Scientific Research Publishing

Open Journal of Applied Sciences, 2022, 12, 2037-2054
https://www.scirp.org/journal/ojapps
ISSN Online: 2165-3925
ISSN Print: 2165-3917

Integration of Fish and Poultry Farming into Cropping Systems to Improve Production Yields

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How to cite this paper: Tine, M., Wade, S. and Sembene, M. (2022) Integration of Fish and Poultry Farming into Cropping Systems to Improve Production Yields. *Open Journal of Applied Sciences*, **12**, 2037-2054.
https://doi.org/10.4236/ojapps.2022.1212142

Received: October 24, 2022
Accepted: December 18, 2022
Published: December 21, 2022

Abstract

This study aims to evaluate and compare the fertilizing effects of fish-breeding water and river water combined or not with composted poultry manure on the growth and production of okra and lettuce crops. Thus, a sample of 2000 Nile tilapia *Oreochromis niloticus* fry and a sample of 100 Cobb 500 strain chicks were reared and monitored for six months and fifteen days. Poultry manure and fish-breeding water were then collected and used to fertilize and water okra and lettuce crops. Two systems were used for the crops (okra and lettuce) tested in an elementary plot design with replicates for each treatment (T1: fish-breeding water alone; T2: river water alone; T3: fish-breeding water combined with manure; T4: river water combined with manure). Morphometric parameters and phenological traits of okra and lettuce crops as well as the total harvest weight and production yield were evaluated and compared between treatments. The results reveal better growth and higher yields (0.67 kg/m^2 vs. 0.45 kg/m^2) of okra crops that received treatment T1 compared to T2. The best growth and yields of lettuce were obtained with treatments T3 (3.34 kg/m^2) and T1 (1.89 kg/m^2) compared to T4 (1.23 kg/m^2) and T2 (1.20 kg/m^2). These results show that fish-breeding water combined with poultry manure can boost okra and lettuce production and would be a real asset to stimulate local agricultural development. Thus, the adoption of such an agro-ecological approach integrating fish farming and animal husbandry could increase local production and provide food of good nutritional quality.

Keywords

Agroecology, Poultry, Fish Farming, Production, Yield, Nile Tilapia, Cobb 500, Okra, Lettuce

1. Introduction

In Africa, in Senegal in particular, the primary sector consisting mainly of agriculture, livestock and fisheries, provides most of the nutritional resources for the population [1]-[6]. Agriculture and livestock are often practiced in parallel especially in rural areas [7] [8]. Livestock farming is perceived as a means of investment or capitalization allowing for the mobilization of funds in case of need, and in addition to satisfying the animal protein requirement of populations [9]. Thus, poultry farming has particularly experienced rapid growth in recent years due to the ban on imports of poultry products since 2005 following the threat of avian flu [10] [11]. In 2017, the total number of poultry registered was 74,869 thousand, corresponding to an increase of 10,328 thousand compared to 2016 [12]. This dynamic trend in 2017 is mainly due to the good performance of industrial poultry, whose numbers increased by 25.0%, after the 11.0% increase noted in 2016 [12].

The fisheries and aquaculture sub-sector also plays a key role in economic growth in addition to its contribution to the well-being of the population by ensuring high quality food [13]. However, these fishery resources are now subject to overexploitation due to an increasingly growing demand that has resulted in a decline in catches [12]. Faced with this situation and numerous challenges that constrain the development of the fisheries sector, aquaculture would be an alternative to satisfy the growing demand for fishery products, including fish. Thus, national aquaculture production increased from 1011 tons in 2017 to 1109 tons in 2018, a 9.7% increase [12].

Despite the importance of the primary sector, the strong demographic growth is a hindrance to the satisfaction of the population's needs in agricultural products, which has led to chronic malnutrition among certain rural populations [4] [14] [15]. In Senegal, in 2017 seven (7) out of ten (10) children under five (5) years of age were anemic, which correspond to a total rate of 71%. Thus, only 8% are fed in accordance with optimal infant and young child feeding practices [12]. Global warming is another constraint, which today is illustrated by extreme climatic conditions, particularly the frequency of drought periods and the irregularity of off-season rainfall [16] [17]. These two phenomena have accentuated the water deficit and affected crop production yield and cropping systems [18] [19] [20] as well as livestock [21] and fisheries and aquaculture [22] [23] [24].

Another constraint the primary sector facing is the availability of financing and access to arable land. Indeed, West Africa African smallholders are encountering considerable obstacles in accessing credit and investing in new agricultural practices [25]. Thus countries like Senegal recognize the decisive importance of the primary sector for diversified growth, food security, and poverty reduction [26] [27]. Although it has received limited attention for a long period of time, a new vision for African agriculture is emerging. This vision of agriculture has crystallized mainly around the Comprehensive Africa Agriculture Development Program (CAADP), which aimed at stimulating the growth in agricultural sector by boosting the investment [26] [28] [29] [30].

