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Floristic Response of Herbaceous Flora to Intensive Cropping Systems: A Case of Ajibode-sasa Arable Agroecosystem, Ibadan, Southwest Nigeria

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Authors' contributions

This work was carried out in collaboration between both authors. Author OOS conceptualized the study. Authors OOS and OFM designed the study, performed the statistical analysis, managed literature searches, and wrote the first draft of the manuscript. Author OOS managed the revisions of manuscript. Both authors read and approved the final manuscript.

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ABSTRACT

Agriculture a most significant land use types which alter natural ecosystem dynamics. Arable farming exerts much pressure on plant biodiversity, especially when practiced intensively in urban centers. There is dearth of information on floristic changes due to intensive arable farming in urban agroecosystems in developing countries. The study therefore assessed floristic changes resulting from and intensive farming practices at Ajibode-Sasa agricultural landscape. Ajibode-Sasa agroecosystem is a complex mix of arable cropping system between latitude N07°28′, E003°53′ and longitude N07°28′, E003°54. Comparative floristic surveys were conducted in 2016 and 2020 using quadrats (1 m^2) systematically laid on 18 Transects ranging from 50 – 250 m long. A total of 224 and 184 quadrats were laid in 2016 and 2020 respectively. Reduction in numbers of quadrats laid resulted from physical anthropogenic development after the 2016 survey. Species identification followed standard procedures, and quantitative occurrence data were collected for determination of species composition and computation of relative importance values (RIV) and diversity indices.

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Land-use changes over four years period was determined using Google earth and QGIS. Herbacous plant composition with 123 cumulative number of species in both years reduced from 98 species in 2016 to 85 species in 2020 species RIV of species ranged from 0.038 – 14.803. *Tridax procumbens* had the highest RIV (14.803) in 2016, while it was *Acmella brachyglossa* (13.248) 2020. Species richness and floral diversity was high with Shannon-Weiner Index (3.081 and 3.088) and Dominance (0.09388 and 0.08746) in 2016 and 2020 respectively. Intensive cultivation favoured introduction and spread of invasive species like *Tridax procumbens* and *Tithonia diversifolia.* Eight introduced and invasive species were newly enumerated in 2020, with a total of 38 herbaceous species no longer encountered in 2020. Concerted efforts should be made to conserve native flora on the agroecosystem through sustainable practices like crop rotation and short fallow.

Keywords: Ecosystem dynamics; arable farming; landscape fragmentation; invasive species; sustainable agriculture.

1. INTRODUCTION

Man has dramatically transformed much of the earth's natural ecosystems through various activities [1] and agriculture remains one of the major contributing factors [2]. Of the 13.2 billion hectares global land area, 1.6 billion hectares that represent 12 per cent is currently in use for agricultural production [3] and this interferes with ecosystem services provided by natural resources [4]. Alteration of natural ecosystems has been ongoing for millennia – but it has accelerated sharply over the last centuries, and in the last several decades [5]. Expansion of agricultural land which for some time was justified as a need to ensure food security has led to habitat fragmentation [6] which is one of the four major threats to world biodiversity [7] and their life-sustaining services [8]. Agricultural intensification in both rural and urban centers as an adaptation to increasing human population has however, continues to disrupt ecosystem integrity of natural environment [9] leading to great negative consequences [10].

Urbanization encourages fragmentation of habitats of plants into patches that contain subsets of species inhabiting different habitat subsets [11]. Species occupancy is related to the specificity of the habitat, if habitat is defined according to Hall et al. [12] and Lindenmayer and Fischer [13], where 'habitat' constitutes the resources and conditions present in an area that produce occupancy for a particular species. The habitat fragments are usually anthropogenic, where it can constitute threats to biodiversity [11]. The anthropogenic nature of the patchiness may be in the form of a number of built structure or like in the case of this study, more agriculture-related in the form of patches of different cropping systems intensively operated The fragmentation thus affects terrestrial biodiversity in way that affect species richness patterns, because species richness is related to landscape structure [14].

However, as more than 50 percent of world population now reside in cities [15], which justifies the need for urban agriculture intensification to ensure food security [16,17], concerns have developed long term sustainability and environmental consequences of the intensification of agricultural systems [18]. Agricultural intensification can have negative local consequences, such as increased erosion, lower soil fertility, and reduced biodiversity; negative regional consequences [19], such as pollution of the ground water and eutrophication of rivers and lakes; and negative global consequences, including impacts on atmospheric constituents and climate [20].

The roles of agriculture in spreading invasive species have also been well documented [21]. This [4] anthropogenic effect [1] together with climatic and geological factors determines biological composition and services rendered by ecological system within space and time [22]. However, there is dearth of information on quantitive floristic changes occasioned by intensive arable agriculture in many urban regions of developing countries in Africa.

Therefore, there is need to critically appraise effects of intensive cropping of urban lands on health and community structure of herbacous flora. Hence this study was carried out to assess response of floral composition and flora invasion of Ajibode-Sasa arable landscape to intensive cropping practices in the area over a period of four years.

