Journal of Basic and Applied Research International

Volume 30, Issue 5, Page 18-28, 2024; Article no.JOBARI.12315
ISSN: 2395-3438 (P), ISSN: 2395-3446 (O)

Management of Agropastoral Waste in Ivory Coast: Case of the Sassandra Agricultural Basin

Kouassi N'guessan Serge [a*] and Coulibaly Yoh [b]

[a] *Institute of Territories Development (IDT), University of Man, BP 20 Man, Ivory Coast.*
[b] *Environmental Sciences and Management, Nangui Abrogoua University, 02 BP 801 Abidjan 02, Ivory Coast.*

Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.56557/jobari/2024/v30i58866

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://prh.ikprress.org/review-history/12315

Original Research Article

Received: 02/07/2024
Accepted: 06/09/2024
Published: 24/09/2024

ABSTRACT

Agropastoral waste constitutes real bio-resources whose valorization could contribute to improving the living conditions of populations, reducing pressure on forest resources, slowing down deforestation and reducing GHG emissions. This study made it possible to examine the management of agropastoral waste in the Sassandra agricultural basin. The survey and field observation carried out made it possible to note that in the agricultural basin of Sassandra we find coffee hulls, bunches, fibers, hulls from oil palm, cassava stems, ears, stems, corn cobs and straw, rice husks and stalks as well as livestock residues such as slurry, manurebones, feathers and animal droppings. Regarding the management method, it appears that straws, husks, ears, stalks and stems are mainly used for livestock feed. Regarding the pods, these are either used for composting. As for the stems, hulls, fibers and bunches, they are also abandoned in the fields.

**Corresponding author: E-mail: serge.kouassi@univ-man.edu.ci;*

Cite as: *Serge, Kouassi N'guessan, and Coulibaly Yoh. 2024. "Management of Agropastoral Waste in Ivory Coast: Case of the Sassandra Agricultural Basin". Journal of Basic and Applied Research International 30 (5):18-28. https://doi.org/10.56557/jobari/2024/v30i58866.*

Thus 85% of planters use agricultural residues to feed livestockwhile 12% of planters compost it. A proportion of 3% use them for other purposes. As for waste from livestock farming, waste from cattle, sheep and poultry farming is either sold or used for spreading. As for pig waste, it is sold. A share of 80% of breeders sell their waste. In addition, a proportion of 15% spread it in the fields. Another 5% of breeders use them for other purposes.

Keywords: Agropastoral waste; sassandra agricultural basin; Cote d'Ivoire.

1. INTRODUCTION

The economy of Côte d'Ivoire is essentially based on agriculture. Indeed, the country occupies a place of choice in Africa and in the world in agricultural production: the world's leading producer of cocoa and cashew nuts, the leading African producer of rubber trees, mangoes, etc. [1]. Significant agricultural production is estimated at 2,000,000 tonnes/year of cocoa, 83,003 tonnes /year of coffee, 490,359 tonnes/year of cotton, 1,000,000 tonnes/year of rubber, 514,941 tonnes/year of oil palm and 902,000 tonnes/year of cashew nuts [2]. As for the livestock sector, there is an annual production of 1,573,000/year head of cattle, 1,420,000 head of /year sheep, 1,116,000 head/year of goat, 34,792,256 head/year of pig and 39,000,000 head/year of poultry [3]. All these crops and livestock produce significant quantities of residues. The Sassandra agricultural basin, in the southwest of Côte d'Ivoire, is an agro-ecological zone favorable to all types of cultivation [4]. It has also become the new cocoa loop in Ivory Coast. It should be noted that the fermentation residues of organic waste could be used as an agricultural amendment [5]. Also, some of the waste could be used to produce compost [6]. Furthermore, flammable waste could undergo thermal treatments, to produce energy or by-products of interest to populations in agricultural regions, improve their conditions, slow down deforestation and reduce Gas has greenhouse effect emissions [7]. It is in this context that this study aims to examine the management of agropastoral waste in the Sassandra agricultural basin. Specifically, this involves (i) determining the typology of agropastoral waste, (ii) determining the quantities of agropastoral waste produced and (iii) examining the method of management of this waste.