Faced with these numerous problems that plague the primary sector, the adaptation and adoption of new agricultural production techniques are becoming increasingly necessary [30] [31]. There is, therefore, an urgent need to take steps to prepare this sector for the prospect of changes compatible with environmental limits [31]. Thus, agricultural systems integrating animal farming constitute an alternative of crucial importance to ensure a harmonious development of agriculture. The main objective of this study is therefore to evaluate the effects of integrating fish and poultry farming with agriculture on the production of okra and lettuce in order to increase agricultural yields. Indeed, this integration could strongly contribute to the increase of agricultural yields by minimizing production costs. To that end, wastewater from the fish pond and composted poultry manure were used to fertilize the cultivated plots.

2. Materials and Methods

2.1. Study Area

The study was conducted at the experimental farm of the Gaston Berger University (UGB) located 12 kilometers (Km) from the city of Saint-Louis, precisely at Sanar (16˚18'N, 16˚29'W and at 4 m altitude), in the commune of Gandon, department and region of Saint-Louis [32]. This farm, which covers an area of 33 hectares (ha), was created to consolidate training, research, and development for all the Training and Research Units (UFR). It is supplied with water by the Djeuss, a tributary of the Senegal River located five kilometers from the farm, which provides most of the water for the irrigation of the developed areas and to meet the needs of other related activities. These activities include agriculture, livestock and fish farming.

2.2. Biological Materials and Experiments

The approach used in this study allows the establishment of an integrated management strategy for fish production with efficient use of water resources in order to enhance irrigated farming. Thus, Nile tilapia *Orechromis niloticus* and a strain of Cobb 500 broiler were monitored with two plant species, okra and lettuce. The experimental equipment consists of all the breeding and cultivation infrastructures (breeding building, fish pond and cultivable plots) and small equipment (rake, planter, fishing net, brooder, feeder, waterer, etc.). This equipment allowed the realization of the activities carried out since the reception of the chicks, the sexing of the fish and the stocking of the pond. It also allowed the preparation of the land (development of plots) for plant production and to carry out harvesting activities and evaluation of the harvested products.

2.2.1. Broiler Raising

The chicks come from Seric Aviboye BP 10 Saint-Louis. They underwent routine checks (count, umbilical and leg condition, liveliness etc.) upon receipt. They were then put in a brooder inside the rearing building for two weeks before being transferred to the rearing area where they were fed continuously until the finishing phase. They were fed during the first fifteen days with starter food in the form of crumbs manufactured and commercialized by AVISEN (a local company) and received tap water as drink during the whole rearing cycle. From the fifteenth to the thirty second day of rearing, they were fed with the so-called growth food and with the finishing food from the thirty third day until the end of the cycle at the forty fifth day. The feed was distributed in two rations per day, distributed in the morning and evening. After reaching market size, the broilers were sold and the manure were collected and put in a composting plant to produce manure that was used to fertilize the cultivated plots.

2.2.2. Fish Farming Management

The stocking of fish ponds constitutes a step of loading of fish in rearing infrastructures. In our experiment, 2000 male *O. niloticus* fry of average size 50 grams were stocked in the fish pond of the UGB farm in Saint Louis with a stocking density of 4 individuals per square meter. The rearing of these fry lasted five months during which they were fed with industrial feed distributed in daily rations taking into account the density and the phases of the rearing cycle. It was distributed in three meals per day and the quantities (in percentage) distributed depended on the number of individuals reared and their average weight. For fry and adults, the feeding rate distributed was 8% and 10% of the total fish body weight, respectively.

The water in fish pond was regularly renewed, twice a week. The drained water (water from the fish pond) was stored in a 30 m^3 tank for watering okra and lettuce crops. The physico-chemical parameters (temperature, dissolved oxygen, pH, phosphorus and nitrite) of the fish-breeding water and river water were measured using an oximeter and a commercial kit. These parameters were taken twice a day, in the morning at 9 am and the evening at 5 pm.

2.2.3. Experiment Setup

Two types of experiments were conducted during the study with two different crops. For each speculation, the design used was the elementary plot design with two (2) replications for each treatment. Thus, the first design consists of testing the effects of two different treatments (fish-breeding water and river water) on okra production: T1: treatment 1 (fish-breeding water); T2: treatment 2 (river water). The size of the plots is 25 m long and 4 m wide (**Figure 1**).

The second experimental design concerns the lettuce crop. It consisted of evaluating the fertilizing effects of fish-breeding water or river water alone and the effects of fish-breeding water and river water combined with poultry manure. The elementary plots of this set-up are 10m long and 1m wide (**Figure 2**) and consist of four treatments: T1: treatment 1 (fish-breeding water alone); T2: treatment 2 (river water alone); T3: treatment 3 (fish-breeding water combined with manure); T4: treatment 4 (river water combined with manure).