2. MATERIALS AND METHODS

2.1 The Study Site

The Ajibode-Sasa arable landscape is located in the University of Ibadan, Nigeria on N07°28′, E003^{0}53′ and N07°28′, E003°54′ with elevation ranging from 189-193 m above the sea level. It covers an area of 0.1685 km² (16.85 ha) of farmlands with diverse cropping systems, and bounded by two streams to the south and to the west with a rich river valley soil (Fig. 1, 2). It is bordered by the forest of the International Institute for Tropical Agriculture and Ajibode-Sasa road to the north and east respectively. The area receive a mean annual rainfall of 1280 mm and mean annual minimum and maximum temperature of 21°C and 30°C respectively. The site was selected because of its location as a complex of crop farms in Ibadan metropolis. It is important to the livelihood of especially Yoruba and Hausa populations in Ajibode, Sasa, Orogun and University of Ibadan communities, being in close proximities to them. The farm complex is coordinated by a Farmers' Association. The farm complex is comprised of various combinations of arable crops that are farmed on a small-holder basis. The farms were so close that many were separated by footpaths, increasing possibility of weed infestation, introduction and spread of invasive plants.

Google Earth ©2016 was used to complement the layout with an aerial view of Ajibode-Sasa arable landscape and its imageries were also used to determine historical changes in the landscape with respect to vegetation dynamics and other landscape features. The Garmin™ etrex 12H model Geographical Positioning System was used for geo-referencing and SILVA plastic compass was used for obtaining a straight baseline and accurate perpendicular location of transects to the baseline for floristic.

2.2 Sampling Procedure

A systematic sampling design was employed for assessment of the flora composition on the landscape. A baseline transect of 900 meters was laid along Ajibode-Sasa road. Along the baseline transect, eighteen transects perpendicular to the baseline transect at an interval of 50 meters apart were laid into the Ajibode-Sasa agroecosystem. The river formed the terminal end of each transect at the other end. We observed a clearance or 5 m to the beginning and end of each transect in order to give due consideration to edge effect from the main road and the river. The transect lengths ranged from 50-260 m with which a total of 225 quadrats were laid in 2016 and 184 in 2020 respectively. A 1 x 1 m^2 square quadrat was laid at an interval of 10 m along each transect for enumeration of herbaceous plants that are rooted in the quadrat. Quantitative values of number of individuals in each quadrat was recorded in a species x attribute data matrix

The vegetation components of the quadrats were identified using A Handbook of West African Weeds [23] and Weeds of Rice in West Africa [24]. Species that could not be identified immediately were preserved and later taken to the Department of Botany Herbarium, University of Ibadan for identification.

2.3 Data Analyses

Analysis of Relative Important Value (RIV) of species followed Kent, (2011) [25] and (Olubode et al., (2011) [26];

where:

Relative Importance Value (RIV) = Relative Frequency / Relative Density × 100

The RIV was obtained by computing:

Frequency = the number of occurrence of a species in a set of quadrat or area.

Relative Frequency = (Frequency of a species / Total Frequency of all species) × 100

Density = (Total number of a species / (Quadrat area × number of quadrats laid))

Relative Density = (Density of a particular species) / (Total density)) × 100

Where,

Diversity Indices

Shannon-Wiener index (H') = $-\sum(\rho í).(\ln \rho í)$
Evenness index (J) = H'/lnS
Simpson index = 1-D
Dominance = 1-Simpson index
D = $\sum(n_i/N)^2$

Fig. 1. Aerial View of Ajibode-Sasa agroecosystem in the University of Ibadan, Nigeria

