NO-TILL CONSERVATION AGRICULTURE EXPERIENCE IN GUINEA

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INTRODUCTION:

Program for Design, implementation and Skills Training for Conservation Agriculture technologies' in Guinea was carried out during 2019 within the framework of the project called: Technologies for the Transformation of African Savannah Agriculture (TAAT-s) of the African Development Bank (AfDB), with the cooperation of the Institute of Agricultural Research of Guinea (IRAG), the Presidential Initiative for Rural Development (IPADER) and the Argentine Association of No-till Farmers (AAPRESID).

Two Aapresid technicians developed soybean and maize crops in plots distributed in 4 localities: Faranah, Tiro, Kankan and Siguiri (image 5) in close collaboration with IRAG technicians. An Argentine machinery company supported the project with a no-till planter and Argentinian National Institute of Agricultural Technology provided theoretical work on water balances, crop simulation and modelling to enrich and improve the planning and conclusions from the empirical observations and field studies being presented here.

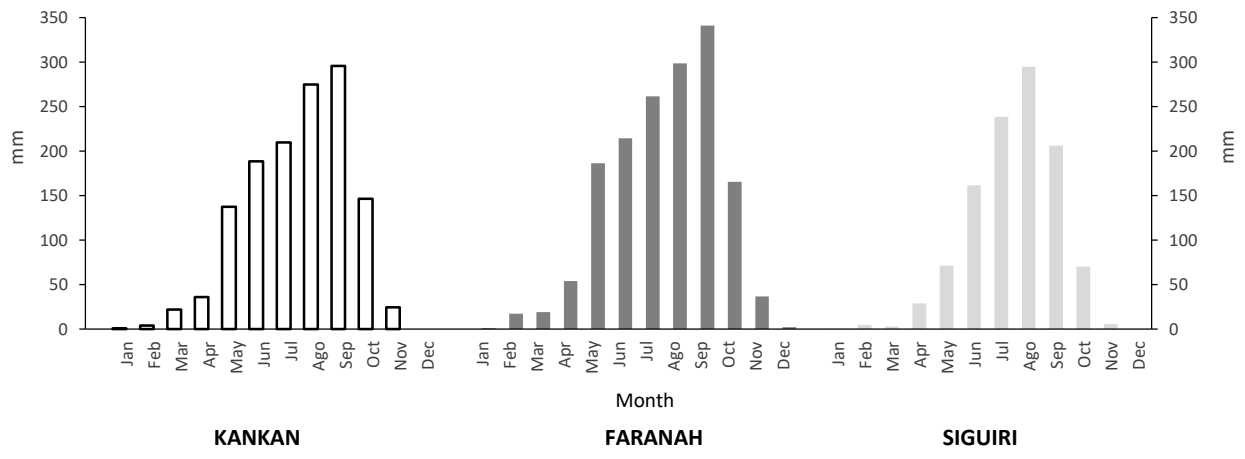
Aapresid's vision is guided by the objective of promoting sustainable production systems of food, fibre and energy through innovation, science, networking and knowledge management. This approach refers to the responsible and efficient use of the world's limited natural resources to maintain the demands of its growing population.

SITES' AGROECOLOGICAL DESCRIPTION:

The above mentioned sites are located in Upper Guinea, a geographical region formed by a vast low savannah (200-400 masl) with areas of forest and crossed by alluvial valleys arranged on the banks of the Niger River and its tributaries. Upper Guinea occupies just under 40% of the country's surface, and comprises two regions, Kankan and Faranah.

The relief is variable, but quite flat, the slopes rarely exceed 4% of inclination. Weather is characterized as tropical Sudanese, which has a very dry season with very low rainfall that can last from 6 to 8

Graph 1. Average monthly rainfall of the three sites for different periods according to the sources of rainfall data found.



Source: Own elaboration with data from Dr Makan Kouruma 2019 (Bordo, Kankan) Meteorologie Nationale de Guinee 2018 (Faranah Airport) FAO 2003 FAOCLIM 2.02: World-wide agroclimatic database software. Agrometeorology Group. Rome, Italy (Siguiri)

months, and a wet rainy season with rains varying from 1000 to 1700 mm per year, depending on the locality (graph 1). Upper Guinea has tropical temperatures, with an annual average that increases as one moves northeast, away from the sea and closer to the desert. It goes from almost 26 °C in Faranah, to reach an annual average of 28 °C in Siguiri. Regarding soils, first thing to note is the large heterogeneity found within Upper Guinea's soil types. Despite this, certain phenomena affect the whole soils in the region in a fairly generalized way: **a)** low chemical fertility, **b)** soil acidity, **c)** history of fires, and **d)** hydric erosion.

ON GROUND ACTIVITIES:

In the fields, activities started in June 2019. The challenge that arises when implementing and adapting technologies in no-till Conservation Agriculture is solved with the searching for the best balance of different good agronomic practices in a sustainable way.

Briefly these good practices could be presented as follows:

a. No-till. Planting without soil disturbance and under vegetal cover.
b. Crop rotation.
c. Balanced nutrition of soil and crops.
d. Scouting and Integrated Weeds, Pest and Diseases Management
e. Efficient use of phytosanitary products.
f. Organized integration of crop production and livestock keeping.

Logically, the best combination of practices changes according to each particular environment, each year and across different plots; as well as evolving and improving along time with the increasing incorporation of sustainable technologies.

In the case of the Aapresid's experience in Guinea, all the plots designed for the project required some degree of tillage either by forest clearing of the land or by the need of levelling furrows from previous tillages and/or erosion. Even so, a plot of corn was planted in total absence of tillage using a no-till seeder provided by a company from Argentina.

In addition to the no-till planting, several other technologies were selected and tested.