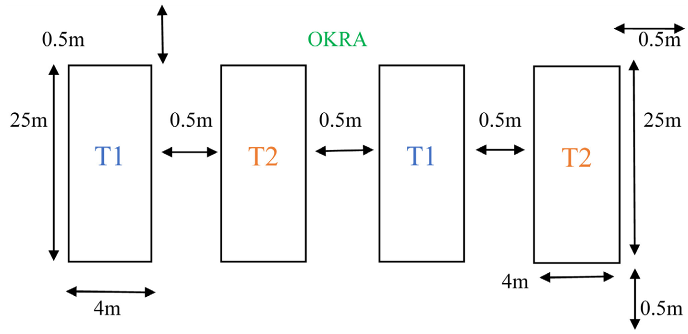

Figure 1. Experimental set-up for okra. T1: treatment 1 (fish-breeding water); T2: treatment 2 (river water).

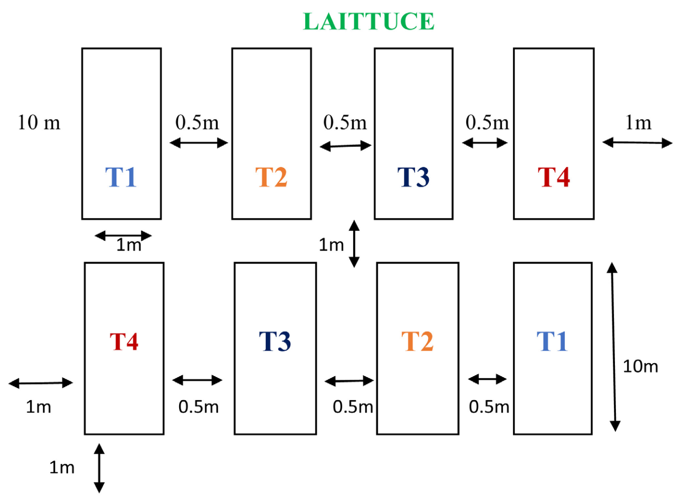

Figure 2. Lettuce experimental setup. T1: treatment 1 (fish-breeding water alone), T2: treatment 2 (river water alone); T3: treatment 3 (fish-breeding water combined with manure); T4: treatment 4 (river water combined with manure).

2.2.4. Crop Management

Drainage water (water from the fishpond) and river water (water from the canal connected to the djeuss) were used to irrigate the agricultural plots. Thus, the type of watering used was "watering can" and was carried out regularly at a frequency of five (5) times per week. However, a pre-irrigation of one week was carried out before the direct semi of the okra and the transplanting of the lettuce. To do this, tanks were installed to store the water used because of the distance between the water sources and the plots to be irrigated (about 40 to 50 meters). Watering cans equipped with a fine nozzle to reduce the water pressure during irrigation were used to prevent the young plants from falling over because of the powerful water jets.

2.2.5. Nursery and Transplanting of Lettuce

The lettuce nursery was done during the period from August 29 to September 24, 2020, with an average of twenty-five (25) days. A bed of one (1) meter wide and two (2) meters long was used to cover the needs of transplanting which took place on September 24, 2020 at about 17:00. Thus, the transplanted plants after this period of nursery correspond to a foliage of five (5) or six (6) leaves per plant. The lettuce beds were identical in size (width = 01 m and length = 10 meters) and a passage of 0.3 m separated them in order to facilitate the execution of certain works such as weeding and irrigation etc.

2.2.6. Direct Seeding of Okra

The activities of semi were made on Thursday, September 03, 2020. They consisted in sowing directly the seedlings on the boards or on the plots of the garden at their definitive place that is to say until the harvest. The okra does not require transplanting, but most often a thinning or a demariage. Thus, a thinning of one plant by poquet was carried out when the seedlings begin to have three (3) leaves. A spacing of one meter between the rows of plants and 0.5 meters between plants on the row was followed during the experiment.

2.2.7. Monitoring, Maintenance and Parameter Crop Measurement

The monitoring of the vegetative cycle and the maintenance of the crops after transplanting constitutes an important step for obtaining quality products (crops) with good yields. Indeed, various activities were carried out in order to achieve the expected results. They consisted of ploughing of plots before sowing to control weeds, performing a regular monitoring of the phytosanitary state of the crops (because some pests can destroy them in a few days), making an execution of weeding to facilitate the infiltration of water in the soil and eliminate weeds and irrigation on a regular basis to meet the water needs of the plants at various stages of the vegetative cycle, and spreading manure on the lettuce plots at a rate of 30 kilograms per 10 square meters.

The knowledge of the germination rate is important in agriculture for the control of the efficiency of its own harvesting methods, the adaptation of the quantity of seeds to be sown according to the fixed objective. The germination rate (GR) was calculated by the following formula:

$$\text{GR} = (\text{Number of germinated seeds})/(\text{Total number of seeds sown}) \times 100$$

Measurements of morphometric parameters and an observation of phenological traits were made on each okra unit plot. The following morphometric parameters and phenological traits were studied on okra: stem length, diameter at the collar, number of leaves, date of appearance of the first flower, date at which 50% of the plants have flowered, date of appearance of the first fruits, length of the plants, width of the plants and number of leaves of the plants.

