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# PROFITABILITY OF FERTILIZER USE IN PINEAPPLE PRODUCTION IN BENIN

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## ABSTRACT

With a contribution of 4.3% to agricultural gross domestic product (GDP) behind cashew (7.4%) and cotton (25%), pineapple has become the third export crop in Benin. However, its yields are still below the potential. Sub-optimal potassium/nitrogen (K/N) ratio in fertilizer use is leading to low fruit quality and limited market outreach. Therefore, an experimental research project was implemented to determine an optimal fertilizer use practice. This paper compares the profitability of the best experimental fertilizer use practice with that of farmers' practices using relevant indicators. Experimental and socioeconomic data were collected from 89 randomly selected pineapple growers among 5381 growers in Zè district. The findings revealed that fertilizer use had a positive marginal effect on pineapple production with both practices. Most importantly, the experimental practice was 2-3 times more profitable than farmers' fertilizer use practice and could be recommended. The rate of pineapple's response to fertilizer almost doubled from 13.42 kg fruit/kg fertilizer with farmers' practices to 23.07 kg fruit/kg fertilizer with the experimental practice. While the profit rate of pineapple production was almost the same (86%) without fertilizer use in both practices, it rather increased more than 2-fold with the experimental practice, reaching 290% against 121% with farmers' practices. Fertilizer use therefore enabled pineapple production profitability to increase from 39% with farmers' practices to 238% with the experimental practice. This practice doubled the marginal effect of fertilizer use and doubled the classic value/cost ratio. However, farmers cannot yet harvest the promised gold as only 1% among them presently apply that high-dose best practice. Labour availability and costs for fractioning the optimum dose over the crop's growing cycle remains a challenge. Further, pineapple's high perishability is another challenge which calls for building strong value chains to enable growers readily direct their harvests to more rewarding markets. Further research is still needed to factor those constraints' alleviation into determining the "real" or affordably relevant optimal doses of fertilizer on pineapple in poor farming settings as the Zè district of Benin. Growers' perceptions on innovative practices and their own financing strategies will be critical to foster the adoption of improved fertilizer use technologies and boost agricultural productivity in Benin. In the meantime, access to credit and off-farm activities are likely to enable a larger adoption of the optimal dose.

**Key words:** fertilizer use, pineapple production practices, adoption, marginal profit, value-cost ratio, poverty reduction

## INTRODUCTION

Agriculture in Benin accounts for about 70% of labour force, 33% of Gross Domestic Product (GDP), 75% of export revenue and 15% of tax revenue [1]. Cotton dominates the sector, representing 40% in export revenue and 13% in Gross Domestic Product. However, its production and farmers' income declined drastically during 2005-2010, before recovering with World Bank-supported subsector reforms [2]. Since 2013, the Bank also supported the implementation of the agricultural diversification program (ProCaD), with focus on promoting maize, rice, pineapple, cashew (cashew nut) and aquaculture value chains [3]. Cashew and pineapple received a particular attention as far as export revenue diversification is concerned, while other projects promoted soya bean. As of November 2016, 74,000 tons of pineapple were exported from the project area, against 30,000 tons forecasted for December. Average yield reached about 60 t/ha, as expected [4]. Pineapple (*Ananas comosus* L. Merill) is the second most important exotic fruit after bananas and contributes 20% to world production of tropical fruits. In 2015, main producers in Africa include Nigeria (1.5 million tons/year), Kenya, Angola, Cameroon and Guinea totalling 3 million tons/year, behind leading producers (Philippines 2 million, Thailand 1.8 million, and Costa Rica 1.7 million) in the world [5].

Benin is not yet a main pineapple producer in Africa; however, it produces the sweet-and-sour yellow-skin variety *"Cayenne lisse"*, which is the most exported, besides the *"Pain de Sucre"* which accounts for 80% of total area planted to pineapple in the country [6]. It is the case because *Cayenne lisse* requires more care and more work to respond to export quality requirements.

For both pineapple varieties, although growers have been increasing the dose of applied mineral fertilizers over the last decade, their fertilizer use practices remained inadequate and soil fertility kept declining. Apart from their traditional financial constraints, farmers just simply don't know the best practices. Updated fertilizer recommendations are not available for pineapple and no relevant mineral nutrition management scheme is available so far from research or extension services in Benin [7]. Oftentimes, uniform fertilizer recommendations elsewhere are counterproductive, as they ignore the socioeconomic diversity of farmers and the agroecological differences across agricultural regions [8].