2. MATERIALS AND METHODS

2.1 Study Area

The Sassandra agricultural basin (BAS), with an area of approximately 42,000 km2, is located in the west of Côte d'Ivoire. and includes four (4) departments, namely Daloa, Soubré, Issia and Sassandra. The climate of the BAS is subequatorial and humid tropical, which combines two rainy seasons which are between April-June and September-November and two dry seasons in July-August and December-March [8]. Annual rainfall varying from 1,000 to 1,700 mm [8]. In addition, the soils of the Sassandra agricultural basin developed on ancient eruptive rocks are mainly ferralitic and strongly weathered. They are often very stony in profile, chemically poor, with a texture varying between clayey silt and silty sand. These soils are deep, permeable and well drained. Furthermore, they are very fertile and well suited to all types of food and industrial crops [9].

2.2 Methods

2.2.1 Data gathering

Data collection took place from July 1 to 31 of 2021. It consisted of two joint activities, namely, field observations and a survey of planters. Field observations provided an overall overview of crop and livestock waste produced on plantations and farms in the departments of the Sassandra agricultural basin. As for the survey, it consisted of filling in the sheets developed for this purpose, by interview and questioning with planters and farmers. It made it possible to collect the different types of crops grown, the quantities produced, the waste generated by type of crop as well as their treatment methods. Concerning breeding, the different types of breeding practiced, the number of heads, the different types of waste generated by type of breeding were noted. The numbers surveyed were determined using the simple random sampling method [11]. This made it possible to select 680 planters and 680 breeders, including 170 of each in each of the four departments.

2.2.2 Data processing

The data collected from the questionnaire was first coded. Then, the information collected was grouped by domain and variables. The frequency of each variable was calculated in relation to the number of planters surveyed using the statistical software R, according to the following relationship:

$$F = \frac{nj}{n} \times 100$$

With:

F : Frequency (%) ;
nj : Number of modality (variable) ;
n : Effectif total de la variable.

2.2.3 Estimation of agropastoral waste

The quantities of residues (QR) from the crops were determined from the relation (1) described according to FAO [12].

$$QR = m \text{ x } Cres \qquad (1)$$

Where:

m: Mass of the production for the considered crop (kg),
Cres: Coefficient relating to the quantity of residues generated according to agricultural production.

The values of Cres and Ip used are consign in Table 1.

The annual quantities of animal manure (ADQ) were calculated using the relation (2)

$$QDA\ (kg) = POPan \text{ x } QMO \text{ x } n \qquad (2)$$

With:

POPan: Animal population of the type of breeding considered ;
QMO : Daily quantity of organic matter (kg/head);
n: Number of days in the year.

The QMO values used to perform the calculations are recorded in Table 2.

3. RESULTS

3.1 Typology of Agropastoral Waste

Agropastoral waste consists of agricultural waste and livestock waste. Agricultural waste produced is composed of cocoa pods, coffee husks, bunches, fibers, husks from oil palm, cassava stalks, cobs, stalks, corn cobs and rice straws, husks and stalks. As for livestock waste, it consists of slurry, manure, bones, feathers and animal droppings. Fig. 2 illustrates some animal waste encountered in the departments investigated.

3.2 Mass of Speculation and Agropastoral Residues

3.2.1 Number of heads of animals from breeding

Fig. 3 shows the number of head of animal according to the type of livestock farming in the Sassandra agricultural basin. The largest number of heads are provided by poultry breeding (44,177 heads) followed respectively by sheep breeding (10,354 heads), goats (8,434 heads), cattle (3,383 heads) and pigs (3,037 heads).

3.2.2 Annual mass of livestock waste available

Table 3 presents the masses of waste produced by type of livestock farming in the Sassandra agricultural basin. The masses of waste vary depending on the type of farming practiced. The largest masses (2,469.5 t/year) are provided by cattle breeding, while the lowest masses are obtained by pig breeding (354.7 t/year). Sheep, goat and poultry farming produces 2,267.5 t/year respectively; 1,847 t/year and 712.1 t/year of waste. In total, the Sassandra agricultural basin has 7,651 t/year of waste from livestock farming.

3.2.3 Production by type of speculation

Fig. 3 shows the annual production of cocoa, coffee, palm oil, corn, rice and cassava. Regarding cash crops, cocoa is the strongest (465,266 t/year), followed by coffee (81,175 t/year) and palm oil (78,917 t/year). Regarding food crops, the highest annual production comes from the cultivation of corn (217708 t/year). The lowest comes from the cultivation of cassava (5384 t/year).

