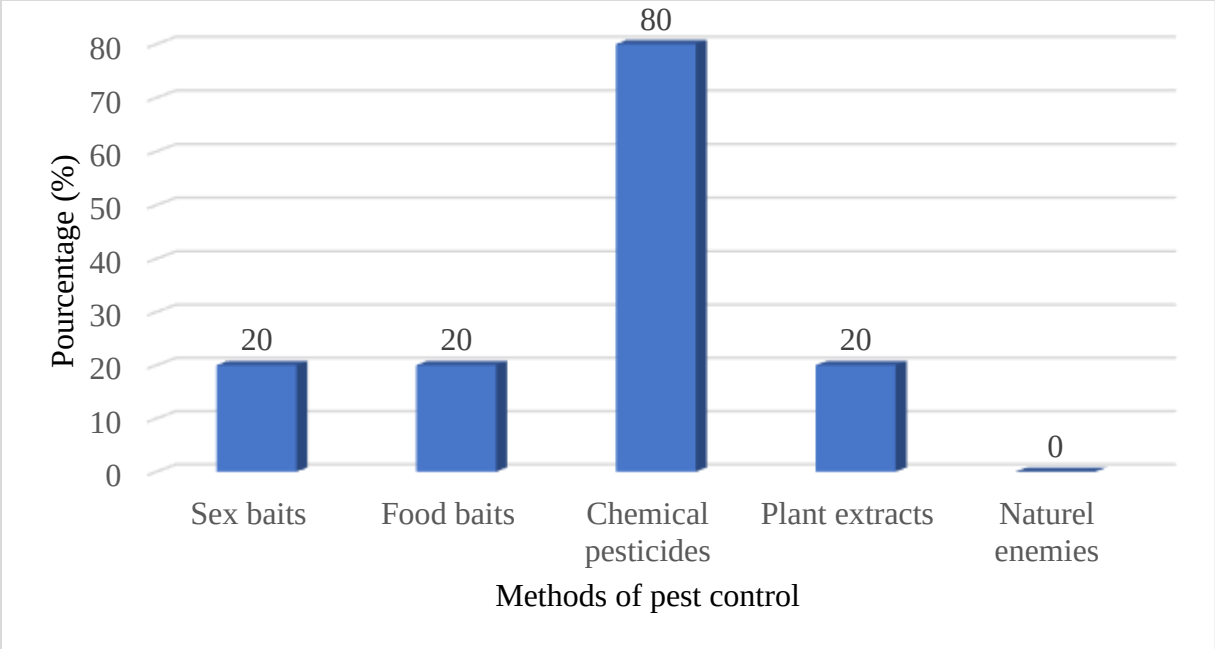

Figure 4: Disease and pest control methods

4.3 Anti-erosion structures for soil recovery in orchards: Figure 5 shows the anti-erosion measures applied in mango orchards in our study area. It can be seen that 100% of the mango farmers surveyed had built bunds of rammed earth to restore the soil (Figure 6-a). 90% used manure/compost and ploughing as cultivation techniques to maintain soil fertility. As for the agroforestry technique and the filter dikes used to treat gullies (Figure 6-b), 20% have used them for soil restoration.