In the face of declining soil fertility in West African countries, fertilizer use intensification has become necessary to improve crop yields and overall productivity of existing farm lands. Fertilizing crops, using the right methods, increases crop yields while improving soil health. Fertilizer application should respect specific conditions (doses, methods and time depending on crops and soil types), while preserving the health of consumers and the environment [9].

However, since the 2006 Fertilizer Summit of Heads of State and Government in Abuja (Nigeria), the adventures of different countries in the subregion and the continent are diverse, so that the average fertilizer use intensity is today about 15 kg of products per ha of arable land, against 45 in Asia and more than 150 in Europe, while more than two


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thirds of African countries are still far below their needs [10]. The profitability of fertilizer use in crop production is at stake [2, 11].

Benin farmers' fertilizer use practices on pineapple do not obey the potassium/nitrogen (K/N) ratio, which should be in the range 2-2.5 over the crop's entire growing period [12]. In order to address that issue, a research project was implemented by the West African Agricultural Productivity Project (WAAPP/PPAAO) under the ProCaD program. The project aimed to determine the best fertilizer practice (doses and number of applications) that should be recommended to pineapple growers. The project aimed to improve pineapple's yield and quality through a good K/N ratio in fertilizer application. Fertilizer trials were done in farmers' fields in Zè and Toffo districts.

This paper compares the profitability of the best experimental fertilizer use practice derived from field trials' response curves, with farmers' practices obtained from socioeconomic surveys. Farmers' practices of fertilizer use result from trial-and-error experiences, and are not based on any recommendation from research or extension services.

Productivity and income gains, and increases in profit rate that farmers would expect from adopting the best experimental practice was assessed, as well as the prospect for them to harvest the expected gold. The latter refers to earnings from the growing exports of yellow-flesh pineapple.

## METHODOLOGY

### Area of study and sample selection

The study area is the Allada plateau of Benin, located 6°25' and 7°30' N; 2° and 2°30' E in the Guinean zone of the country. The WAAPP/PPAAO fertilizer research project investigated fertilizer use among pineapple growers in five districts (Zè, Toffo, Tori-Bossito, Allada and Abomey-Calavi). The districts were purposively chosen taking into account the extent to which the technical itinerary of pineapple production was practiced, from planting to harvesting. Using the Dagnelie random sampling method [13], the project selected a total of one hundred and fifty-one (151) pineapple growers from a list of 9111 growers across the districts. The present paper concerns the Zè district where the population of pineapple growers is 5381, representing 59% of all growers and 11% of all farmers in the study area. A sub-sample of 89 growers among the above 151 were considered for the analysis, based on that district's largest share of growers compared to other districts, but also the quality of socioeconomic data. Indeed, in that sub-sample, there were less missing data and outliers with regard to reference values of certain variables such as the fertilizer dose applied by growers and labour use.

### Methods of data collection and analysis

Experimental fertilizer application data were obtained from field trials, while farmers' practice were part of socioeconomic data collected through farmers' household surveys. The trials aimed to identify the best practice adapted to the soils and that meets pineapple quality requirements.



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The experimental design (Figure 1) was a complete randomized block design with 17 treatments, including the absolute control (no fertilizer) and the relative control (average fertilizer dose in farmers' practices), and 4 replications. Two factors were studied, namely the mineral fertilizer dose factor with 5 levels corresponding to the following doses (NPK) per plant: D1 (5.52-2.42-12.45), D2 (3.68-2.42-8.3), D3 (5.52-2.42-8.3), D4 (3.68-2.42-12.45), D5 (6.44-6.08-8.96); and the splitting or fractionation factor with 3 levels: 3 splits (F3), 4 splits (F4), and 6 splits (F6). The combinations of doses and fractionations make the treatments T1 to T15 (Table 1). T0 is the absolute control with no fertilizer, T15 is the recommendation from extension services and T16 is the relative control or farmer's fertilizer use practice with the dose per pineapple plant D6 (2,13-0,75-2) and three splits (F3). Thus, there were 17 treatments comprising 15 treatments with the doses D1-D5 plus two controls (the absolute control and the farmer's practice or relative control) applied in 3 splits. The doses are detailed in terms of fertilizer NPK formula as: D1 (276-121-622.5), D2 (184-121-415), D3 (276-121-415), D4 (184-121-622.5), D5 (322-30.4-448.2) and D6 (106.7-37.6-100). D1 (NPK 276-121-622.5) to D4 (NPK 184-121-622.5) were derived from the combinations of the optimal doses of nitrogen, phosphorus and potassium obtained earlier from the response curve test done during phase 1 of the project, making sure the K/N ratio was between 2 and 2.5 as recommended [14, 15].