3.2.4 Annual mass of agricultural waste

The masses of waste vary depending on the type of residue considered. Pods and stems are the most important residues with respectively 465,266 t/year and 175,000 t/year, while husks (12,000 t/year) and bunches (10,987 t/year) are the lowest (Table 4).

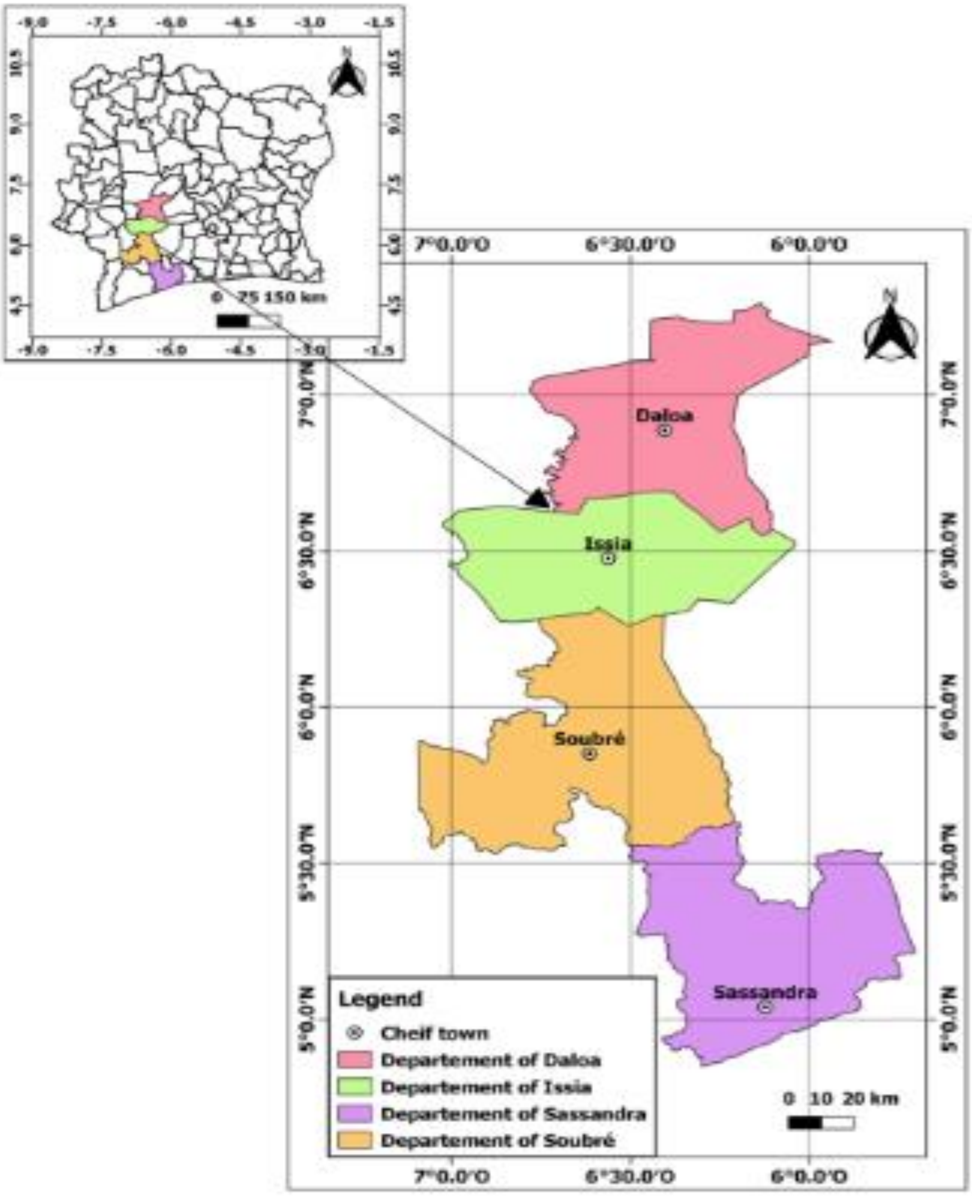

Fig. 1. Geographical location and administrative division of Sassandra agricultural basin [10]

Table 1. Cres values FAO [12],

Crops	Wastes	Cres
	Straw	1.757
Rice	*Husk*	0.267
	Stalk	0.20
Maize	*Cob*	0.273
	Stem	2.00
	Cluster	0.23
Palm oil	*Fiber*	0.14
	Shell	0.065
Cocoa	*Pods*	1.00
Coffee	*Shell*	2.10
Cassava	*Stem*	0.62