2.2.8. Harvesting Technique

For okra, harvesting began after 43 days of sowing (sowing date: 03/09/2020; harvesting start date: 16/10/2020) and then spread over a period of 55 days (harvesting end date: 04/12/2020). The harvest frequency was 3 revolutions days at a rate of twice a week. Since okra fruits lignify quickly, a short harvest frequency is necessary or refers to the length of the fruits which should not exceed 16 cm before harvest. The harvest was done with scissors in order to avoid any injury to the plant. For lettuce, harvesting started 75 days after nursery, *i.e.* 50

days after transplanting (nursery start date: 29/08/2020; harvest start date: 24/09/2020). Thus, the apples were cut, with a few leaves open at the base using a knife. The weight of each crop of okra and lettuce was measured with a precision mechanical scale 200 g to 50 Kg.

The production yield (PY) which corresponds to the ratio between the quantity of production in an agrosystem and the exploited surface was calculated by the following formula:

$$PY = \text{Production quantity}/\text{Cultivated surface}$$

2.3. Data Analysis and Processing

The normality of the morphometric data of okra and lettuce as well as the homogeneity of variances were tested beforehand using Shapiro-Wilk test [33] and Levene test [34], respectively. All analyses and data processing were done with R software version 3.6.1. The distribution of the data was normal and the variances were homogeneous for all morphometric parameters. Therefore, Student's t test was used to compare the means of each parameter between treatments with a significance level of 5%. Indeed, the t test is used to determine a significant difference between two groups of samples when the variances of the dataset are homogeneous. It used for testing whether both samples and groups are affected by a process.

3. Results

3.1. Physico-Chemical Parameters

The mean water temperature is significantly higher for the river water (T2) compared to the fishpond water (T1) (**Figure 3(a)**). For dissolved oxygen, comparison of mean values reveals a significant difference (Student's t test; $p = 0.0039$). The mean dissolved oxygen concentration of the fish-breeding water was significantly higher than that of the river water (**Figure 3(b)**). Likewise, the mean pH of the fish-breeding water was significantly higher (Student's test; $p < 0.001$) than that of the river water (**Figure 3(c)**).

The comparison of the phosphorus content shows no significant difference between the fishpond water and the river water (Student's test; $p = 0.165$) (**Figure 4(a)**). With regard to the nitrate content, it is also significantly higher in the fish-breeding water compared to the river water (Student's test; $p < 0.0001$) (**Figure 4(b)**).

3.2. Morphometric Parameters of Okra

The length growth of okra stems was significantly higher for T1 compared to T2 (Student's t test; $p < 0.001$) (**Figure 5(a)**). Likewise, the diameter at the neck of okra was significantly higher for T1 compared to T2 (Student's t test; $p < 0.001$) (**Figure 5(b)**). The comparison of the number of leaves of okra did not show significant difference between treatments (Student's test; $p = 0.06158$) (**Figure 5(c)**).

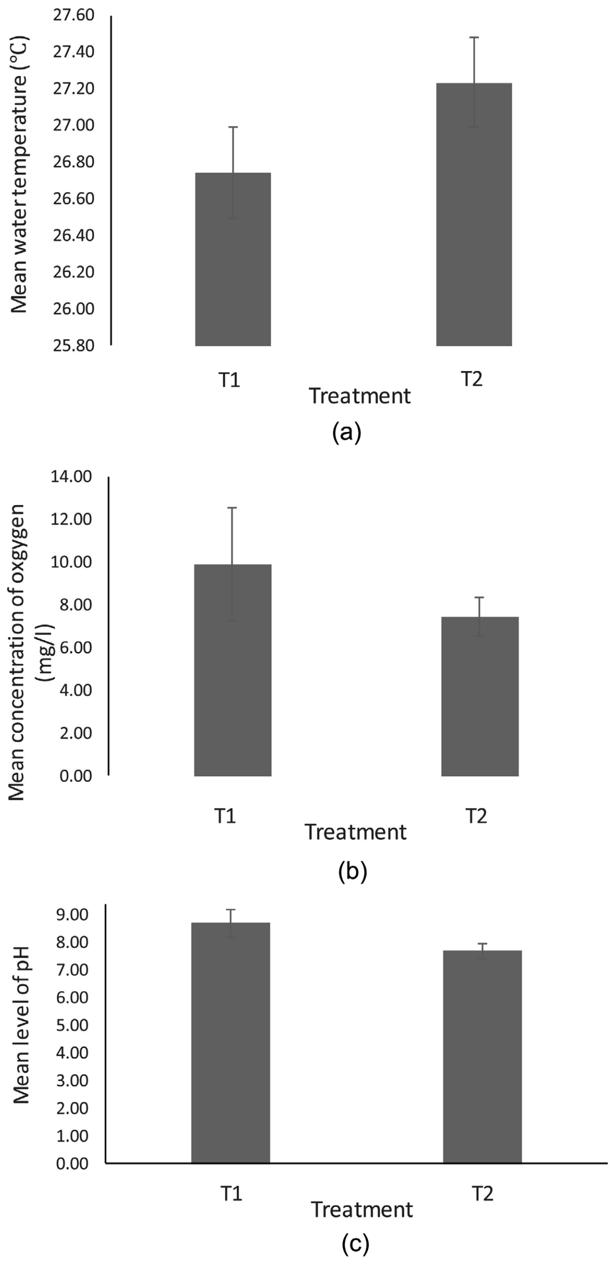

Figure 3. Comparison of temperature (a), dissolved oxygen (b) and pH (c) means between treatments.