The response curve test was performed using single fertilizers (urea, TSP and $K_2SO_4$), and separate randomized complete blocks for each type of fertilizer, before the results were factored into the fractionation trials where the three types of fertilizers were combined.

Regarding socioeconomic data, 89 pineapple growers randomly selected as mentioned earlier, were interviewed using a questionnaire to elicit their sociodemographic characteristics (age, sex, household size), farm characteristics (area cultivated, type of grower, experience in pineapple production, labour force, annual income), and their fertilizer use practices (types and applied dose of fertilizers, number and timing of applications).

Thirteen (13) group discussions were also held to cross-check some responses from the sample individuals, besides eliciting many other socioeconomic information for the WAAPP/PPAAO fertilizer project. The profitability of the best experimental practice of fertilizer use, compared with farmers' practices, was assessed using the marginal effect of fertilizer use on yields, the increase in overall farm profit rate due to fertilizer use and the traditional value/cost ratio (VCR).



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| Block 1 | Block 2 | Block 3 | Block 4 |
|---|---|---|---|
| T2 | T3 | T10 | T9 |
| T0 | T5 | T1 | T6 |
| T4 | T14 | T12 | T10 |
| T16 | T2 | T15 | T11 |
| T11 | T7 | T2 | T5 |
| T6 | T0 | T16 | T14 |
| T1 | T13 | T6 | T3 |
| T8 | T4 | T0 | T12 |
| T15 | T1 | T4 | T7 |
| T3 | T9 | T8 | T1 |
| T10 | T11 | T3 | T4 |
| T5 | T6 | T14 | T15 |
| T13 | T16 | T5 | T13 |
| T7 | T8 | T9 | T2 |
| T12 | T10 | T11 | T16 |
| T9 | T12 | T13 | T0 |
| T14 | T15 | T17 | T8 |

2 m

✸ Space between plots = 1.5 m

**Figure 1: The complete randomized block experimental design**

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## RESULTS AND DISCUSSION

Table 2 shows a few among growers' characteristics and the fertilizers doses they applied, and Table 3 summarizes the characteristics by types or categories of growers. The results revealed that women represented only 10% out of 89 growers in our sample (against 22% in the whole research project zone [7]). In the sample, they were all small growers and accounted for 12% of that category. This could be explained by the fact that, compared to other food crops, pineapple requires more financial resource (average production cost with fertilizer was 2 million FCFA/ha in farmers' practices) and more physical effort, which women cannot afford. Indeed, unlike classic sowing of grains in standing position, planting pineapple requires that one bends completely and squats to fix each cutting on the ground, over a pineapple plantation density of 45000-50000 plants per ha in farmers' fields. Women lack the required resources and would also find it difficult to combine heavy works in pineapple farms with the drudgery of domestic activities. Another reason is women's limited access to land [16, 17, 18].

Small growers represent 83.14% of the sample and cultivate less than 1 ha in a growing season, medium-size growers 12.35% and 1-3 ha, and large growers 4.51% and more than 7 ha. Corresponding sizes of pineapple farms in the project area were 0.4-1 ha, 0.8-1.2 ha and 2-4 ha respectively. Small growers face investment limitations, especially the unavailability of plant material and financial resource. A previous classification of pineapple growers on the Allada plateau based only on planted area, indicated that large growers contributed 80% to total pineapple income, against 30% and 50% respectively for small and medium-size growers [4]. Large growers produce mainly pineapple and therefore devote large labour force and large amount of fertilizers to that crop.