Table 2. Mean QMO values used to calculate manure amounts [12,13]

Type of animals	Cattle (250-400 kg)	Sheep (45 kg)	Goat (45 kg)	Pigs (30-80 kg)	Poultry (0,5 kg)
QMO (kg/head)	2	0,6	0,6	0,32	0,04

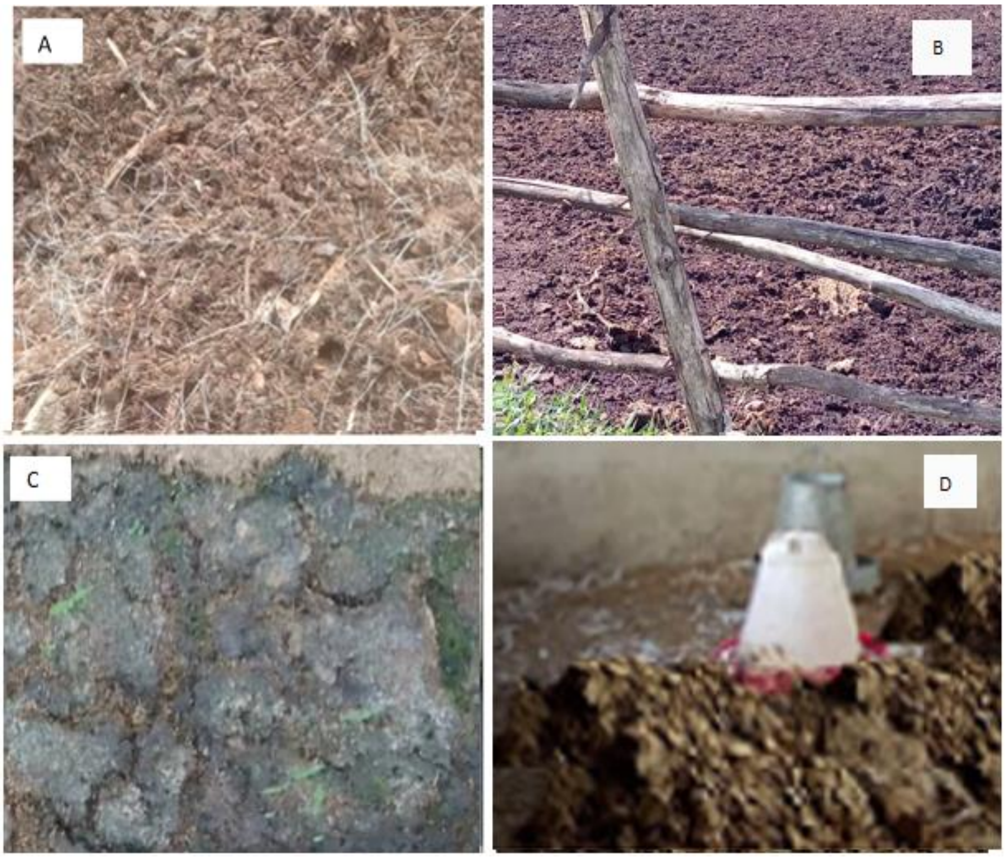

Fig. 2. Livestock waste illustration. A: sheep manure, B: cattle manure, C: pig manure, D: poultry manure

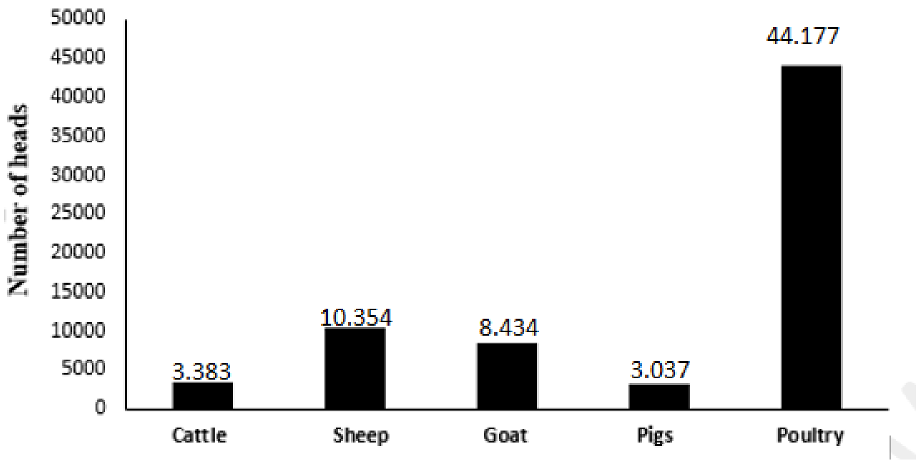

Fig. 3. Number of heads of animals from breeding

Table 3. Mass of animal waste (slurry, manure, and animal droppings)

livestock	Cattle	Sheep	Goat	Pigs	Poultry
Waste ton/year	2 469,5	2 267,5	1 847	354,7	712,1