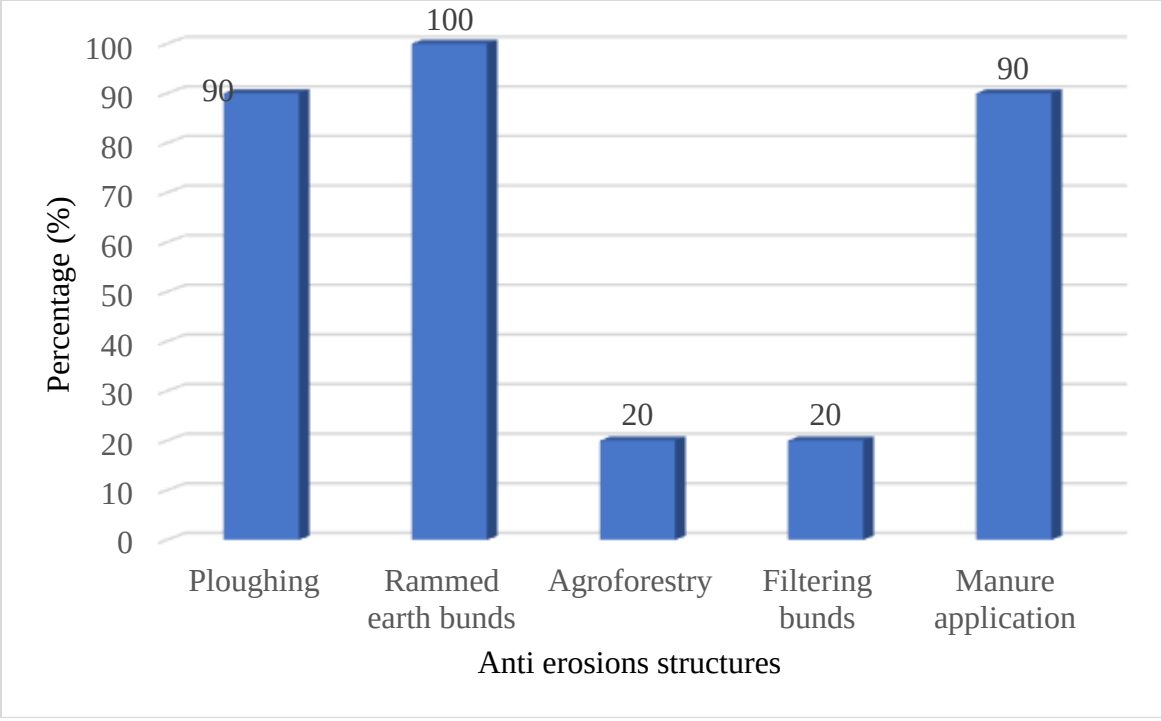

Figure 5: Anti-erosion management practices in mango orchards

a) Diguette feeder b) Rammed earth cages

Figure 6: Some anti-erosion works carried out in mango orchards

4.4 Impacts of erosion control measures: Figure 7 shows the positive impacts of management on orchard soil. These include increased productivity, soil reclamation, runoff control, groundwater recharge and improved incomes. For example 80% of mango orchard farmers mentioned the effects of soil restoration, with less gullying, a reduction in surface runoff and improved incomes on managed soil. 60% of mango orchard farmers said that the improvements offered opportunities to increase yields. As for the impact of development on orchard soils, 15% of farmers pointed to the recharging of water tables.

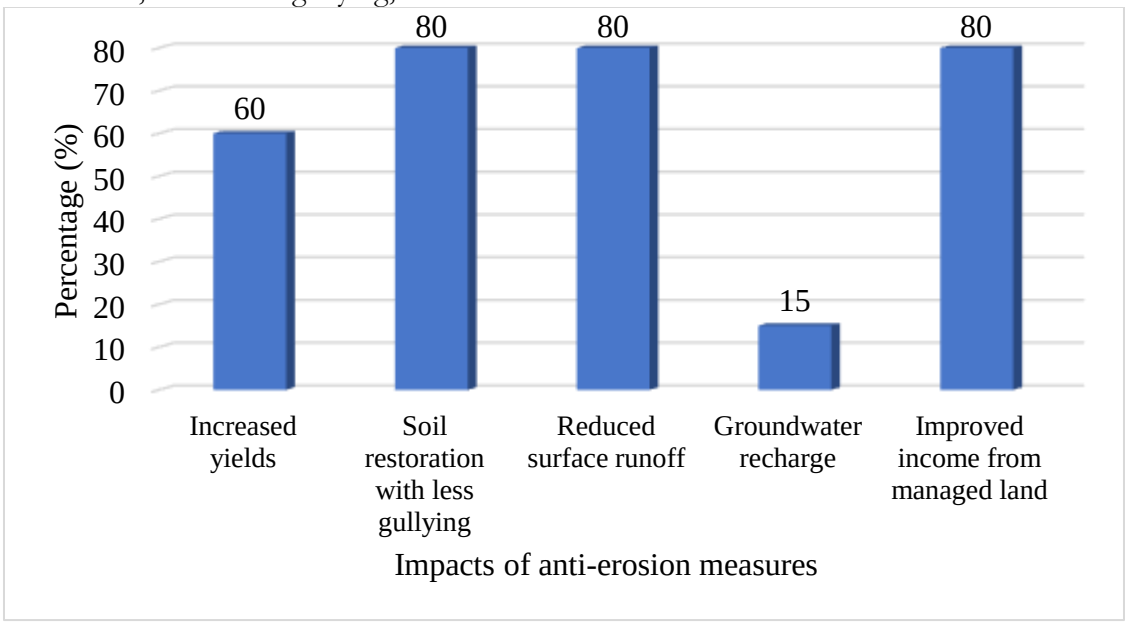

Figure 7: Impact of anti-erosion measures

4.5 Topics of training received: Figure 8 shows the topics of training received by farmers. In fact, 80% of the farmers surveyed had received training on "Techniques for recovering degraded soil", "Orchard hygiene" and "Compost production". 50% of farmers said they had received training on "Knowledge of pests and diseases", "Control of mango pests and diseases" and "Integrated management of fruit flies".