Phenological traits marked by the appearance of the first flower were observed first in T1 plots compared to T2. In the T1 plots, the first flowers appeared at the forty-fifth day, while an increase in the number of flowers to more than one hundred (100) was observed at the fifty-second day after sowing. On the other hand, the plots treated with river water (T2) started flowering at day forty-seven before reaching 100 flowers at day fifty-three after sowing. However, the appearance of the first fruits was noted at forty-eighth days for T1 at line n˚3 and at plant n˚28. For T2, on the other hand, the first fruits appeared at the fiftieth day after semi on the line n˚1 and on the foot n˚8.

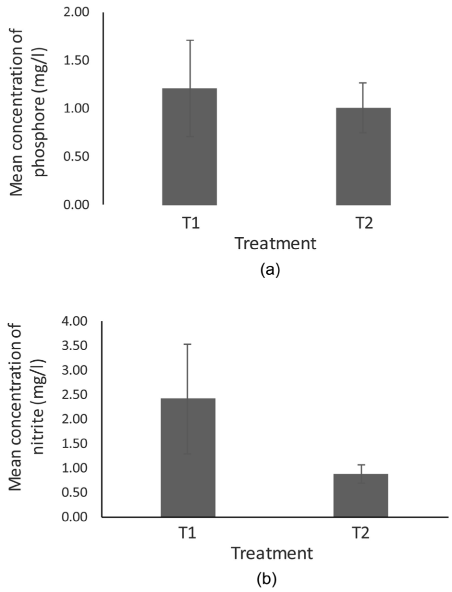

Figure 4. Comparison of phosphorus and nitrite means between treatments.

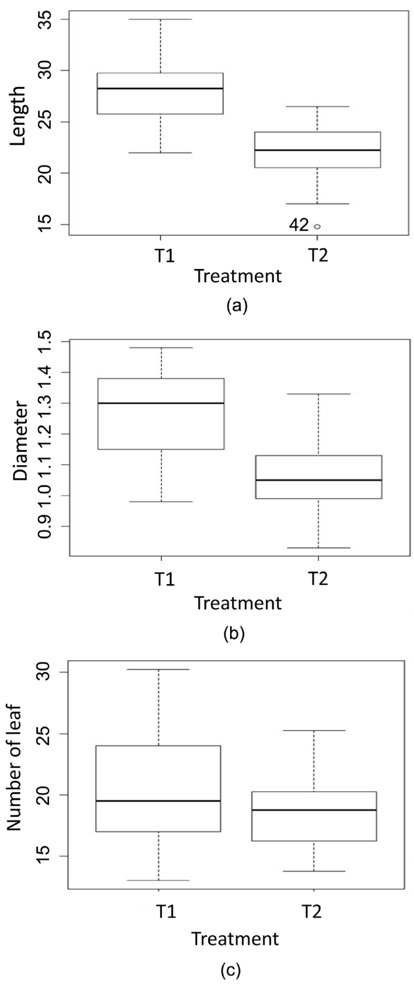

Figure 5. Comparison of means of stem length (a), crown diameter (b) and number of leaves (c) of okra between treatments.

3.3. Morphometric Parameters of Lettuce

Thus for lettuce, the plant length was overall higher for T3 (**Figure 6(a)**). Plant length of T3 was significantly higher than T1 (Student's test; $p < 0.05$; **Table 1**). The plant length of T3 was slightly higher than T2 and T4 although the differences were not significant (Student's test; **Table 1**). No significant differences in plant length were observed between T1, T2, and T4 (Student's test; **Table 1**).

For the plant width, overall the results revealed significant differences between treatments (Student's test; **Table 1**). The plant width of T3 was higher than those in T1 and T2, but not significantly different from that of T4 (Student's t test; **Table 1**). On the other hand, the plant width was not significantly different between T1, T2 and T4 (Student's test; **Table 1**).