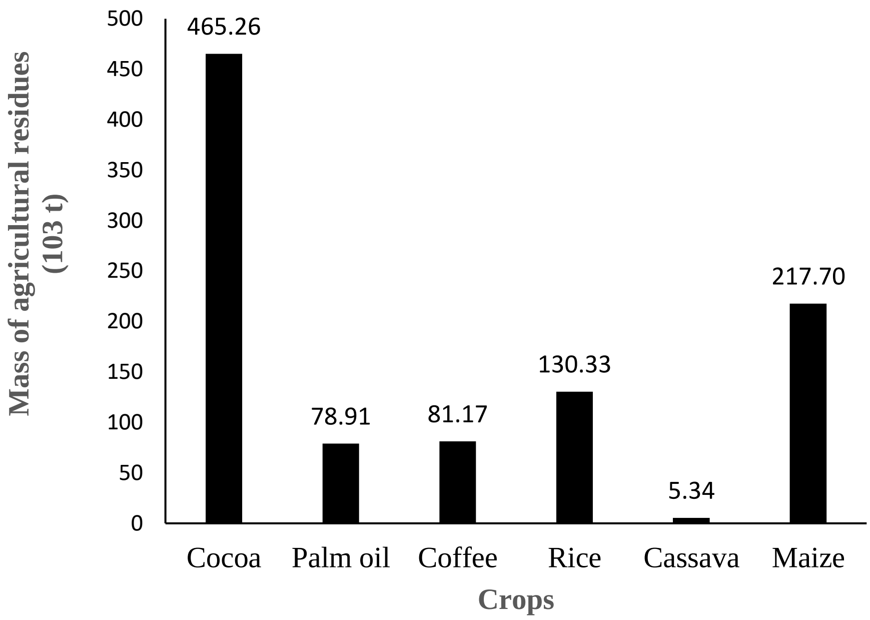

Fig. 4. Mass of product per speculation

3.3 Method of Managing Agropastoral Waste

3.3.1 Method of managing agricultural waste

The method of agricultural waste management by type of residue is presented in Table 5. Indeed, in the Sassandra agricultural basin, straws, husks, stalks, hulls, clusters are used to feed livestock (Fig. 5). Regarding the pods, fibers and bunches, these are either used for composting.

Fig. 6 shows the proportions of planters as per the implemented crop waste management methods. It appears that 85% of planters use agricultural residues to feed livestock while 12% of planters compost it. A proportion of 3% use them for other purposes such as the production of potash and briquettes.

Fig. 5. Method of managing crop residues (A = Dried cassava residues for livestock feed; B = rice husk packaged in bags for poultry feed

Table 4. Mass of agricultural residues

Departments	Pods	Cluster	Fiber	Schel	Husk	Straw	Stem	Cobs	Stalk
Daloa	16118,65	794,65	483,7	1130,0719	5073	33383	145058,29	19671,015	14411
Issia	132244	1282,48	780,64	41900,44	1565,5545	10302,1695	13829,332	1822,06479	1334,846
Sassandra	44638	8910,2	66666	37014,8	3019,99428	19873,1459	14695,614	1964,508	1439,2
Soubré	272265,658	0	0	4234,8936	1869	12299	0	0	0
Total	**465266,308**	**10987,33**	**67930,34**	**84280,2055**	**11527,5488**	**75857,3154**	**173583,236**	**23457,5878**	**17185,046**

Table 5. Method of managing crop residues by type of residue

Type of residue	Management methods	
	Livestock feed	Composting
Cobs	Yes	No
Pods	No	Yes
Stalk	Yes	No
Schel	Yes	No
Husk	Yes	No
Epis	No	No
Fiber	No	Yes
Stem	Yes	No
Cluster	Yes	Yes