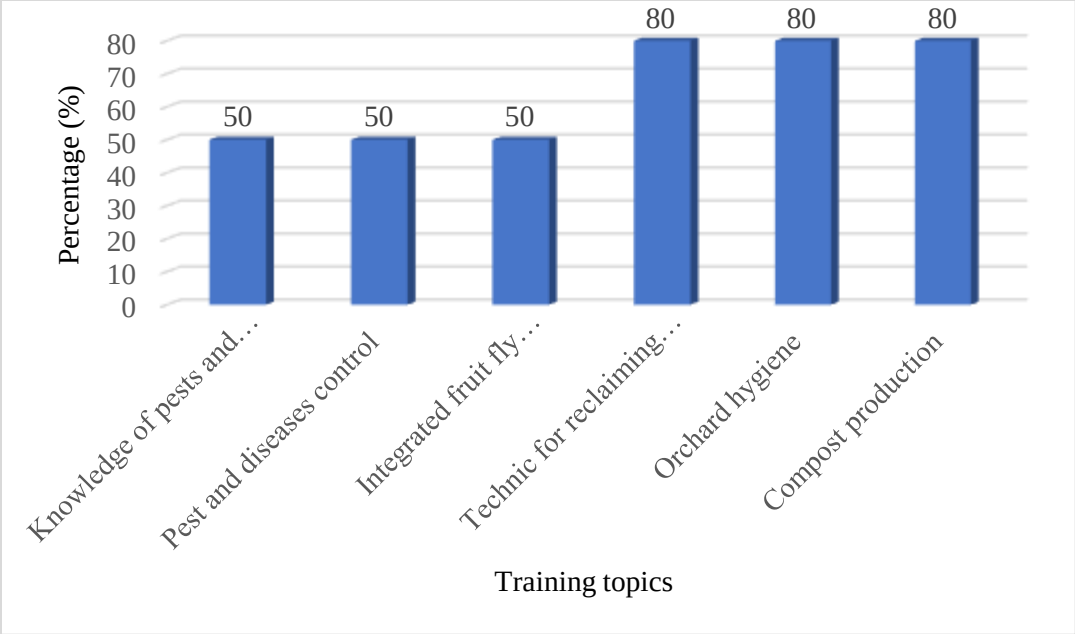

Figure 8: Training topics received

5 DISCUSSION

The orchards' soils in the study area are in an advanced state of degradation according to the various soil observations and pedological profiles carried out. This state of degradation is thought to be due to the loss of topsoil and the significant runoff of water into the orchards. This water run-off outside the orchards will then cause a reduction in organic matter and, consequently, a drop in nutrient content. The state of soil degradation in orchards is confirmed by the work of Ouedraogo (2002), who stated that favorable soil and climatic conditions are a guarantee for the development of the fruit sector in Burkina Faso, provided that certain major constraints are overcome. Most farmers see soil degradation in the form of rainwater run-off, the disappearance of arable soil and the appearance of gullies. The consequences of this degradation of orchard soil are low yields, the exposure of plant roots to the open air and the filling in of watercourses. The farmers surveyed described the phenomenon in terms of the morphology of the fruit, which was becoming smaller and smaller. This approach to the perception of soil degradation is in line with previous studies (Mukenza *et al.,* 2021). The anti-erosion measures applied in the mango orchards in the study area are rammed earth bunds, the addition of manure/compost, ploughing, agroforestry and filter bunds. Ultimately, all the mango farmers surveyed had built rammed earth bunds to restore the soil. This shows the importance of rammed earth bunds in the soil recovery process. Manure, compost and ploughing are cultivation techniques that help to maintain soil fertility. However, the low level of mastery of cultivation techniques is a serious handicap in obtaining the quality products required for export (Ouedraogo 2002). Agroforestry and filter dikes are cultivation techniques used to protect the soil. For trees in production, the recommended quantities of manure and chemical inputs for each tree are 1 kg of manure, 1.8 kg of oilcake, 4.55 kg of bone meal, 0.91 kg of ammonium sulphate and 13.6 kg of wood ash (Nadie *et al.,* 2009). These fertilizers ensure good growth and better yields from the mango trees. Similarly, erosion control measures have a positive impact on the soil. The use of natural enemies in the treatment of mango trees against pests is still unknown to farmers. The work of Sakandé et al (2022) indicates that farmers have a good perception of the involvement of pesticide use