The experimental results showed that treatments T2 (276-121-622.5) and T14 (322-30.4-448.2) gave the best yields. Yet, Treatment T2 was the best one, with an optimum fertilizer application formula of 276N-121P-622.5K, corresponding to the dose of 2700 kg/ha of fertilizers (Urea, Triple Super Phosphate (TSP) and Potassium Sulphate ($K_2SO_4$)) applied in 4 splits or fractionations. Pineapple's growing cycle lasts 14 to 18 months. Growers usually apply fertilizers in three splits on average. The dose of fertilizers in farmers' practices varies a lot with the type of growers (Figure 2). The average is D6 (106.7-37.6-100), corresponding to 657.36 kg of fertilizer per ha. Small-size growers use on average 398 kg/ha of urea against 1339 kg/ha for medium-sized growers and 2112 kg/ha for large growers. Corresponding amounts were 54 kg/ha, 248 kg/ha and 681 kg/ha for potassium sulphate, and 325 kg/ha, 1195 kg/ha and 2656 kg/ha for NPK 10-20-20. Most growers use NPK 10-20-20; only a few use potassium sulphate. Their average income was about 900 000 FCFA/ha per growing season.

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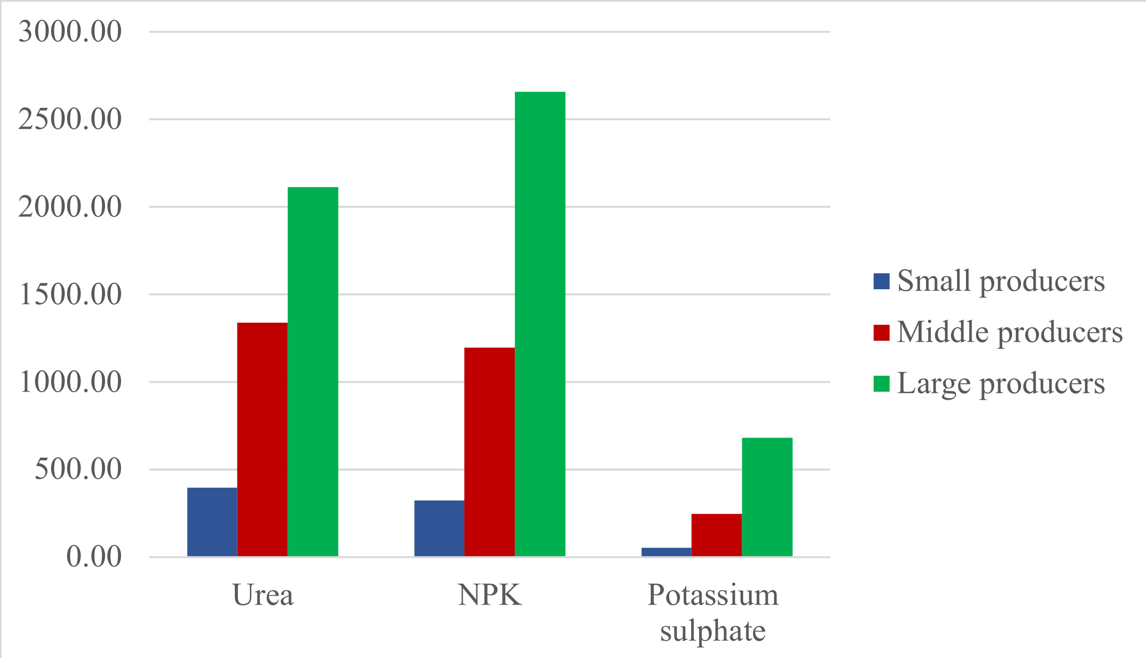


**Figure 2: Doses of various fertilizers applied on pineapple by types of growers in Zè district**
***Source: Socioeconomic data, WAAPP/Pineapple research project***

Earlier before the project, farmers were not using the appropriate fertilizers for pineapple production. With fertilizer, their average pineapple yield was 43 339 kg/ha against 30 990 kg/ha without fertilizer, that is 39.8% increase (Table 4). Corresponding figures for the best experimental practice were 93 076 kg/ha, 30 781 kg/ha and 202.4%. Therefore, yield gains from fertilizer use were multiplied by more than 5 with the best experimental practice, compared with farmers' fertilizer use practices. Unlike with the latter, pineapple's nutrient requirements were met better, while experimental fields were well maintained and monitored. This result is in agreement with those of [18, 19] who found similar results with pineapple in Nigeria.