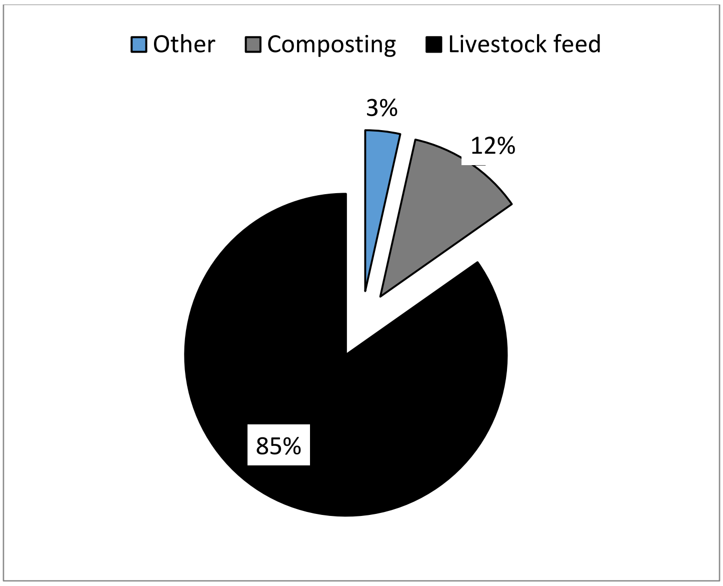

Fig. 6. Proportion of planters according to the method of management of agricultural residues in the Sassandra agricultural basin

Table 6. Mode of management of livestock waste depending on the type of livestock

Type of breeding	Management methods	
	Epandage	Vente
Caprin	No	No
Volaille	Yes	Yes
Porcin	No	Yes
Ovin	Yes	Yes
Bovin	Yes	Yes

3.3.2 Method of managing livestock waste

Table 6 presents the method of management of livestock waste generated in the BAS departments depending on the type of animal species raised on the farms. In fact, some waste from cattle and poultry farming is sold and others are used for spreading. As for pig waste, it is either sold or abandoned on farms. Regarding waste from sheep farming, it is used for agricultural spreading. While goat waste is left on farms.

Fig. 7 shows the proportions of breeders according to the different waste management practices implemented. It appears that 80% of breeders sell their waste. In addition, a proportion of 15% spread it in the fields. Another 5% of breeders abandon them on farms.

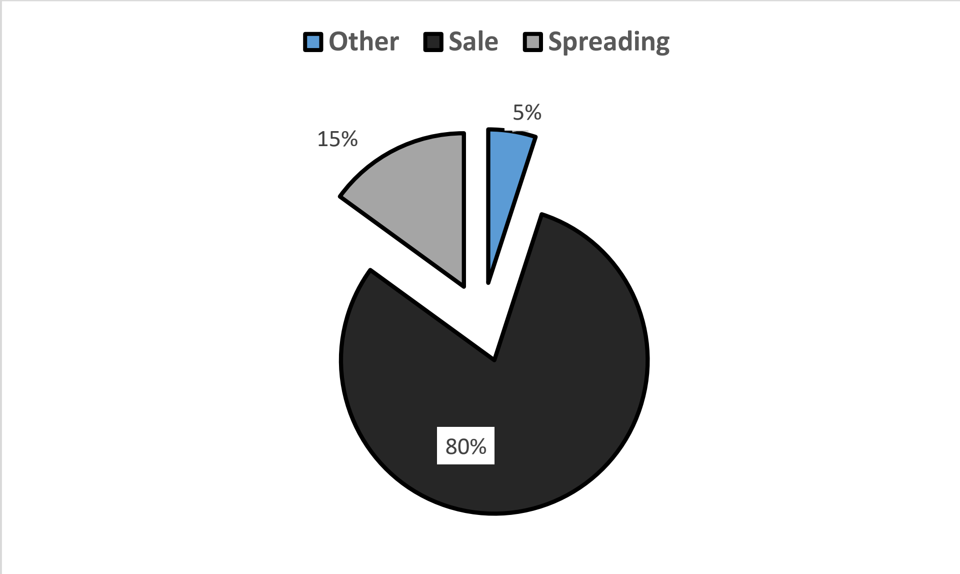

Fig. 7. Proportion of breeders according to the method of management of livestock waste