in soil degradation, even if this is not perceived in our case. Phytosanitary treatments have already been recorded in mango orchards in western Burkina Faso, with weeding being the only cultivation operation (Ouattara, 2009). Preventive measures such as collecting and destroying fallen fruit containing larvae reduce the rate of reinfestation and delay it (Ouedraogo 2002). Nowadays, many countries are developing rational chemical control methods for these pests. This method uses trapping to monitor pest population levels and to attract them to specific areas of the orchard where localized applications of insecticides are made (Dabire, 2000). The various training courses received by farmers are also very useful and will make it possible to restructure and train organizations so that they can act as a lever for modernizing the sector and lifting farmers out of poverty (Passannet *et al.,* 2017).

6 CONCLUSION

The general objective of this study was to contribute to the recovery of degraded soil in mango orchards in order to optimize yields. It emerged from this work that the development of earth bunds combined with manure and filter bunds had significant impacts, particularly in terms of increasing mango yields, reconstituting soils, reducing erosion and retaining moisture on the developed soils. This study clearly shows that soil management and other agro-ecological approaches have had a multi-faceted impact, helping to improve people's well-being. In a global context characterized by a sharp increase in the price of chemical fertilizers, there is an urgent need to develop policies that encourage producers to invest in improving the fertility of orchard soils.

7 ACKNOWLEDGEMENTS

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8 REFERENCES

APROMAB. 2022. Mango sector in Burkina Faso. http://www.fao.org. Accessed 15/06/2022.

Dabiré R., 2002. Rapport de mission et proposition d'un plan d'action de lutte contre la cochenille farineuse du manguier Rastrococcus invadens et les mouches de fruits. Ouagadougou, Burkina Faso, IN.E.RA., 14p.

Fontès J. and Guinko S., 1995. Carte de la végétation et de l'occupation du sol du Burkina Faso: Notice explicative. Toulouse: Ministère de la coopération Française, 66p.

Mukenza MP, Mwenya IK, Kalumbu JT, Misonga AK, Kaleba SC, Sikuzani YU. 2021. Perception de la dégradation de la fertilité des sols et de sa gestion par les agriculteurs de la cité de Kasenga en République Démocratique du Congo. Geo-Eco-Trop, 45(2): 211-220.

Nadie AK, Zongo A, Kabre E, Nacro S, Kabore C, Ouedraogo S, Guira M. 2009. Manuel de Formation Participative sur la Production de Mangue Biologique à Travers les Vergers-Ecoles au Burkina Faso. Édition Souleymane NACRO, 69p.

Ouattara SG. 2009. Analyse socio-économique et institutionnelle de l'adoption des technologies d'amélioration de la productivité des manguiers dans l'ouest du Burkina Faso. Dissertation, Polytechnic University of Bobo-Dioulasso, Burkina Faso, 76p.

Ouedraogo N. S. 2011. Dynamique spatio-temporelle des mouches des fruits inféodés aux orchards de manguiers de l'Ouest du Burkina Faso en fonction de facteurs biotiques et abiotiques Doctoral

thesis, Université Paris Est (France), 146p.

Ouedraogo S.N., 2002. Étude diagnostique des problèmes phytosanitaires du manguier (Mangifera indica L.) de l'oranger (Citrus sinensis (L.) Osbeck) et du mandarinier (Citrus reticulata Blanco) dans la province du Kénédougou. Dissertation, Polytechnic University of Bobo-Dioulasso, Burkina Faso. 95p.

Programme d'Appui Aux Filières Agro-Sylvo-Pastorales (PAFASP). 2011. Pilot mapping of mango orchards in Burkina Faso, 76p.

Passannet A.S., Aghofack-Nguemezi J. and Gatsing D., 2017. Varietal diversity, production and conservation of mangoes in Chad. Int. J. Biol. Chem. Sci. 11 (3): 1145-1164.

Sakandé F., Traoré M., Koulibaly B., Lankoandé Y.F., Paré T., Coulibaly K. and Nacro H.B., 2022. Perception locale de la dégradation des sols et pratiques de réhabilitation dans la zone cotonnière Ouest du Burkina Faso. International journal of biological and chemical sciences. 16 (5) : 2189-2201.