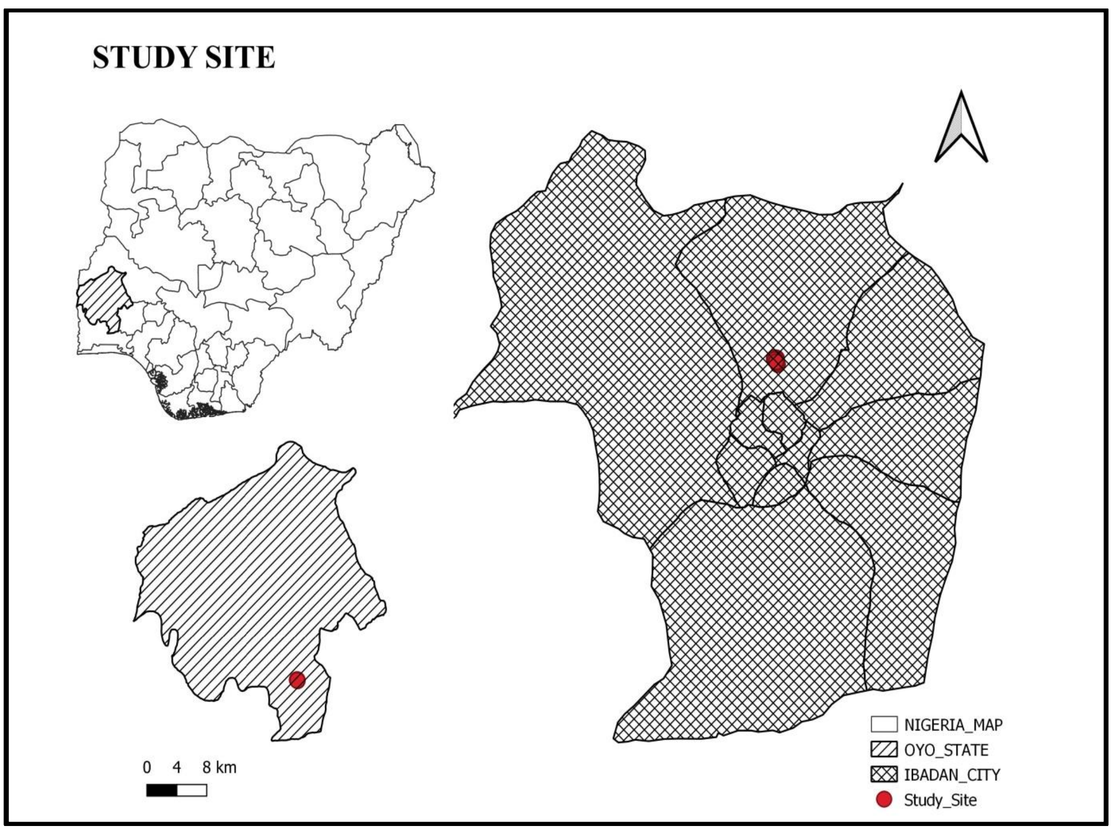


Fig. 2. Map generated from QGIS describing the location of the Study Site in Ibadan, Southwest Nigeria

Where,

ρí = the proportion of individuals or the abundance of the ith species expressed as a proportion of total abundance of all species (ρí = n/N)
n_1 = number of individuals in the ith species,
N = total number of individuals in the sample
In = log base
S = number of species

Paleontological Statistics (PAST) [27] was used to conduct a multivariate exploration of the quantitative floristic attributes of the agroecosystem in the two years. Diversity indices – Dominance, species richness/Simpson index, Shannon-Weiner index, Evenness index and Equitability index were computed to determine the nature of the community structure, while cluster analysis was used to nexplore the dissimilarity that existed among the plant species in the agroecosystem. Euclidean Distance [28] was employed as the index of dissimilarity on the paired group algorithm.

Together with phytosociological classification to produce dendrograms of floral relationship completed with. The Two-Way Indicator Species Analysis [28] was used to determine the percentage cover of each relevee/stand from species composition in each quadrat and on the landscape based on scale of 0-100. It was also used to explain the dendrograms obtained from the classification.

3. RESULTS

Herbaceous plant species composition reduced from 98 species in 25 families in 2016 to 85 species in 25 families in 2020 (Table 1). Introduction and invasion of new species is implicated in the loss of species (Table 1). Eight introduced invasive species were enumerated in 2020 that were not encountered in 2016. A total of 38 species were no longer encountered in 2020, but which were encounterd in 2016. Four of the first five species with the highest RIV in two years under comparison were known invasive species (Table 1). These were: *Tridax procumbens (*RIV: 14.803), *Euphorbia heterophylla* (RIV: 11.415), *Tithonia diversifolia* (RIV, 9.824), *Desmodium scopiorus* (RIV:3.712) and (*Acmella brachyglossa* (RIV: 3.647) in 2016; while in the 2020 survey, their RIVs indicated that *Acmella brachyglossa* (RIV:13.248) was becoming more invasive than the others - *Euphorbia heterophylla* (RIV: 9.322), *Tridax procumbens (*RIV*:* 9.025), *Tithonia diversifolia* (RIV: 8.357) and *Desmodium scopiorus* (RIV: 6.333) respectively (Table 1). Poaceae was the most represented family (25 species) in the study area in years compared, however, with loss of 7 species by 2020 (Table 2). Fabaceae family increased from nine to 11 species in the same period. Four new families introduced into the agroecosystem from which species were enumerated in 2020 were Colchicaceae, Pedaliaceae, Smilacaceae and Sphenocleaceae.

The numbers of individuals recorded reduced from 8919 in 2016 but to 8165 in 2020 (Table 3). The dominance indices of the community in the two years were low in 2016 (0.09388) and 0.08746 in 2020. The species richness of the landscape as modeled by Simpson's index was higher (0.9126)) in 2020 than in 2016 (0.9061), probably as a result of proliferation of a few invasive species in the agrecosystem, despite the clearing a portion of the land for erection of a communication mast and a building (Fig. 3). The study area exhibited high alpha diversity of species in the two years (3.081 in 2016; 3.088 in 2020). The disparate nature of the agroecosystem due to the varied cropping system was revealed in the low Evenness index indicating non-even distribution of species. The Evenness indices were low for the two years. In 2016, the Evenness index was 0.2222 but slightly increased to 0.2579 in 2020 (Table 3).