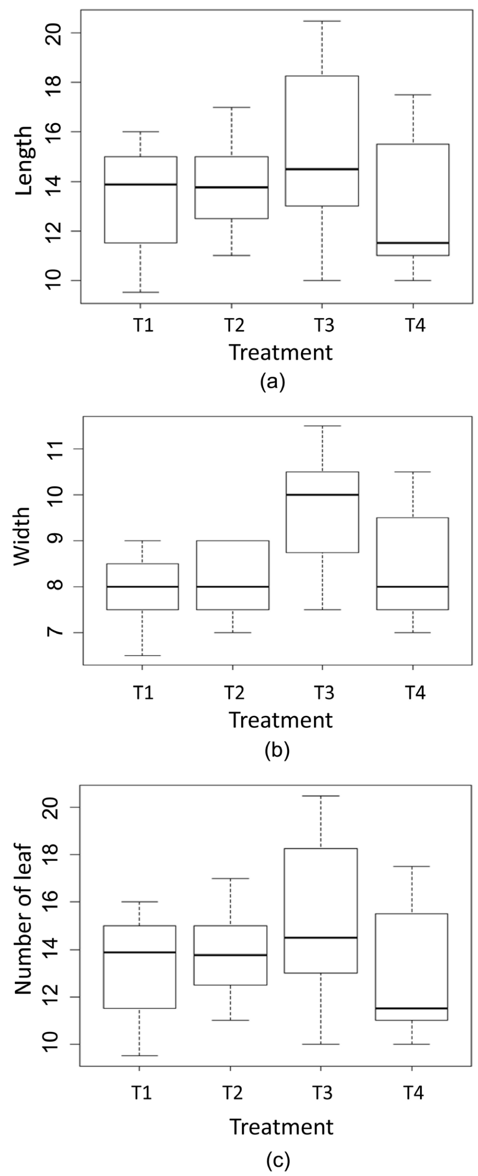

Figure 6. Comparison of means of lettuce plant length (a), width (b), and number of leaves (c) between treatments.

Table 1. Results of statistical tests of length (bottom of diagonal) and width (top of diagonal) of lettuce plants according to treatments.

	T1	T2	T3	T4
T1		0.534	0.0001429*	0.294
T2	0.534		0.0004384*	0.531
T3	0.048*	0.111		0.116
T4	0.582	0.283	0.116	

The comparison of the number of leaves showed that it was overall higher for T3 compared to the other treatments (**Figure 6(c)**). The number of leaves of the T3 plants was significantly higher than that of T2 (Student's t test; **Table 2**). However, it was not significantly different from those of T1 and T4 (Student's t test; **Table 2**). No significant difference in the number of plant leaves was observed between T1, T2 and T4 (Student's t test; **Table 2**).

3.4. Crop Yields in the Study

The evolution of harvest weight over time showed overall better okra production for T1 than for T2 (**Figure 7**). In general, for all samples taken, okra production was significantly higher for T1 than T2 (**Figure 7**). It increased for all treatments and reaches its maximum at the fourth sampling and then decreased at the fifth sampling (**Figure 7**). It varied slightly from the fifth sample for T2 until the last sample (**Figure 7**). Overall, for all samples taken, the yield of the crop was higher for T1 than for T2 (**Figure 7**).

Comparison of mean crop weight showed that total okra production was significantly higher for T1 than for T2 (**Figure 8**). Similarly, the yield of okra production was significantly higher for T1 (0.67 kg/m^2) compared to T2 (0.45 kg/m^2).

For lettuce, the evolution of the weight of the different samples taken was significantly higher for T3, followed by T1, T4 and T2, respectively (**Figure 9**). The average weight drops in the third sampling for all treatments and increased slightly in the fourth sampling with a superiority of T1 (**Figure 9**). During the last harvests, the evolution of the weight of the different treatments progressively decreased and became null towards the end of the harvest (**Figure 9**).

Overall, the comparison of the total harvest weight on lettuce production showed that it was significantly higher for T3 than the other treatments (**Figure 10**). As for the total harvest weight, the yield was significantly higher for T3 (3.34 kg/m^2), followed by T1 (1.89 kg/m^2) and lower for T4 (1.23 kg/m^2) and T2 (1.20 kg/m^2).

4. Discussion

The comparison of the averages of the growth parameters and the yields between treatments of the different speculations showed significant differences. Overall,

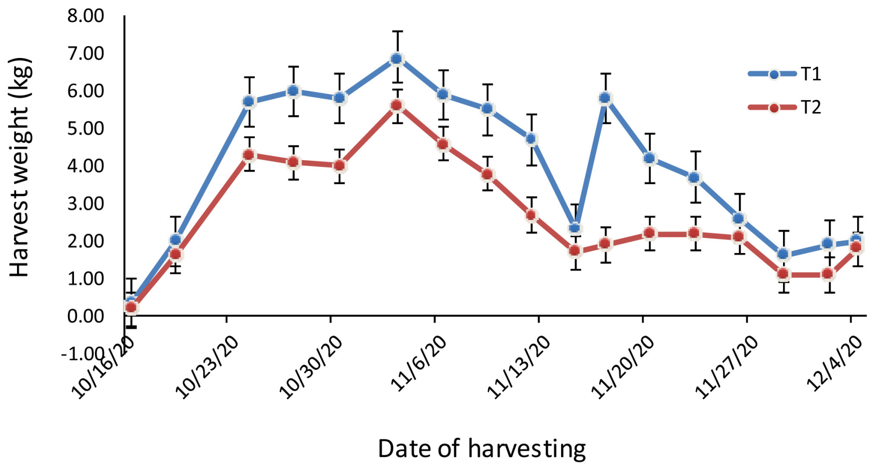

Figure 7. Okra production (in kg) according to harvest dates.

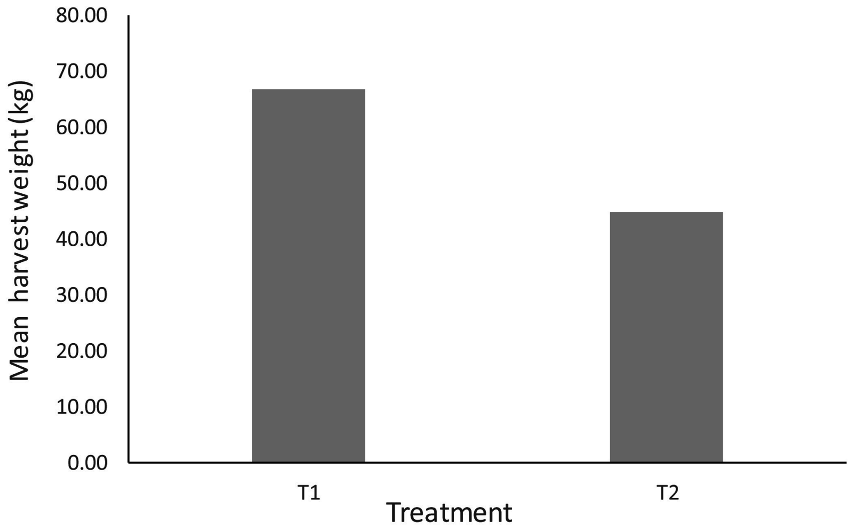

Figure 8. Mean weight of okra crops as a function of treatments.

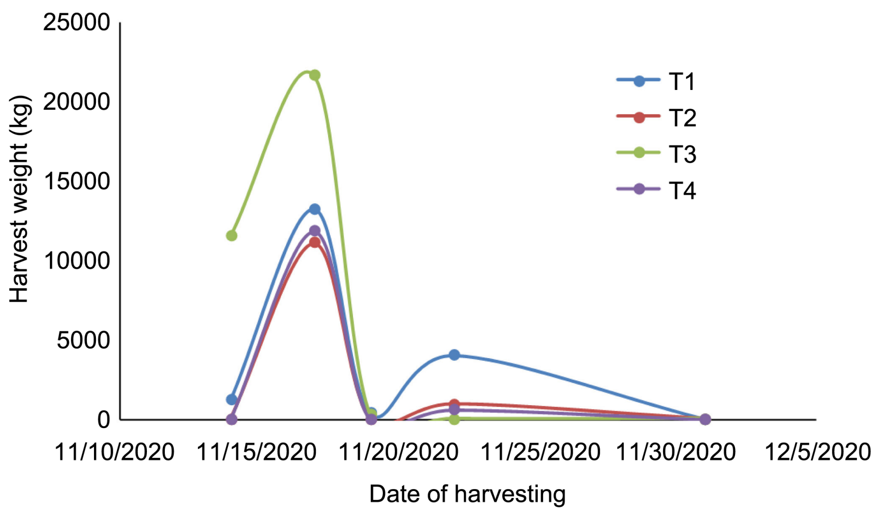

Figure 9. Lettuce harvest production (in kg) according to harvest dates.

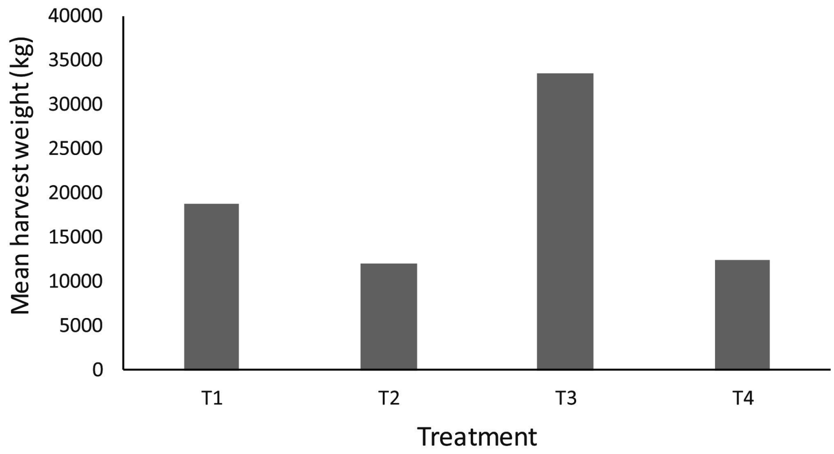

Figure 10. Mean weight of lettuce crops as a function of treatments.

Table 2. Results of statistical tests of the number of leaves of lettuce plants according to treatments.