With farmers' practices, the increases in pineapple yield due to fertilizer use is comparable with previous results on various crops in West Africa: 36% for rice in Senegal with good fertilizer use management and weeding [20]; 20 to 80% for oil palm and yam in Côte d'Ivoire [21, 22]. Integration of different soil fertility management methods and handling labour stress in fertilizer application will be useful to ensure a sustainable improvement in crop yields and farmers' incomes [23, 24]. In Benin, "Integrated Pest Management (IPM) combined with Integrated Soil Fertility Management (ISFM)" enabled cotton yield to increase by 82%, and was found to be economically more cost effective than conventional cotton production [25].

Pineapple's response rate to fertilizer (additional yield per kg of applied fertilizer) almost doubled from 13.42 kg fruit per kg fertilizer with farmers' practices to 23.07 kg fruit per

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kg fertilizer with the experimental practice. While the profit rate of pineapple production was almost the same (86%) without fertilizer use in both practices, it rather increased more than 2-fold with the experimental practice, reaching 290% against 121% with farmers' practices. Fertilizer use therefore enabled pineapple production profitability to increase from 39% with farmers' practices to 238% with the experimental practice (Table 4). This practice doubled the marginal effect of fertilizer use and doubled the classic value/cost ratio.

Sohinto [26] and Sodjinou *et al.* [27] found that pineapple production in Benin was profitable both with and without fertilizers. But they only analysed fertilizer data from farmers practices, and found a value/cost ratio of 5.56. With the optimal dose of the WAAPP/pineapple research project, a much higher value/cost ratio of 9.56 (Table 4) is obtained, indicating that the experimental practice was by far more profitable. Considering again our results, the profit rate either with farmers' practice or with the experimental practice are far beyond the 56% increase in net income cotton farmers could get from using the above-mentioned IPM-ISFM technology. Indeed, cotton inputs were so expensive and cotton buying prices so low and variable overtime that little room was left for profit.

Overall, whichever profitability indicator is considered, the experimental practice of fertilizer use on pineapple was by far more beneficial than farmers' practices. However, the experimental practice can be used only if enough financial resources are available to growers. Lower profit ratio with farmers' practices could be also due to shortage of improved planting materials, weak production technology, and high perishability of the crop which led to low output price [19]. In West Africa in general, despite its potential or proven benefits, the use of mineral fertilizer is not systematic among farmers. The technical efficiency and economic viability of fertilizer use depends not only on applied fertilizer doses, but also on the physical and socio-economic conditions of the different adoption environments that govern the choice of fertilizer use options [11].

Figure 3 presents the proportion of pineapple growers by range of applied fertilizer dose. Only 1% of growers apply more than 2500 kg/ha of fertilizer and would likely adopt the experimental optimal dose of 2700 kg/ha that gave the highest yield. About 80% apply less than the optimal fertilizer dose, 70% applied 1350-1999 kg/ha of fertilizers and 2% applied 2000-2500 kg/ha. It is necessary to know the prospects for pineapple growers to harvest the income gains promised by the above-assessed best experimental fertilizer use practice.

The high proportion of growers still applying less than 2500 kg/ha, for example the current low use of the optimal dose, is probably due to the lack of credit, lack of training and the long growing cycle of pineapple (16-24 months depending mainly on size of pineapple cuttings and suitability of weeding) which does not allow farmers to buy enough fertilizers. The latter reason pertains to the increased time and cost of crop husbandry and the related increased interests on loans. Considering the high profitability of fertilizer use in pineapple production, the 2% and 17% of growers who applied, respectively 2001 – 2500 kg/ha and 1350 – 2000 kg/ha will likely follow the 1% applying


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more than 2500 kg/ha. Therefore, in the short term, 20% of growers are expected to move upward to the dose of 2700 kg/ha of the best practice with quite little or no support and will harvest the promised gold.