The phytosociology of the agroecosystem were being modified by the presence and proliferation of iinvasive species (Fig. 3). In 2016, *Tridax procumbens* was formed a distinct cluster of flora whose attributes were mainly unrelated to other species. It was a dominant species on the landscape. *Thithonia diversifolia* and *Acmella brachyglossa* behaved in a similar way but to lesser extents. Others, such as *Euphorbia heterophylla* formed large clusters around which other plants clustered. In 2020 bowever, the clusters were more pronounced, with *Acmella brachyglossa* replacing *Tridax procumbens* as the most prominent species in the agroecosystem. *Thithonia diversifolia, Tridax procumbens* and *Euphorbia heterophylla* formed discrete groups that separate clusters that are dissimilar in association to them. The results were corroborated by the fragmented landscape as indicated by the Google Earth imageries (Fig. 4). However, there were more anthropogenic incursions by 2020 as indicated by presence of a large building and a telecommunication mast constructed after the 2016 survey.

Table 1. Relative Importance Value (RIV) of Flora Species in Ajibode-Sasa Farmland in 2016 and 2020

				RIV	
S/N	**Species**	**Status***	**Family**	**2016**	**2020**
1	*Tridax procumbens*	I[29]	Asteraceae	14.803	9.025
2	*Euphorbia heterophylla*	I[30]	Euphorbiaceae	11.415	9.322
3	*Tithonia diversifolia*	I[30]	Asteraceae	9.824	8.357
4	*Desmodium scopiorus*	ND	Fabaceae	3.712	6.333
5	*Acmella brachyglossa*	ID*	Asteraceae	3.647	13.248
6	*Ageratum conyzoides*	I*	Asteraceae	3.301	3.244
7	*Talinum fruticosum*	INT*	Portulacaceae	3.279	1.965
8	*Cyperus esculentus*	N[31]	Cyperaceae	2.628	0.285
9	*Commelina diffusa*	N*	Commelinaceae	2.646	2.889
10	*Synedrella nodiflora*	N[32]	Asteraceae	2.513	2.147
11	*Euphorbia hirta*	INT*	Euphorbiaceae	2.438	1.172
12	*Callopogonium mucunoides*	ND	Fabaceae	2.283	2.701
13	*Paspalum scrobiculatum*	N[33]	Poaceae	2.24	2.467
14	*Mariscus alternifolius*	N*	Cyperaceae	1.892	3.428
15	*Spigelia anthelmia*	INT*	Loganiaceae	1.804	0.514
16	*Centrosema pubescens*	INT*	Fabaceae	1.692	1.494
17	*Spermacoce ocymoides*	INT*	Rubiaceae	1.635	1.057
18	*Corchorus olitorius*	N*	Malvaceae	1.637	0.186
19	*Digitaria horizontalis*	N*	Poaceae	1.622	1.281
20	*Oplismenus burmanni*	N*	Poaceae	1.554	1.583
21	*Larportea aestuans*	N*	Urticaceae	1.546	1.69
22	*Leptochloa caerulescens*	ND	Poaceae	1.449	0.415
23	*Brachiaria deflexa*	N*	Poaceae	1.234	-
24	*Pouzolzia guineensis*	N*	Urticaceae	1.147	1.28
25	*Mimosa pudica*	I[30]	Fabaceae	1.074	2.166
26	*Ipomoea cairica*	N*	Convulvulaceae	1.01	-
27	*Acalypha segetalis*	N*	Euphorbiaceae	0.927	0.589
28	*Phyllantus amarus*	ND	Phyllantaceae	0.888	1.632
29	*Brachiaria lata*	N*	Poaceae	0.816	0.087
30	*Stachytarpheta cayennensis*	ND	Amaranthaceae	0.78	1.24
31	*Chromolaena odorata*	I[30,34]	Asteraceae	0.741	0.292
32	*Commelina benghalensis*	I*	Commelinaceae	0.732	0.112
33	*Euphorbia hyssopifolia*	INT*	Euphorbiaceae	0.704	0.948
34	*Ipomoea triloba*	INT*	Convulvulaceae	0.634	1.028
35	*Ruellia tuberosa*	INT*	Acanthaceae	0.559	-
36	*Diodia sarmentosa*	N*	Rubiaceae	0.551	0.821
37	*Merremia aegyptia*	N*	*Convulvulaceae*	0.47	1.061
38	*Kyllinga erecta*	N*	Cyperaceae	0.424	0.074
39	*Alternanthera brasiliana*	INT*	Amaranthaceae	0.419	0.093
40	*Sida acuta*	N*	Malvaceae	0.328	0.31
41	*Indigofera hirsuta*	N*`	Fabaceae	0.285	0.05
42	*Paspalum conjugatum*	INT*	Poaceae	0.278	-
43	*Boerhavia erecta*	INT*	Nyctaginaceae	0.272	-
44	*Pupalia lappacea*	ND*	Amaranthaceae	0.267	1.855
45	*Leptochloa filiformis*	INT*	Poaceae	0.262	0.044
46	*Andropogon gayanus*	N*	Poaceae	0.261	-
47	*Solenostemon monostachyus*	N*	Lamiaceae	0.245	0.793
48	*Amaranthus hybridus*	INT*	Amaranthaceae	0.243	-
49	*Passiflora foetida*	I*	Passifloraceae	0.24	0.472
50	*Desmodium tortuosum*	INT*	Fabaceae	0.239	0.105
51	*Pennisetum polystachion*	ND	Poaceae	0.236	0.136
52	*Senna hirsuta*	INT*	Fabaceae	0.201	0.044
53	*Panicum maximum*	I[33]	Poaceae	0.201	0.304