	T1	T2	T3	T4
T1	0.534			
T2	0.360	0.04129*		
T3	0.851	0.117	0.116	
T4				

the plots that received fish-breeding water alone or fish-breeding water combined with poultry manure gave the best results compared to those treated with river water alone or river water combined with poultry manure. These differences in growth and yield cannot be explained by variations in the physico-chemical parameters measured. Indeed, the temperature of the fishpond water and the river water were not significantly different (Student's test; p = 0.6206), which indicates that it does not have a significant effect on plant growth. The average temperature of these waters (26.74˚C and 27.23˚C, respectively), are in the range of values (20˚C - 27˚C) favorable for optimal growth of okra. This interpretation is in agreement with that of Amel *et al.* [35], who demonstrated that okra requires a temperature above 20˚C for normal growth and development. Furthermore, the best periods for optimal growth and development of okra are the warm and humid seasons [36] where the average temperature hovers around 26˚C - 28˚C, which is consistent with our results. As for lettuce, it is one of the vegetable crops that prefer cool and rainy seasons. However, the Sativa Lactuca variety is an Iceberg type variety that shows an excellent performance under hot weather conditions. Indeed, its vegetative growth is optimal at temperatures ranging from 20˚C - 25˚C, although maximum temperatures of 25˚C - 30˚C, are tolerable [37]. Our results are also similar to those of an organic field crop in the Lodève region [38] which shows that lettuce needs warm and dry temperatures during its maturation.

The results obtained in this study show that the yield and growth parameters are better for the fish-breeding water treatments and those combining fish-breeding water and poultry manure. Thus our results on okra particularly showed a difference in flowering at 50% of plants between treatments. Indeed, the appearance of the first flowers and fruits was observed first for the T1 treatment (fish-breeding water) compared to the T2 treatment (river water) with an interval reduced by one day. These observations on phenological traits are consistent with those of Beniest *et al.* [39] which indicate that okra prefers organic-rich, light, and easily drained soils.

Like okra, lettuce prefers soils rich in organic matter, especially nitrogen [39]. This is because nitrogen in nitrate and phosphorus play a key role in plant and animal life [40]. In addition to being an essential element for plant growth, nitrogen is taken up by plants in the form of nitrate ion (NO_3^-) and ammonium ion (NH_4^+) through their roots [41]. Thus, the higher nitrate and phosphate levels in the fish-breeding water (2.41 vs. 0.88 and 1.21 vs. 1.00, respectively) that yielded the best growth and yields, demonstrate the importance of these elements on the survival and growth of okra and lettuce. Although inorganic element measurements were not made, poultry manure is important source of ammonia and phosphorus. The latter could contribute to the better growth and yield of lettuce obtained with the treatments combining fish-breeding water and poultry manure. Our results are similar to those of trials on the role of phosphorus and nitrogen on the growth of herbs [42]. Indeed, these authors show that these elements (phosphorus and nitrogen) are responsible for plant elongation, stem diameter enlargement and leaf size increase. It has also been shown that nitrogen supply has a significant impact on the yield of vegetable crops and that in poultry manure, it is in the form of ammonium that can be easily used by plants [41]. Furthermore, our results are consistent with those of a study conducted in South Asia on fruits and vegetables grown on land fertilized with poultry manure and irrigated with fish-breeding water [43]. Indeed, complementary compost inputs are necessary to balance the fertilization of arable land and only soils amended with high doses of composts can accumulate a lot of organic matter and important reserves of fertilizing elements [44] [45] [46]. In summary, our results show that treatments with fish farm wastewater alone or combined with organic compost (poultry manure) give the best growth and yields for okra and lettuce production.

5. Conclusion

Despite the major challenges facing the Senegalese agricultural sector as a whole, adaptation and adoption of new techniques can change the way this agriculture is perceived as a true driver of inclusive economic growth. Indeed, integrated farming systems could be an alternative that would address development concerns in general and significantly enhance farmers' efforts in particular. Thus, this study which is part of an agroecological approach has shown the importance of wastewater from fish farming and industrial poultry manure in agricultural production. Indeed, the okra and lettuce crops treated with fish-breeding water alone and with fish-breeding water combined with composted poultry manure show the best zootechnical performances and the best production yields. The date of appearance of the first flowers and fruits, and the attainment of 50% of flowering and fruiting show a favorable effect of the fish-breeding water on the development of okra compared to the river water. In general, the results on the morphometric characteristics of the lettuce show that there are significant differences in favor of the plants of the plots having received the T3 treatment (fish-breeding water combined with manure) and the T1 treatment (fish-breeding water alone). These results show that fish farm water and poultry manure can boost the productivity of okra and lettuce and would therefore be a real asset to stimulate agricultural development in Senegal, a country with an agri-livestock vocation. Thus, the results of the study can be considered satisfactory and would open the way to new research perspectives in order to enhance and make more available the organic matter (fish and agricultural residues, manure, etc.) in crops and to reduce production costs throughout the agricultural chain. From a perspective, the adoption of an agro-ecological approach integrating fish farming and animal husbandry, could allow an increase in production in strict respect of the environment. Thus, the development and financing of integrated research projects would constitute a lever to support the actors of the agricultural chain, which could in the long term allow to reach self-sufficiency and food security. This approach should be supplemented by the implementation of a local agricultural policy that would convince the actors of its importance. This will involve making the different agricultural actors aware of the results of such studies and of the importance of surface water on irrigated agriculture in a context of climatic hazards and widening the tests by integrating the different agricultural activities (agriculture, fish farming, poultry farming).

Acknowledgements

The authors thank the Gaston Berger University for allowing and supporting this study.

Conflicts of Interest

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

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