The remaining 80% will need a dedicated support, especially credit. The 58% who apply 501 – 1500 kg/ha would need greater support (training, extension and credit). On the contrary, the 22% who apply less than 500 kg/ha are unlikely to harvest the promised gold in the next 10 years, unless a special support program for fertilizer use intensification in pineapple production is implemented. The program should also address the issue of market access for pineapple, as the average producer price in Benin was as low as 80 FCFA/kg in 2017 against 140 FCFA/kg in Côte d'Ivoire [28]. In the study area, however, an average producer price of 116 FCFA/kg was prevailing in 2015 when the experiments were conducted. Anyway, without such a program, the latter growers should be advised to quit pineapple production and shift to a more rewarding crop or business in order to make a better use of their time and resources.

The above projections are based on our knowledge about fertilizer adoption on food and non-food crops in Benin [6, 2, 25]. They are also drawn from the trends in fertilizer use in West Africa since the Abuja Declaration in 2006 [15, 17].

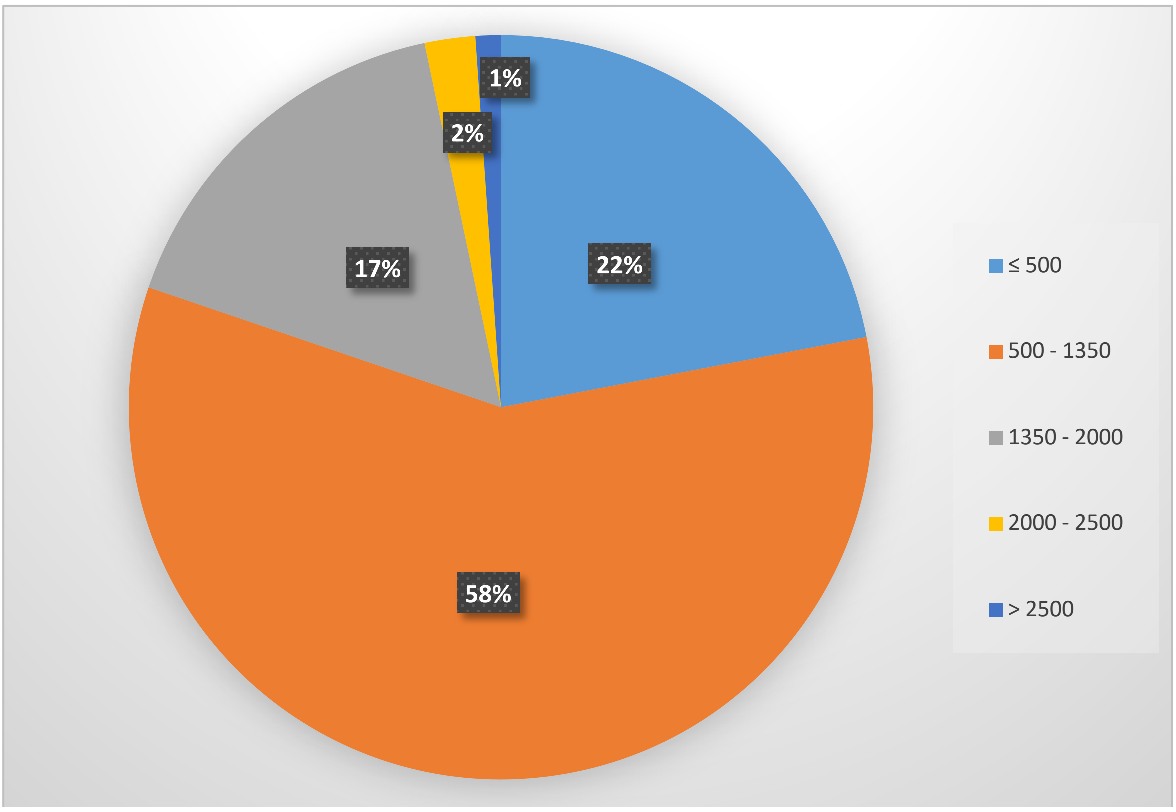


**Figure 3: Proportion of pineapple growers by range of applied fertilizer dose**
***Source: Socioeconomic data, WAAP/Pineapple research project***