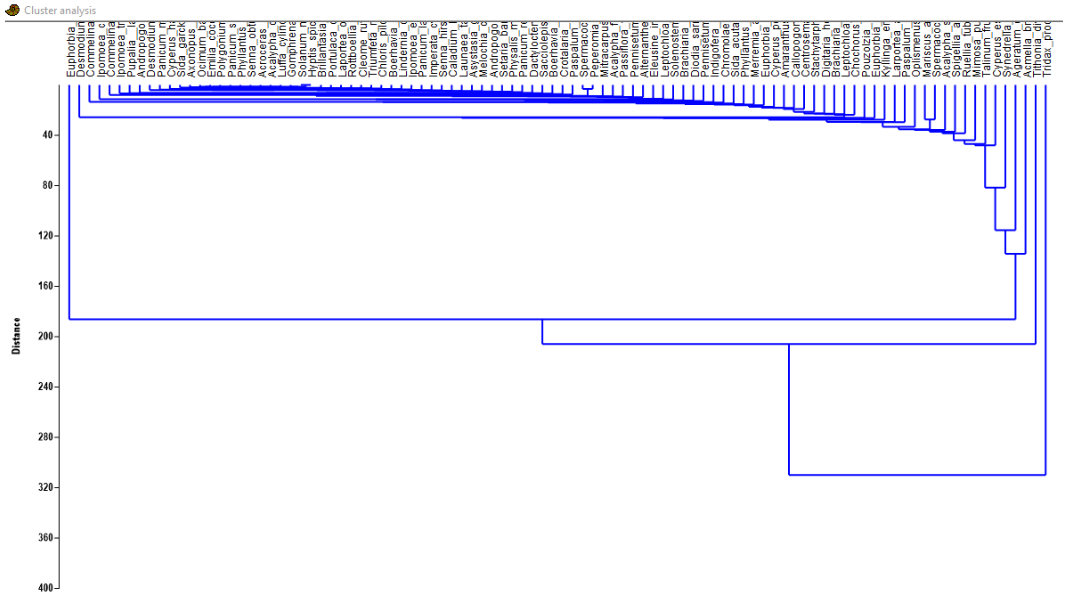
				RIV	
S/N	**Species**	**Status***	**Family**	**2016**	**2020**
54	*Eleusine indica*	N*	Poaceae	0.175	0.044
55	*Pennisetum pedicellatum*	N*	Poaceae	0.175	-
56	*Andropogon tectorum*	N[30]	Poaceae	0.168	-
57	*Cyperus podocarpus*	N*	Cyperaceae	0.16	-
58	*Cyperus haspan*	N*	Cyperaceae	0.157	0.248
59	*Setaria barbata*	I*	Poaceae	0.136	0.254
60	*Physalis micrantha*	ND	Solanaceae	0.136	0.044
61	*Asystasia gangetica*	ND	Acanthaceae	0.13	0.093
62	*Melochia corchorifolia*	ND	Malvaceae	0.13	-
63	*Spermacoce ruelliae*	N*	Rubiaceae	0.121	-
64	*Sida garckeana*	ND	Malvaceae	0.114	-
65	*Dactyloctenium aegyptium*	N*	Poaceae	0.109	-
66	*Sacciolepis africana*	N*	Poaceae	0.109	-
67	*Crotalaria retusa*	INT*	Fabaceae	0.109	0.056
68	*Launaea taraxacifolia*	N*	Asteraceae	0.098	-
69	*Panicum laxum*	ND	Poaceae	0.093	-
70	*Imperata cylindrica*	I*	Poaceae	0.093	0.574
71	*Boerhavia diffusa*	ND	Nyctaginaceae	0.087	-
72	*Lindernia crustacea*	ND	Linderniaceae	0.087	-
73	*Rottboellia cochinchinensis*	N*	Poaceae	0.081	0.502
74	*Cleome rutidosperma*	N*	Cleomaceae	0.081	-
75	*Triumfeta rhomboidea*	I*	Malvaceae	0.081	-
76	*Chloris pilosa*	N*	Poaceae	0.081	-
77	*Peperomia pellucida*	N*	Piperaceae	0.077	0.475
78	*Mitracarpus villosus*	ND	Rubiaceae	0.077	-
79	*Acalypha fimbriata*	N*	Euphorbiaceae	0.077	-
80	*Axonopus compressus*	INT*	Poaceae	0.076	-
81	*Panicum repens*	N*	Poaceae	0.06	-
82	*Caladium bicolor*	ND	Araceae	0.055	-
83	*Ipomoea eriocarpa*	N*	Convulvulaceae	0.049	0.05
84	*Brillantaisia lamium*	N*	Acanthaceae	0.043	0.05
85	*Portulaca oleracea*	N*	Portulacaceae	0.043	-
86	*Laportea ovalifolia*	N*	Urticaceae	0.043	0.148
87	*Ocimum basilicum*	INT*	Lamiaceae	0.038	-
88	*Emilia coccinea*	N*	Asteraceae	0.038	-
89	*Polygonum lanigerum*	ND	Polygoniaceae	0.038	-
90	*Panicum subalbidum*	N*	Poaceae	0.038	0.124
91	*Phyllanthus reticulatus*	ND	Phyllantaceae	0.038	-
92	*Solanum nigrum*	ND	Solanaceae	0.038	-
93	*Hyptis spicigera*	INT*	Lamiaceae	0.038	-
94	*Senna obtusifolia*	INT*	Fabaceae	0.038	-
95	*Acroceras zizanioides*	N*	Poaceae	0.038	-
96	*Acalypha ciliata*	N*	Euphorbiaceae	0.038	-
97	*Gomphrena celosioide*	ND	Amaranthaceae	0.038	-
98	*Luffa cylindrica*	ND	Cucurbitaceae	0.038	0.044
99	*Commelina erecta*	N*	Commelinaceae	-	1.889
100	*Oldenlandia corymbosa*	N*	Rubiaceae	-	1.213
101	*Cyathula prostrata*	N*	Asteraceae	-	0.594
102	*Alternanthera sessilis*	I*	Amaranthaceae	-	0.476
103	*Pennisetum purpureum*	ND	Poaceae	-	0.39
104	*Gloriosa superba*	N*	Colchicaceae	-	0.366
105	*Waltheria indica*	INT*	Malvaceae	-	0.29
106	*Phyllanthus niruri*	ND	Phyllantaceae	-	0.241
107	*Digitaria nuda*	ND	Poaceae	-	0.186
108	*Physalis angulata*	INT*	Solanaceae	-	0.18
109	*Malvastrum coromandelianum*	INT*	Malvaceae	-	0.161