4. DISCUSSION

The characterization of agropastoral waste made it possible to highlight their typology in the Sassandra agricultural basin. This waste consists of bunches, fibers, hulls, pods, straws, husks, cobs, stalks and stems. These residues come from cash crops such as cocoa (pod, fiber), coffee (hull) and oil palm (clusters, fiber), from food crops, namely rice (straw, husk), corn (cobs, stalks and stems) and cassava (stems). Livestock waste consists of slurry, manure and animal droppings and comes from animals such as cattle, sheep, goats, pigs and poultry. This typology of waste identified in the study area is similar to the result of the work of Coulibaly et al. [14] in the Sassandra River watershed. This could be explained by the fact that this agro-ecological zone is favorable to the production of cash crops, such as food crops and also certain livestock. Indeed, the climate and soils are fertile and support these speculations. The results showed that residues from cocoa cultivation dominated the waste masses in the BAS. This result can be explained by the fact that the BAS contains numerous cocoa plantations. Moreover, the BAS is in the new production loop of the coffee and cocoa pair [15]. Regarding livestock residues, the results showed a variation in residues depending on the type of livestock; the low production of pig waste would be due to the fact that the BAS does not contain a significant herd. Regarding the method of managing crop residues, the results showed that 85% of farmers use agricultural residues for livestock feed. This result is similar to the results of Messou Aman [6] who also showed that residues from rice cultivation are used for livestock feed. Also [16] showed that in Benin. 8% of planters use their residues for livestock feed. Indeed, according to Fagnon [17], rice bran is rich in fat (15 to 20%) which can be used for nutritional purposes [16]. As for husk ash, it is composed almost entirely of silica (94.1%) which is useful for fertilizing the soil [18]. 12% of planters compost it to fertilize the soil for new crops. This result corroborates those of the Daniel Bienvenu effect. Indeed Daniel Bienvenu et al. [18] also showed that in Kinshasa 82% of producers completely recycle their residues by using them during fertilization for new crops. Kouassi-Kouadio et al. [10] also showed that the use of rice straw and others would constitute a contribution of “natural” organic matter such as composts or manure, to cultivated soils. This waste also has a stabilizing effect on the structure of the soil [19]. These results can also be explained by the fact that rural populations only know these training methods. However, some producers know adequate valorization methods but do not have financial resources. In terms of animal waste, the results showed that 80% of breeders sell their waste. This practice is carried out because animal waste constitutes an alternative fertilizer for crops. In fact, controllable animal waste would constitute a resource of raw material rich in nitrogen and other nutrients. They are therefore purchased by operators wishing to use them in the fertilization of crops and the production of renewable energy. Indeed, [20] showed that poultry droppings combined with mineral fertilizer release important nutrients essential for the growth of corn and ensure a high water retention capacity. Jan [20] demonstrated that the combined use of poultry manure and mineral manure would increase the yield of the corn plant compared to the application of organic or mineral manure alone.