## CONCLUSION

The results of the study show that the use of mineral fertilizer on pineapple has a positive effect on yield and net income, both with farmers' practices and experimental practices. In particular, the best experimental practice promised to boost yields and net incomes 2-fold the average pineapple response to fertilizer with farmers' practices. The marginal effect of fertilizer use on net income is also multiplied by two. All the indicators of fertilizer use profitability (net farm income/ha, overall farm profit rate, marginal effect, and value-cost ratio) showed unequivocally that the best experimental practice really promises gold to pineapple growers far beyond their own practices. The best practice could be recommended to growers to allow them substantially increase their incomes, not just for poverty reduction but for wealth creation. However, the great challenge remains the adoption of that fertilizer recommendation. Undoubtedly, growers will require access to credit to apply the high dose of 2700 kg/ha of the said "optimal" or "best practice". Indeed, the prospects for harvesting the gold are still lean as only 3% of growers presently apply a dose closer to that optimum and no more than 17% applying 1350-2000 kg/ha will be disposed to reach that level in a near future. Labour availability and costs for fractioning the optimum dose over the crop's growing cycle remains a challenge. Further, pineapple's high perishability is another challenge which calls for building strong value chains to enable growers readily direct their harvests to more rewarding markets.

Further research is still needed to factor those constraints' alleviation into determining the "real" or affordably relevant optimal doses of fertilizer on pineapple in poor farming settings as the Zè district of Benin. Growers' perceptions on innovative practices and their own financing strategies will be critical to foster the adoption of improved fertilizer use technologies and boost agricultural productivity in Benin. Substantial wealth creation, alongside poverty reduction among farmers should be sought through the development of sustainable value chains.

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**Table 1: Description of treatments in the fertilizer experiments on pineapple in Zè district**

| Treatments | Fertilizer formulae ($N-P_2O_5-K_2O$) kg/ha | Total fertilizer dose (kg/ha) | Quantity per type of fertilizer (kg/ha) | | | Number of fractionations (F) |
|---|---|---|---|---|---|---|
| | | | Urea | TSP | $K_2SO_4$ | |
| T0: Absolute control | 0 | 0 | 0 | 0 | 0 | 0 |
| T1 | (276-121-622.5) | 2700 | 600 | 600 | 1500 | 3 |
| T2 | (276-121-622.5) | 2700 | 600 | 600 | 1500 | 4 |
| T3 | (276-121-622.5) | 2700 | 600 | 600 | 1500 | 6 |
| T4 | (184-121-415) | 2000 | 400 | 600 | 1000 | 3 |
| T5 | (184-121-415) | 2000 | 400 | 600 | 1000 | 4 |
| T6 | (184-121-415) | 2000 | 400 | 600 | 1000 | 6 |
| T7 | (276-121-415) | 2200 | 600 | 600 | 1000 | 3 |
| T8 | (276-121-415) | 2200 | 600 | 600 | 1000 | 4 |
| T9 | (276-121-415) | 2200 | 600 | 600 | 1000 | 6 |
| T10 | (184-121-622.5) | 2500 | 400 | 600 | 1500 | 3 |
| T11 | (184-121-622.5) | 2500 | 400 | 600 | 1500 | 4 |
| T12 | (184-121-622.5) | 2500 | 400 | 600 | 1500 | 6 |
| T13 | (322-30.4-448.2) | 1930.74 | 700 | 150.74 | 1080 | 3 |
| T14 | (322-30.4-448.2) | 1930.74 | 700 | 150.74 | 1080 | 4 |
| T15: Extension rec. | (322-30.4-448.2) | 1930.74 | 700 | 150.74 | 1080 | 6 |
| T16: Farmer's practice | (106.7-37.6-100) | 657.36 | 231.95 | 184.45 | 240.96 | 3 |

Note: Fertilizer fractionations of the total dose is: F3 = 3 splits, F4 = 4 splits, F6 = 6 splits.