				RIV	
S/N	**Species**	**Status***	**Family**	**2016**	**2020**
110	*Indigofera spicata*	N*	Fabaceae	-	0.111
111	*Mimosa diplotricha*	I*	Fabaceae	-	0.099
112	*Momordica charantia*	N*	Cucurbitaceae	-	0.099
113	*Pennisetum polystachion*	ND	Poaceae	-	0.087
114	*Smilax anceps*	N*	Smilacaceae	-	0.087
115	*Digitaria gayana*	N*	Poaceae	-	0.086
116	*Amaranthus spinosus*	INT*	Amaranthaceae	-	0.056
117	*Paspalum vaginatum*	INT*	Poaceae	-	0.056
118	*Ipomoea vagans*	N*	Convulvulaceae	-	0.05
119	*Mariscus longibracteatus*	ND	Cyperaceae	-	0.05
120	*Mucuna piuriens*	I*	Fabaceae	-	0.05
121	*Sida rhombifolia*	ND	Malvaceae	-	0.05
122	*Sphenoclea zeylanica*	N*	Spenocleaceae	-	0.05
123	*Sesamum alatum*	N*	Pedaliaceae	-	0.044

Key: I = Invasive Species, N = Native, INT = Introduced and ND = Not-Determined
*Source * = Plants of the World Online, Kew Science (2020);*
http://www.plantsoftheworldonline.org/taxon/urn:lsid:ipni.org:names:541268-1#distribution-map

Table 2. Comparative floristic representation of species in taxonomic families encountered at Ajibode-Sasa agroecosystem in 2016 and 2020 in Ibadan, Southwest Nigeria

		Number of Species	
S/N	**Family**	**2016**	**2020**
1	Poaceae	25	18
2	Fabaceae	9	11
3	Asteraceae	8	7
4	Euphorbiaceae	6	4
5	Amaranthaceae	5	5
6	Cyperaceae	5	5
7	Malvaceae	5	5
8	Rubiaceae	4	3
9	Convulvulaceae	4	4
10	Lamiaceae	3	1
11	Acanthaceae	3	2
12	Urticaceae	3	3
13	Portulacaceae	2	1
14	Phyllantaceae	2	2
15	Solanaceae	2	2
16	Commelinaceae	2	3
17	Araceae	1	0
18	Cleomaceae	1	0
19	Linderniaceae	1	0
20	Nyctaginaceae	1	0
21	Polygoniaceae	1	0
22	Loganiaceae	1	1
23	Passifloraceae	1	1
24	Piperaceae	1	1
25	Curcubitaceae	1	2
26	Colchicaceae	0	1
27	Pedaliaceae	0	1
28	Smilacaceae	0	1
29	Sphenocleaceae	0	1



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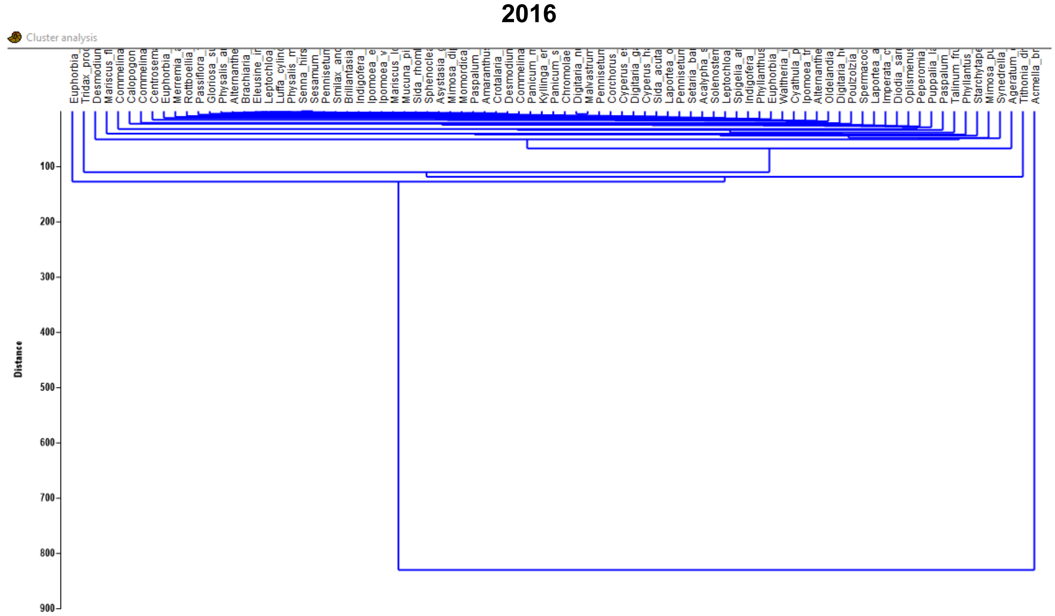

2020

Fig. 3. Cluster dendrogram of floristic association in Ajibode-Sasa agroecosystem in Ibadan, Southwest Nigeria in 2016 and 2020

Table 3a. Diversity Indices of Ajibode-Sasa in 2016 and 2020

Year	2016			2020		
	Index Value	Lower	Upper	Index Value	Lower	Upper
Taxa_S	98	90	98	85	79	85
Individuals	8919	8919	8919	8165	8165	8165
Dominance_D	0.09388	0.09061	0.09726	0.08746	0.08424	0.09096
Simpson_1-D	0.9061	0.9027	0.9094	0.9125	0.909	0.9158
Shannon_H	3.081	3.045	3.107	3.088	3.052	3.113
Evenness_e^H/S	0.2222	0.2201	0.2429	0.2579	0.2538	0.2783
Equitability_J	0.672	0.6687	0.6859	0.695	0.6906	0.708

Table 3b. t-test comparison of species diversity of Ajibode-Sasa in 2016 and 2020

Year	2016	2020
Total	8919	8165
Richness	98	85
H	3.080998	3.087617
S2H	0.00025	0.000237
t	0.300066	
df	17078.51	
Crit	1.960103	
p	0.764131	
CI	0.031601	0.030783

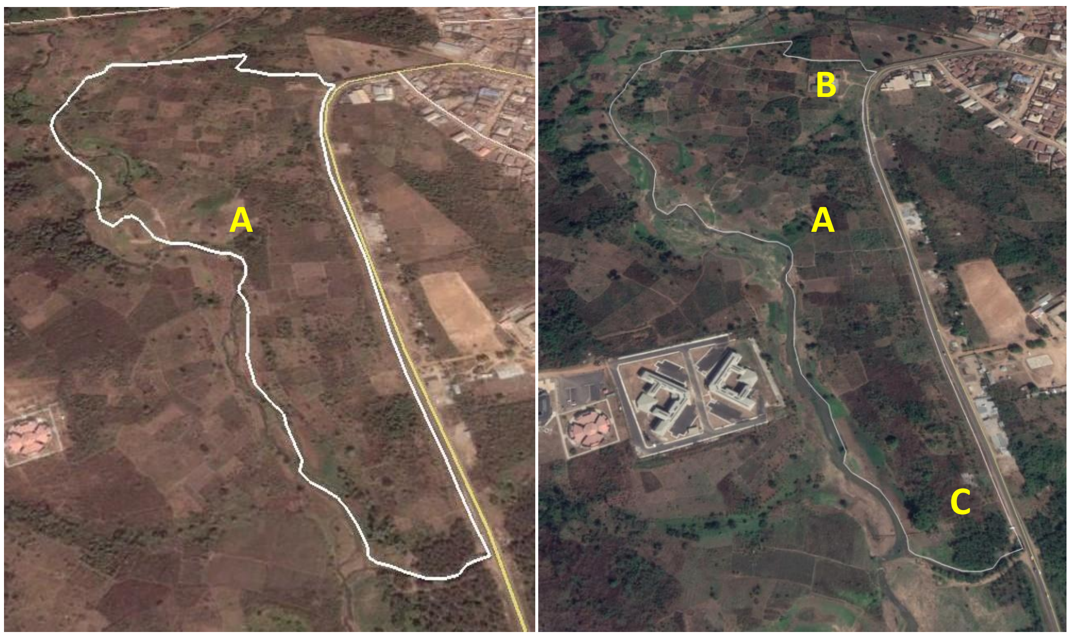

Fig. 4. Aerial imageries of Ajibode-Sasa agroecosystem in 2016 and 2020 showing mosaic pattern of fragmentation in the sampled portion (A) of the landscape. The 2020 image indicates a newly constructed building (B) and Telecomunication Mast (C) within the sampled area

4. DISCUSSION

Our results indicate that subtle floristic changes have occurred in the Ajibode-Sasa agroecosystem between 2016 and 2020. The changes are mainly attributable to the intensive cultivation of arable crops in different cropping system on a small-holder basis which encourage species invasion. The results of this study further supports the observation of [26] that Weed diversity is often related to local conditions, most especially habitat heterogeneity, with high weed species richness in complex landscape. The species invasion reduced the taxonomic number of species over the period, and in the process ousted some species and involved introduction of four new families. The changes portend threat to ecosystem functions, especially the ability of the ecosystem to cope with climate change, as indicated by various studies [35,36] since changes in diversity is a main driver of ecosystem functioning [37]. For instance, the implication of the increase in the members of the Fabaceae in this study is a potential increase in the deposition of Nitrogen in the soil of the study site. This might have been responsible for further increase in the abundance of invasive species. The study of Manning et al. [38] showed that N deposition had direct effect in stimulation plant growth and thus strongly affected ecosystem function.

Fragmentation of the agricultural landscape through small-holder farming of different types of arable crops favours widespread occurence of some noxious plants like *Tridax procumbens,* *Euphorbia heterophylla, Acmella brachyglossa* with high relative importance values. These plants are mostly categorized as invasive [30,33]. The result indicated that the ecosystem is anthropogenically disturbed, leading to loss of native flora. The fragility of the arable ecosystem from the changing flora can cause a disruption in its structural and functional integrity. This supports Stoate et al. [34] that disturbed ecosystems are particularly vulnerable to invasion by alien species. The invasive species are most likely responsible for the low RIVs of many native species that were enumerated in this study, thus floristically simplifying the ecosystem overtime like Poggioa et al. [39] reported. They are responsible for changes in the structure and species composition in the ecosystem [40].

Decreased taxa on the landscape were partly due to intensive cultivation, construction of a large building and telecommunication mast after the 2016 survey. This conspicuous change reduced the number of quadrats from 224 to 184 and flora diversity. This is suspected to have negative impacts on the resilience of the native flora and conservation of community structure and functions. The continuous cultivation could have been responsible for proliferation of grasses (Poaceae family) at the expense of other families. The loss of species was compensated for by increase in the number of individuals of invasive species in the existing species and the introduction of new families which compensated for the families that were lost.

5. CONCLUSION

The study revealed that species invasion is a key driver of floristic changes at Ajibode-Sasa arable landscape through the agency of intensification of arable crop farming. The study also explained trends in community structure as related to intensive farming. Some species are phasing out while others are gaining ground due to their invasive attributes. *Acmella brachyglossa* seems to be becoming more aggressive in outcompeting *Tridax procumbens, Tithonia diversifolia* and other invasive plants; although this would require further studies for confirmation. The high flora diversity is being subtly undermined by increase in invasive taxa 9species and families). The study has indicated that it is possible for intensive cultivation of small holder-farmlands to constitute an avenue to encourage proliferation of invasive plants. The spread of the invasive species could threaten native flora biodiversity and hence, disruption of natural ecosystem dynamics. It is therefore necessary that while encouraging urban agriculture, measures should be taken to curtail introduction and spread of invasive plants. We suggest that adequate phytosanitation, regular monitoring and reporting of invasive plants and sustainable agricultural practices like use of certified and clean seeds, clear demarcation of boundaries and provision of pathways rather than unregulated traversing farmlands.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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