SNRCRS 2019. Stratégie nationale de restauration, conservation et récupération des sols de 2020-2024, Burkina Faso, 82p.

UNPM-B (Union nationale des producteurs de mangues du Burkina), 2020. Atelier bilan campagne mangue 2020, Burkina Faso, 11p.

I. Identité de l'enquêté

1. Date:

2. Région

3. Province

4. Commune

5. Village

6. Nom

7. Prenom

8. âge

15. Quelle est la date d'implantation du verger?

16. Quelle est l'âge du verger?

○ [0 ○ 5] ○ [6 ○ 10] ○ [11
○ 15] ○ [16 ○ 20] ○ [21 ○ 25]
○ [26 ○ 30] ○ >30

17. Quelles sont les variétés produites?

☐ Lippens ☐ Amélie
☐ Brooks ☐ Kent
☐ Keitt ☐ Mangots ordinaires
☐ Valencia ☐ Autres

Vous pouvez cocher plusieurs cases.

18. Quel est le type de production?

○ Pure (mono variétale) ○ Association
○ Pluri-variétale

III-Itineraires techniques

19. Quelles sont les techniques de preparation de sols que vous pratiquez ?

○ Labours
○ Piquettage
○ Trouaison
○ Apport de fumiers/compost

20. Quels sont les écartements que vous preconisez?

☐ 5 m X 5 m ☐ 10 m X 10 m ☐ 7 m X 7 m

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25. Quelles sont les mésures CES/DRS appliquées ?
- ○ Labours
- ○ Diguettes en terre battues
- ○ Demi-lunes
- ○ Agro-forestérie
- ○ Digue filtrante
- ○ Apport de fumier/compost

26. S'il y a aménagements CES/DRS
- ○ La superficie couverte
- ○ La longueur de l'ouvrage réalisé

27. Quels sont les rendements des mangues fraîches vendues?
○ Tricycle ○ Camions ○ Caisses ○ Cartons

28. Qui sont vos clients?
○ Unités de séchage ○ Coopératives ○ Autres

29. Quels types de contrat existe t'il entre vous et vos clients?
○ Formel ○ Informel

IV- Etat de dégradation des sols

30. La perception du phénomène de dégradation des terres des vergers se traduit:
- ☐ Ruisselement des eaux de pluies
- ☐ Fréquence de la sécheresse
- ☐ Utilisation excessive des intrants chimiques
- ☐ Comblement des cours d'eaux
- ☐ Disparition des terres arabes
- ☐ Faiblesse des rendements des manguiers
- ☐ Diminution de la tailles des manguiers, des fruits et des feuilles
- ☐ Apparition des ravines, des griffes et des rigoles
- ☐ Baisse des revenus des producteurs
- ☐ Exposition des racines des manguiers à l'air libre
- ☐ Autres

Vous pouvez cocher plusieurs cases (7 au maximum).

V- Entretien des vergers

31. Quelle quantité de fumier apportez-vous au pieds?

_____

_____

33. Quels traitements phytosanitaires pratiquez-vous ?
- ☐ Appats alimentaires ☐ Appats sexuels
- ☐ Pesticides chimiques ☐ extraits de plantes
- ☐ Ennemies naturels

Vous pouvez cocher plusieurs cases.

VI- Renforcement des capacités

34. Avez-vous deja reçu une formation du projet ou de l'Etat?
○ Oui ○ Non

35. Si oui, dans quel thématique?
- ○ Connaissances des ravageurs et des maladies
- ○ Lutte contre les ravageurs et les maladies
- ○ Gestion integrée des mouches de fruits
- ○ Techniques de recupération des sols
- ○ Hygiène des vergers
- ○ Production de compost
- ○ Autres

VII- Difficultés de réalisation des aménagements anti-érosifs

36. Quelles sont les contraintes liées à la réalisation des aménagements anti-érosifs?
- ○ Insuffisance de matériels et équipements
- ○ Insuffisance de main d'oeuvres
- ○ Non maîtrise de la technique d'implantation de l'ouvrage
- ○ Degâts fréquents de l'eau sur les ouvrages
- ○ Autres

VIII- Maladies et Ravageurs

37. Quelles sont les principaux ravageurs et maladies que vous rencontrez dans les vergers?
- ☐ Mouches de fruits ☐ Dessèchement
- ☐ Anthracnose ☐ Bactériose
- ☐ Cochénilles farineuses ☐ Gommose

Vous pouvez cocher plusieurs cases.

IX- Impacts des aménagements dans les zones de productions

38. Quelles sont les impacts des aménagements: