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Species composition of Home gardens and Food security in Maluku, Kinshasa

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Abstract:
This study aimed to assess the species composition of home gardens and their contribution to farmers' food security. Through a questionnaire-based survey in Maluku, Kinshasa, it was determined that the primary use of home garden products is household consumption. Most respondents indicated that home gardens significantly contribute to the households' food security. The chi-square test result indicated that only the livestock variable was statistically significant. The species composition presented a diversity of species that we categorized into three components: crops, trees, and livestock. The most commonly cropped species are *Manihot glaziovii, Ipomoea batata, Saccharum officinarum*, and various species with the Musa genus. The most planted are *Manguifera indica, Persea americana, and Elaeis guineensis*. Regarding livestock, the most reared are *Gallus gallus* and *Anas platyrhynchos*. The choice of these particular species depicts the diet and cultural values of farmers. The study shows the critical role of home gardens in supporting households' food security, hence combating hunger and malnutrition using a sustainable agricultural practice.

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INTRODUCTION

Food is the most basic human need and food security must be seen as a global public good (Muteba et al., 2011) and as a fundamental human right (Shaw, 2007). There is a consensus today that food security is essential to peace and security (Muteba, et al., 2011). One of the most intriguing global phenomena has been the increase in human population (Hartemink, 2007). Demographic growth in megacities in developing countries is of great concern as evidenced in food insecurity (Alexandratos, 2005; Kattumuri, 2018). This growing population brings many challenges in both urban and rural communities among which is that of food insecurity (Hartemink, 2007; Alpas, 2010) as in many developing countries, urban communities have become vulnerable for they cannot adequately meet their basic food needs. This is partly because, in most of Sub-Saharan Africa countries the population has low purchasing power and food production has not kept pace with the increasing population (Kung'u, 2007; Sharma, 2016).

The city of Kinshasa in the Democratic Republic of Congo (DRC) is not spared from this phenomenon. Most of the households in Kinshasa live in precarious conditions, in an environment characterized by a strong economic crisis exemplified by food insecurity (Muteba, et al., 2011). In the context of this crisis, the capital city of DRC has about 70% of its population experiencing food insecurity, making the challenge quite prodigious (Muteba et al., 2011; Muteba & Nkulu, 2019).

Food security is a situation whereby a people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (FAO, 1996). According to Kung'u (2007) food security is one of the most complex political, economic and moral problems of our times. In Kinshasa (DRC), this situation has led the population to create resourceful mechanisms in order to exploit all food resources available (Makumbelo et al., 2005). One of these mechanisms is the establishment of home gardens in the outskirts of the city (Biloso, 2009). However, there is still a gap in the literature on the species composition of home gardens in the municipality of Maluku. We, therefore, deemed it important to carry out a survey on home gardens' species composition and their contribution to food security of farmers' households in Maluku.

A home garden may be defined as an intimate association of multipurpose trees and shrubs, annual or perennial plants, or livestock within the household compound, with the whole unit being managed by family labor (Fernandes & Nair, 1986). It is generally a small fenced plot near the house where vegetables and fruits are grown in whole or in part to supplement the staple food (Verheij, 2003; Reyes-García et al., 2013). This agroforestry system can also provide shade for livestock or serve ornamental purposes (Atangana et al., 2014).

Literature review/Related work

Agroforestry systems, particularly home gardens, have been recognized as vital components of rural and urban landscapes across the globe, offering a sustainable blend of agricultural biodiversity with food security and livelihood enhancement. Home gardens, a traditional form of agroforestry, integrate trees, shrubs, and perennial plants with crops and livestock within the household's vicinity (Atangana et al., 2014).

The concept of food security encompasses the availability, access, utilization, and stability of food. As multifunctional systems, home gardens contribute uniquely to each of these dimensions. Kumar and Nair (2004) provide a foundational understanding of home gardens within agroforestry, highlighting their ecological and economic benefits, which directly and indirectly enhance food security. They contribute significantly to food availability by producing

a diverse array of edible plants and animal products throughout the year. Galluzzi et al. (2010) documented the role of home gardens in maintaining agricultural biodiversity, which is crucial for dietary diversity and nutritional security. Torquebiau (1992) highlighted that home gardens serve as a buffer against food insecurity by providing immediate access to food resources, especially in times of economic or climatic crises.

The diversity of home garden products contributes to balanced diets, enhancing the nutritional status of household members. Taylor & Lovell (2015) showed that home gardens are significant sources of vitamins, minerals, and proteins, contributing to better health and nutrition outcomes. Furthermore, Kortright and Wakefield (2011) discussed the role of home gardens in educating household members about nutrition and sustainable food practices, enhancing food utilization. They also contribute to the stability of food systems by offering resilience against market volatility and climatic variations. Galhena et al. (2013) demonstrated how home gardens' diverse and perennial nature makes food production less susceptible to external shocks, ensuring continuous food availability.

MATERIAL AND METHODS

The research was carried out in Maluku which is the largest municipality in Kinshasa with an area of 7,948.80 km^2 which represents 79% of the total area of the city (Kinyamba et al., 2015). It is located in the Eastern part of Kinshasa between latitude 4°27'41''S and longitude 16°04'43''E with an altitude of about 2,000 meters. The population is essentially rural with agriculture being the principal activity (Biloso, 2009).

In order to achieve the objectives of this study, the methodology used was mainly a questionnaire-based survey. A pre- survey was first conducted in order to verify the relevance of the questionnaire and the feasibility of the investigation after which, systematic surveys were carried out from June to August 2015 by administering a questionnaire to 255 heads of households in 3 main villages (Mbankana, Maluku centre and Mutiene) of the municipality of Maluku. These phases were preceded and succeeded by a bibliographic research to deepen certain aspects of the thematic and confirm the observations made while conducting the survey. The observations made in the course of the visit of home gardens, was a key element as it enabled us to verify the statements of respondents with regard to species found in home gardens.

We used demographic data (Table 1) collected from the municipal authorities and the formula of (Yamane, 1967) to constitute the sample size. The quota per village was obtained by calculating the percentage in relation to the total number of households.

$$n = \frac{N}{\{1 + (N \times e^2)\}}$$

n = sample size; N = total number of households; e = 5% margin of error

A database was made thanks to Microsoft Excel (2007) and the data analyzed by use of with SPSS 20.

Table 1. Distribution of households in Mbankana, Maluku Centre and Mutiene in 2015

Site	Number of Households	Percentage	Quota by village
Mbankana	321	45.7	117
Maluku Centre	333	47.4	121
Mutiene	48	6.8	17
Total	702	100	255

Determinants of the contribution of home gardens to food security

The ability of the rural population of Maluku at the outskirts of Kinshasa to adapt to the socio-economic crisis and be able to meet their food needs may explain the presence of home gardens. Thus, the dependent variable is the "Contribution of the home garden to food security of the household" (CGFS). That contribution was rated on a qualitative scale of 1 to 10. Then, the scale was split into 2 to make the variable binary. Thus, we assigned the following values to it: CGFS: 0 = Not significant contribution to food security (< 5); CGFS: 1 = Considerable contribution to food security (≥ 5). Independent variables used are: sex, age, education level, marital status, economic activity, household size, land tenure, motivation, livestock, animal load, number of trees; garden amendment, institutional support, affiliation to association(s), favorable season. We used the chi-square test to test the relationship between each independent variable and the dependent variable.

RESULTS

Exploratory Results

Out of a total of 255 respondents, the female sex dominated 81.1% while the male represented 18.9%. The age varies as follows: between 40 and 49 years (29.1%), 50 and 59 years (25.2%), 30 and 39 years (24.4%), 20 and 29 years (12.6%) as well as 60 and over (8.7%). Majority (56.7%) have attained secondary level education followed by those which have primary level (28.3%), while 13.4% are illiterate and only 1.6% have attained the tertiary level. Married represents a majority (81.1%), followed by widowed (11.8%) while the unmarried and divorced are 6.3% and 0.8% respectively. Agriculture is the main economic activity practiced by half (50.4%) of the respondents, followed by trade with 35.4 % taxi driving at is 4.7%. Most of the households (51.2%) have a size of between 6 and 10 individuals, while 40.1% have a size between 1 and 5 persons, and 8.7% have 10 or more individuals. Almost all of the respondents (92.9%) own their plots of land with tenants representing only 7.1%. Farming for subsistence is the main motivation for 74% of respondents, while proximity and education of children represent 25.2% and less than one percent respectively. Most of the households (67.7%) have been home gardening for between 1 and 5 years, while 17.3% between 6 and 10 years and 15% for at least 11 years.

Only 21.3% of respondents are members of some associations, while 78.7% are not, the majority of them alleging that they are not aware of any association while others were disappointed by existing associations. Despite the existence of several national and international organizations, 77.2% of respondents declared to have never received any institutional support, with only 29.8% having received such, in order to conduct agricultural activities.

The majority of the respondents (52.4) declared not being engaged in livestock in their home gardens, while 47.6% are. For those engaged in livestock, the capacity (number of animals) varies, 50% of respondents have between 1 to 10 animals; 25% between 11 to 20; 15.8% of respondents have between 21 and 30 heads while 9.2 % have at least 30 heads. Straying is the main (70.5%) mode of this livestock, housing accounts for 29.5%. With regard to the number of trees, majority (35.4%) home gardens have between 1 and 10 trees with a variety of species; 26.8% have 11 to 15 trees of various species; while 1 to 5 trees and 21 to 25 trees are represented by 14 % with a diversity of species. All of the respondents indicated that the favorable season for the good production of the home garden the rainy season. 63% of the respondents amend their home gardens to make it more fertile 37% do not. The types of amendment used are: plant biomass (30.7%), household waste (20.5%), animal excrements (11.8%) and mineral fertilizers (0.8%). 85.8% of respondents indicated that home gardens

contribute effectively to food security of households, while 14.2% declared that home gardens do not contribute effectively to food security for their households.

Chi-square test results

The result of the chi-square test in Table 2 between each of the independent variables and the dependent variable, shows that only the variable "livestock" is statistically significant (p = 0.022, dof = 1, chi-square = 1, 5.268). That means that households that practice livestock in their home gardens are likely to meet food security. Indeed, livestock in a home garden gives added value as in addition to traditional crops and tree products, animals are another very important resource. The nutritional importance of meat cannot be overemphasized.

Table 2. Chi-square results of the survey carried in Mbankana, Maluku Centre and Mutiene in 2015

Independent variables	**Dependent variable: CJSA**		
	Chi-square	**dof**	**P-value**
Sex	0.830	1	0.362
Age	0.032	1	0.858
Marital status	0.151	1	0.697
Educational level	1,648	1	0.199
Land tenure	1,600	1	0.206
Main Activity	0.001	1	0.971
Livestock	5.268	1	0.022*
Institutional support	0.004	1	0.947
Affiliation to association	0.012	1	0,914
Favorable Season	-	-	-
Years of home gardening	0.265	1	0.606
Household size	0.151	1	0.906
Amendment	0.498	1	0.481

P ≤ 0.05: significant incidence between the independent variable and the dependent variable.

Species composition of home garden resources

Like any agroforestry system, the home garden consists of several components, which can mainly be subdivided in three: crops, trees, animals. Below are presented the resources encountered in the home gardens of the study area.

Floristic resources

Below are presented floristic resources found in studied home gardens, they are categorized in 2 groups: crops (Table 3) and tree species (Table 4).

Crops

Table 3. Composition of crops in Mbankana, Maluku Centre and Mutiene in 2015

Species			**Species**		
Family	**Scientific name**	**%**	**Family**	**Scientific name**	**%**
Alliaceae	*Allium fistulosum* L.	**1.5**	Solanaceae	*Nicotiana tabacum* L.	**1.5**
Amaranthaceae	*Amaranthus sp.*	**19.6**		*Lycopersicon esculatum* L.	**1.5**
Bromeliaceae	*Pineapple comosus* L.	**11.8**		*Solanum scabrum* Mill.	**2.4**
Basellaceae L.	*Basella alba*	**5.5**		*Solanum melongena* L.	**3.1**
Araceae	*Colocasia esculenta* L.			*Capsicum fructenscens* L.	**34.6**
	Xanthosoma sagittifolium L.	**28.3**	Musaceae	*Musa sp.*	**47.2**
Malvaceae	*Abelmoschus esculentus* L.	**7.0**	Dioscoreacea	*Dioscorea sp*	**5.5**
	Gossipium arboretum L.	**0.7**	Lamiaceae	*Ocimum basilicum* L.	**8.6**
	Hibiscus sp	**19.6**	Cucurbitaceae	*Cucurbita pepo* L.	**2.3**
Euphorbiaceae	*Ricinus communis* L.	**2.3**	Convolvulaceae	*Ipomoea batatas* Lam.	**50.3**
	Manihot glaziovii L.	**100**	Brassicaceae	*Brassica rapa* L.	**1.5**
				Brassica oleraceae L.	**1.5**
Poaceae	*Saccharum officinarum* L.	**49.6**	Fabaceae	*Vigna unguiculata* L. Wald	**2.3**
	Cymbopogon citratus DC	**32.2**		*Phaseolus vulgaris* L.	**2.3**
	Shorgum bicolor L.	**2.3**		*Psophocarpus scandens* Endl	**6.3**
	Zea mays L.	**3.9**	Passifloraceae	*Passiflora edulis* Sims	**17.3**

Results of Table 3 show that Cassava (*Manihot glaziovii*) is grown in all visited home gardens, followed by sweet potato (*Ipomoea batatas*) which has a frequency of 50.3%. Cassava and Sweet potato are grown for their leaves that are consumed as vegetable. Sugarcane (*Saccharum officinarum*) and banana (*Musa sp*) is also well represented with 49.6 and 47.2% respectively. The less represented crops are garlic (*Allium fistulosum*), cabbage (*Brassica oleraceae),* tobacco (*Nicotiana tabacum*), tomato (*Lycopersicon esculatum*), field mustard (*Brassica rapa*) with 1.5% each and tree cotton (*Gossipium arboretum*) with 0.7%.

Tree species

Table 4. Tree species Composition in Mbankana, Maluku Centre and Mutiene in 2015

Species			**Species**		
Family	**Scientific name**	**%**	**Family**	**Scientific name**	**%**
Annonaceae	*Annona muricata* L.	**11.8**	Mimosaceae	*Acacia sp*	**33.8**
	Cananga odorata Lam	**1.5**		*Albizia lebbeck* L.	**0.7**
Anacardiaceae	*Spondias cytherea* Sonn	**0.7**	Myrtaceae	*Eucalyptus sp.*	**3.9**
	Manguifera indica L.	**92.9**		*Psidium guajava* L	**3.9**
Arecaceae	*Elaeis guineensis* Jacq.	**66.9**		*Syzygium malaccence* L.	**3.1**
	Cocos nucifera Lam.	**10.2**	Moraceae	*Artocarpus communis* G. Forst	**3.1**
Bombacaceae	*Adansonia digitata* L.	**0.7**	Moringaceae	*Moringa oleifera* Lam.	**10.2**
Burseraceae	*Dacryodes edulis* Lam.	**48.8**	Poaceae	*Bambusa vulgaris* Schrad.	**7.0**
Caricaceae	*Carica papaya* L.	**58.2**	Rutaceae	*Citrus limon* L.	**19.6**
Casuarinaceae	*Casuarina equisetifolia* L.	**0.7**		*Citrus reticulata* Blanco	**5.5**
Combretaceae	*Treminalia superba*	**5.5**		*Citrus maxima* (Burm) Merr	**0.7**
	Terminalia catapa L.	**0.8**		*Citrus sinensis* L.	**5.5**
Cecropiaceae	*Myrianthus arboreus* P. Beauv	**0.7**	Rubiaceae	*Morinda morindoides* L.	**0.7**
Fabaceae	*Milletia laurentii* De Wild	**1.5**	Flacourtiaceae	*Flacourtia jangomas* Lour	**4.7**
Lauraceae	*Persea americana* Mill.	**83.4**		*Oncoba welwitschii* Oliv	**1.5**

Table 4 shows that mango tree (*Manguifera indica*) (92.9%), avocado tree (*Persea americana*) (83.4%) and palm tree (*Elaeis guineensis*) (66.9%) are the most planted species. The less frequent species are siris tree (*Albizia lebbeck*), *Morinda morindoides,* monkey fruit tree (*Myrianthus arboreus*), pomelo (*Citrus maxima*), yellow mombin (*Spondia mombin*), baobab tree (*Adansonia digitate*), Golden apple tree (*Spondias Cytherea*) and autralian pine tree (*Casuarina equisetifolia*) with a frequency of 0.7%.

Animal resources

Table 5. Composition of animal species in Mbankana, Maluku Centre and Mutiene in 2015

Vernacular name	**Scientific name**	**Family**	**(%)**
Chicken	*Gallus gallus* L.	Phasianidae	100
Duck	*Anas platyrhynchos* L.	Anatidae	46
Pig	*Sus scrofa* L.	Suidae	19
Guinea fowl	*Numida meleagris* L.	Numididae	1.5
Goat	*Capra hircus* L.	Bovidae	27
Cow	*Bos taurus* L.	Bovidae	2
Pigeon	*Columba sp*	Columbidae	3

From the Table 5, it appears that poultry farming is the most prevalent livestock practice encountered in the home gardens visited with chicken rearing at (100%) and duck (46%) being the most encountered in visited home gardens. Goat and pig rearing represent 27% and 19% respectively, while cows account for only 2%.

Diet

Diet plays an important role in the composition of the home garden. The most cultivated species are the ones providing food that meets the dietary needs of the household. These

species are presented according to three types of components of home gardens, namely, vegetables from crops, fruits produced mainly by trees, and animal products.

Vegetables

Table 6. Most consumed vegetables in Mbankana, Maluku Centre and Mutiene in 2015

Family	Scientific name	%	Family	Scientific name	%
Euphorbiaceae	*Manihot sp*	**98.4**	Malvaceae	*Abelmoschus esculentus*	**3.1**
Convolvulaceae	*Ipomoea patatas*	**87.4**		*Hibiscus acetosella*	**47.2**
Basellaceae	*Basella alba*	**13.3**	Fabaceae	*Phaseolus vulgaris*	**7.8**
Denstaediaceae	*Pteridium Centrali-Afrcanum* Hieron *	**3.9**		*Psophocarpus scandens*	**7.8**
Cucurbutaceae	*Cucurbita pepo*	**3.1**	Brassicaceae	*Brassica rapa*	**14.1**
Amaranthaceae	*Amaranthus sp*	**74.8**		*Brassica oleraceae*	**8.8**
Gnetaceae	*Gnetum africanum* Welw *	**8.6**	Solanaceae	*Solanum melongena*	**3.9**
Araceae	*Xanthosoma sagittifolium*	**4.7**		*Solanum scabrum*	**9.4**
Celastraceae	*Salacia pynaertii* De Wild *	**0.8**			

* Vegetables not produced in the garden. Usually harvested in the forest.

The results presented in Table 6 show that cassava leaves (*Manihot sp*) are the most consumed vegetable (98.4%). Followed by sweet potato leaves (*Ipomoea batatas*) (87.4%), amaranth (*Amaranthus sp*) (74.8%) and sorrel (*Hibiscus acetosella*) (47.2%). The importance of these vegetables in the diet justifies their presence in home gardens.

Fruits

The 5 most commonly consumed fruits by household are presented in the Table 7.

Table 7. Most consumed fruits in Mbandaka, Maluku Centre and Mutiene in 2015

Fruit	Scientific name	%	Fruit	Scientific name	%
Mango	*Manguifera indica*	**94.4**	Orange	*Citrus sinensis*	**34.6**
Avocado	*Percea americana*	**85.0**	Pineapple	*Pineapple comosus*	**7.8**
Papaya	*Carica papaya*	**44.8**	Jinguenga	*Aframomum alboviolaceum*	**1.5**
Palm nuts	*Elaeis guineensis*	**26.7**	Guava	*Psidium guajava*	**1.5**
Safou	*Dacriodes edilus*	**48.0**	Pomelo	*Citrus maxima*	**0.7**
Lemon	*Citrus limon*	**11.8**	Coconut	*Cocos nucifera*	**4.7**
Tangerine	*Citrus reticulata*	**3.94**	Indian plum	*Flacourtia jangomas*	**1.5**
Soursop	*Annona muricate*	**6.3**	Yellow mombin	*Spondia mombin*	**0.7**
Malay apple	*Syzygium malaccence*	**7.8**	Passion fruit	*Passiflora edulis*	**7.8**
Banana	*Musa sp*	**19.6**			

It appears from the results shown in Table 7 that mango (94.4%) is the most consumed fruit, followed by avocado (85%) and safou with 48%. This result justifies the prevalence of these species in home gardens.

Animal products

The most consumed animal meats, produced in home gardens, are: chicken (90.6%), goat (27%), pork (15%) and beef (2%). Others animal meats consumed but not farmed in home gardens are: fish (44.8%), caterpillar (10.2%), cricket (7%) and bush meat 5. The majority of respondents like caterpillars but they are underrated because of their seasonality. Respondents declared not to buying from the market, they eat what is harvested by themselves.

DISCUSSION

Home gardening is widely practiced in Maluku. Findings from this work indicate a large diversity of species in the home gardens of the municipality of Maluku. This is in accordance with results found by (ABEBE, et al., 2006; REYES-GARCÍA, et al., 2013; KUMAR & NAIR, 2004) declaring that home gardens are very widespread in tropical zones and are characterized by a multispecies composition. The specific diversity of home gardens is quite remarkable for this

type of ecosystem (TCHATAT, et al., 1995). Plant species most commonly encountered in this study (Table 3 and Table 4) are the same as those found in the wetlands of southern and central Cameroon by Tchatat et al. (1996). The species, either plant or animal, mostly found in home gardens are of capital importance regarding to food, medicinal sector and other aspects like efficient nutrient cycling, conservation of bio-cultural diversity, product diversification, social and cultural values as well as non-market values of products and services (KUMAR & NAIR, 2004). Home gardens are not market oriented (VAN DER STEGE, et al., 2012), therefore, goods produced in home gardens in Malaku are mainly directed to households' consumption as noted by Maroyi (2009) who found that almost all home gardens are subsistence production systems. This production is spread throughout the year. The diversity of species within the home garden bridges the gap of slowed vegetative activity of plants in dry season. Gardens are therefore permanently exploited by households. This matches with results of Abebe et al., (2006) who stated that in a good home garden trees and other perennials are grown, to ensure that there is still something to be picked during the dry season when there are no seasonal garden crops available to make the meals tastier and nutritious.

Regarding livestock, only a minority (47.3%) of the studied home gardens have the animal component. Peasants, knowing the harm caused animals, limit the number of livestock in home gardens (TCHATAT, et al., 1995). Though among those who have livestock, poultry farming is the most practiced, followed by goats and pigs and very few cattle (Table 5). The predominance of poultry in the home gardens can be explained by the fact that it is easy to farm since the animals can feed themselves, it requires little space and besides that, it is of great cultural value. The results from this research show that home gardens are an important asset for food security as found by George and Christopher (2020). Livestock is a value added to this agroforestry system comparing to traditional agricultural systems. Though statistically only the animal component had a significant effect on the contribution of home gardens to food security, from the exploratory results it can be seen that the diversity of specifies (Tables 3, 4 and 5) and the proximity to households are very important factors as food security is relative to the quality, the availability and accessibility of food products. This is in accordance with Abebe et al., (2006) who said that vegetables, fruits, animal products produced in home gardens together with staple food constitute a balanced diet as vegetables and fruits are protective foods that provide mainly protein, vitamins and minerals. Findings by Reyes-García, et al. (2013) indicate that home gardening is an adequate strategy adopted by farmers to ensure food security.

CONCLUSION

Home gardens can be regarded as one of the strongest strategies for people living in Maluku to meet food security by offering food availability and access. It appeared to us that home gardening is the least demanding agroforestry system and that is easy to manage even in urban areas. Analysis of the structure helped to identify three types of components classified according to their natures. The first component consists of crops (*Manihot sp*., *Hypomoea patatas , Phaseolus vulgaris, Solanum melongena, Amaranthus sp., Basella sp., e*tc.) ; the second is that of woody *species* (*Mangifera indica , Persea americana, Dacryodes edulis, Acacia sp*, *Abisia lebbeck, Myrianthus arboreus, Spondia cytherea ,* etc.) and the third is that of animal resources (poultry, goats, pigs and cattle). Those species are culturally linked to the farmers as they are the expression of farmers' diet. The diversity within a home garden and its proximity to the households allow farmers to harvest a variety of products all through the year. This satisfies their food needs and help to meet food security.

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