Source: WAAPP/Pineapple research project



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**Table 2: Pineapple growers' household characteristics and applied fertilizer doses**

| Variables* | Values (min – max) |
|---|---|
| Age of pineapple grower (years) | 37 – 54+ |
| Household size (number of individuals) | 5 – 19+ |
| Labour force in household (number of individuals) | 5 – 19+ |
| Area cultivated to pineapple (ha) | 1 – 7+ |
| Experience in pineapple production (years) | 5 – 19+ |
| Estimated annual income from pineapple production (CFA) | 903 581 – 12 000 000 |
| Dose of applied urea (kg/ha) | 397.8 – 2 112.5 |
| Dose of applied potassium sulphate (kg/ha) | 53.6 – 681.2 |
| Dose of applied fertilizers (Urea + TSP + Potassium Sulphate) (kg/ha) | 325.2 – 2 656.2* |

* Pineapple grower used to apply fertiliers in this range of doses.

Source: Socioeconomic data, WAAP/Pineapple research project

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**Table 3: Types/Categories of pineapple growers**

| Socioeconomic characteristics | Small growers* | Medium-size growers* | Large growers* |
|---|---|---|---|
| Proportion in the sample (%) | 83.14 | 12.35 | 4.51 |
| Proportion of women per category (%) | 12 | 0 | 0 |
| Age (years) | < 37 | 37 – 45 | ≥ 54 |
| Size of pineapple farm (ha) | < 1 | 1 – 3 | ≥ 7 |
| Pineapple growing experience (years) | < 5 | 5 – 9 | ≥ 21 |
| Labour force (number of persons) | ≤ 5 | 5 – 7 | ≥ 19 |
| Annual income from pineapple (million FCFA/ha) | ≤ 0.9 | 1.5 – 4.5 | 1.7 – 12 |
| Share of pineapple in agricultural income (%) ** | 30 | 50 | 80 |

* Small growers: Pineapple area less than 1 ha; Medium growers: Pineapple area between 1 and 3 ha; Large growers: Pineapple area more than 7 ha.

Sources: Field survey (2016), and ** [4]

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**Table 4: Comparative fertilizer use profitability analysis, experimental vs. farmers practices in Zè district**

| Variables of fertilizer use performance | Farmer's practice | | Experimental practice | |
|---|---|---|---|---|
| | Without fertilizer (a) | With fertilizer (I) | Without fertilizer (b) | With fertilizer (II) |
| ***Production variables*** | | | | |
| A. Production yield (Kg/ha) | 30 990 | 43 339 | 30 781 | 93 076 |
| B. Pineapple average producer price (FCFA/kg) | 116 | 116 | 116 | 116 |
| C. Dose of fertilizer applied (kg/ha) | 0 | 920 | 0 | 2 700 |
| D. Fertilizer average price (FCFA) | 0 | 280 | 0 | 280 |
| Y. Gross income (A*B), FCFA | 3 594 840 | 5 027 324 | 3 570 596 | 10 796 816 |
| E. Fertilizer cost (C*D), FCFA | 0 | 257 600 | 0 | 756 000 |
| F. Other costs (variable Costs + fixed costs), FCFA | 1 922 658 | 2 014 093 | 1 922 658 | 2 014 093 |
| G. Total production cost (E+F), FCFA | 1 922 658 | 2 271 693 | 1 922 658 | 2 770 093 |
| ***Indicators of fertilizer use profitability*** | | | | |
| Tr. Response rate of pineapple to fertilizer ($\Delta A/\Delta C$) | - | 13.42 | - | 23.07 |
| Rn. Net income or profit (Y-G), FCFA | 1 672 182 | 2 755 631 | 1 647 938 | 8 026 723 |
| Rp. Profit rate of the practice ($100 * \frac{Y-G}{G}$) , % Total production cost | 87 | 121 | 86 | 290 |
| Growth in profit rate due to fertilizer use $100*[(Rp_e-Rp_0)/Rp_0]$, % | - | 39 | - | 238 |
| Marginal effect of fertilizer use on net income ($\Delta Rn/\Delta G$) | - | 3.10 | - | 7.53 |
| Value/cost ratio of fertilizer use ($RVC = \frac{\Delta Y}{E}$) | - | 5.56 | - | 9.56 |

Source: Calculated using data collected from field survey in 2016

$Rp_e$ = Profit rate with fertilizer use; $Rp_0$ = Profit rate without fertilizer
In either case (farmer's practice or experimental practice), the same formula applies for growth in profit rate due to fertilizer use, but $Rp_e$ values are not the same



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