5. CONCLUSION

This study made it possible to examine the management of agropastoral waste in the Sassandra agricultural basin. The Sassandra agricultural basin produces enormous quantities of crop (914,777 t/year) and livestock (7,649 t/year) residues. Effective management of agropastoral waste is essential to minimize environmental impact, improve soil health and promote sustainable agriculture. Agropastoral waste is either sold, used for agricultural spreading, or for livestock feed. In proportion, 85% of planters use agricultural residues to feed livestock while 12% of planters compost them. As for breeders, 80% of them resell their waste. In addition, a proportion of 15% spread it in the fields. Practices such as composting, the recovery of organic residues and the establishment of recycling channels contribute to reducing pollution and optimizing the use of resources. It is imperative that farmers, ranchers and policymakers collaborate to implement innovative and sustainable strategies to effectively manage these wastes.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Global Business Network Partnership Ready Ivory Coast: Management and recycling of organic waste. 2020;8.
Available:https://www.giz.de/en/downloads/Global Business Network_Sector%20Brief_CIV
2. Interprofessional Fund for Agricultural Research and Consulting Annual Report 2020. Ministry of State Ministry of Agriculture and Rural Development, Abidjan, Côte d'Ivoire. 2020 ;45.
3. Ministry of Animal and Fisheries Resources. Strategic Plan for the Development of Livestock, Fisheries and Aquaculture in Côte d'Ivoire (PSDEPA 2014-2020). Volume I: Diagnostic-Development Strategy-Orientations. Abidjan, Côte d'Ivoire. 2020;102.
4. Adou DL. Plantation economy and settlement dynamics in the Haut-Sassandra region, Single PhD thesis in geography, Félix Houphouët-Boigny University, Abidjan, Côte d'Ivoire. 2012; 286.
5. Food and Agriculture Organization of the United Nations. Organic soil management and composting. Activity report, Abidjan, Côte d'Ivoire. 2017;62.
6. Messou Aman, Bakayoko Mariama Epouse Sekongo, Ouattara Pétémanagnan Jean-Marie, and Coulibaly Lacina Management of rice hulling residues in Côte d'Ivoire: Case of the Lôh-Djiboua region, International Journal of Innovation and Applied Studies; Rabat. 2022;37(3): 693-701.
7. Pellerin S, Bamière L, Angers D, Béline F, Benoît M, Butault JP, Chenu C, Colnenne-David C, De Cara S, Delame N, Doreau M, Dupraz P, Faverdin P, Garcia-Launay F, Hassouna M, Hénault C, Jeuffroy MH, Klumpp K, Metay A, Moran D, Recous S, Samson E, Savini I, Pardon L. What technical levers for the mitigation of greenhouse gas emissions from agriculture? Agronomic Innovations. 2014;37:1-10.
8. Anouman DL. Trends and ruptures observed in the low-water regimes of the Sassandra River in Côte d'Ivoire. Master in Geosciences and Environment, NANGUI ABROGOUA University, Abidjan, Ivory Coast. 2014;62.
9. Tagini B. Structural sketch of Ivory Coast, regional geotectonics essay. SODEMI, Abidjan, Ivory Coast. 1971;302.
10. Kouassi-Kouadio AAM, Ouattara PJM, Coulibaly TJH, Zahui FM, Coulibaly L. Typology of Crop Residues and Energy Recovery in Heavily Agricultural Areas: Case of the Departments of Soubré, Daloa, Issia and Sassandra (Ivory Coast).

Journal of Agricultural Chemistry and Environment. 2022;11:196-208.
11. Statistics Canada, Probabilistic sampling ; 2013. Available :http://Les%20statistiques%20_%20le%20pouvoir%20des%20donn%C3%A9es!%20%C3%89chantillonnage%20probabiliste.html, (August 19, 2021).
12. FAO. Proceedings of the regional expert consultation on modern application of biomass energy. FAO Regional Wood Energy Development program in Asia, Report 36, Bangkok. 1998;22.
13. FAO. Crop and livestock residues. Rapid Assessment - Bioenergy and Food Security (Befs Ra). User manual. 2014b;35.
14. Coulibaly L, Ouattara JMP, Tiho S. Biogas potential of agro-pastoral residues and human excrement from the Sassandra River watershed (Côte d'Ivoire). International Journal of Biological and Chemical Sciences. 2012b;6(6):6003-6016.
15. Conseil Café Cacao. Quantity-quality-growth program "2QC" 2014-2023. Reference and orientation document for the coffee-cocoa sector, Ministry of Agriculture, Côte d'Ivoire. 2020;17.
16. Fagnon BA. Valorization of rice husks: study and design of a rice husk densification press. Bachelor's thesis, University of Abomey-Calavi (Benin). 2014;125.
17. Fagnon BA. Valorization of rice husks: study and design of a rice husk densification press. Bachelor's thesis, University of Abomey-Calavi (Benin). 2014;125.
18. Gomgnimbou APK, Abdramane S, Bandaogo AA, Coulibaly K, Ouattara S. and NACRO H. B. Short-term effects of poultry manure application on maize (*Zea mays* L.) yield and chemical characteristics of a ferralitic soil in the South Sudanese zone of Burkina Faso. International Journal of Biological and Chemical Sciences. 2019;13(4):2041-2052.
DOI:10.4314/ijbcs.v13i4.11
19. Žydelis R, Sigitas L, Jonas V, Virmantas P. Effect of Organic and Mineral Fertilizers on Maize Nitrogen Nutrition Indicators and Grain Yield. Zemdirbyste Agriculture. 2019; 106(1):15-20.
DOI:10.13080/z-a.2019.106.002
20. Jan MF. Impact of Integrated Potassium Management on Plant Growth, Dry Matter Partitioning and Yield of Different Maize (*Zea mays* L.) Hybrids. Pure Appl. Bio. 2018;7(4).
DOI:10.19045/bspab.2018.700148

Peer-review history:
The peer review history for this paper can be accessed here:
https://prh.ikprress.org/review-history/12315