With regard to maize cultivars, two hybrids (SC510 and Kabamanouj) and an open pollinated variety (OPV - Wari) were tested as well as two varieties of soybean (Kaba G-115 and TGX-1910-14F). Different sowing dates were compared in four locations, although due to different delays for logistical reasons, all seeding dates were about the end of the optimal planting window.

Regarding soil and crops nutrition, the management plan was based on soil sampling and analysis of each of the plots. From 1 to 2 tons*ha^{-1} of dolomite were applied as the first application of a long-term plan to amend the soil acidity (currently pH 4.8 to 5.5 depending on plot) but also looking for the effects of improvements in chemical and physical conditions of the topsoil (levels of aluminium and manganese reduction, correct calcium deficiency, improving phosphorus absorption, enlarging soil biological organisms' population, etc.). 150 to 200 kg*ha^{-1} of NPK fertilizer were applied with the planter. In case of maize crop, urea was applied at the maturity stage of six to eight fully developed leaves. In soybeans the seeds were treated with rhizobia bacteria to improve the N symbiotic fixation.

In what has to do with labour and mechanization, 4 different planters were calibrated and put into operation, local technicians and operators were trained on the capacities and regulation of each one of them.

Regarding equipment for spraying of herbicides, insecticides and fungicides, personnel were trained for the assembly, set-up and use of sprayers of Chinese origin.

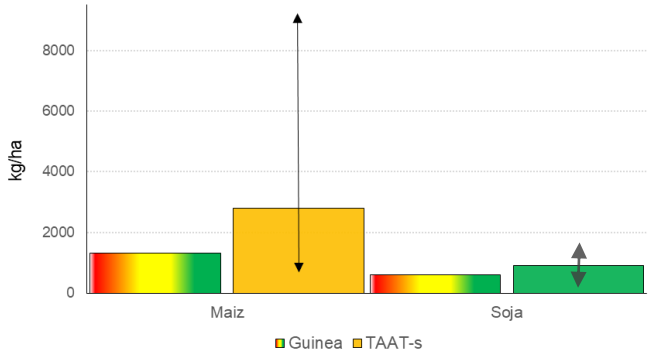
About monitoring and management of insect pests, weeds and diseases, scouting techniques were done systematically and at regular intervals. Among weeds, Cyperus spp was identified as the most difficult to control and among insects, Spodoptera spp as a pest of huge damage and with great effects on the productivity of both maize and soybeans.

Image 1. Crop yield estimation workshop.

Herbicides were evaluated for total fallow burning (glyphosate, paraquat) selective pre-emergence herbicides (atrazine, imazetaphir, pendymethalin) and post-emergence herbicides (nicosulfuron, bentazon, 2.4D, quizalofop).
Seed treatments (imidachloprid, thiram); insecticides (lambdacyalotrine, clorpyriphos, thiametoxam) and even some fungicide (difenoconazole, azoxystrobine) were also tested.
For the evaluation of crops productivity, a last work was the assessment of yields from all the plots in the all localities by counting and weighing the different yield components (plant densities, ears, pods, grains) that were carried out by AAPRESIDs' technicians together with local experts and university students trained for this purpose.

RESULTS AND DISCUSSION:

Graph 2. Maize and Soybeans Yields



Graph 2 shows the yields obtained in this TAAT-s project (orange bars for maize and green for soybeans) in comparison with the last 5 years average yields observed for the all Guinea at www.fao.org/faostat/es/#data.
In the same graph, the lines with arrows indicate the dispersion between the maximum and minimum yield observed for each crop.
The average yield achieved was almost 3 ton*ha^{-1} in maize and 1 ton*ha^{-1} in soybeans. Beyond that these values are comparatively good, the importance of the dispersion or the yields variability in both crops is remarkable.

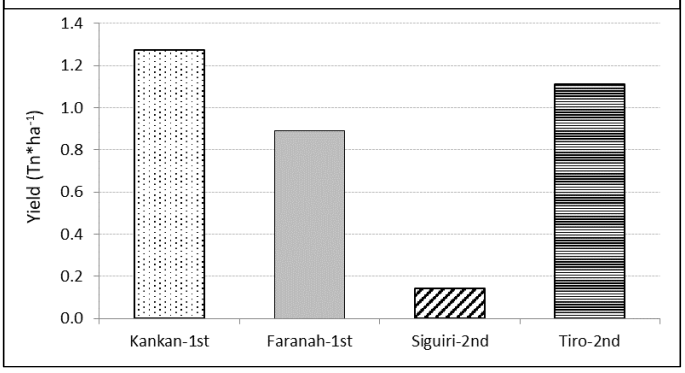
In maize, yields of less than 0.5 to more than 9 tons*ha^{-1} are observed while in soybeans yields vary from around 0.3 to 1.8 tons*ha^{-1}. Some of the main issues that explain this variability are: **a)** locality rainfall and soils differences; **b)** planting date delays; **c)** severity of fall army worm (FAW) attacks and the effectiveness of its control or the phytotoxicity of certain mixtures of herbicides and insecticides applied; **d)** cultivars and their interaction with environment and **e)** the tillage system.

Although detailed analysis of all these variables is beyond the scope of this article, some results that might be worth mentioning are discussed below.
In the first place, the no till maize plot outperformed all plots with a similar planting date cropped under conventional tillage and this allows hypothesis that the negative effects of late plantings in crops water balance (closer to the dry season) could be moderate by the better soil coverage with vegetal stubbles under no-till.

Soybeans plots were planted in early august in Kankan and Faranah and by the end of august in Tiro and Siguiri, as shown in graph 3 planting date effects on yields is not clear and it could be stated that Siguiri's site lower rainfalls have had fairly more effects on yields rather than planting dates.

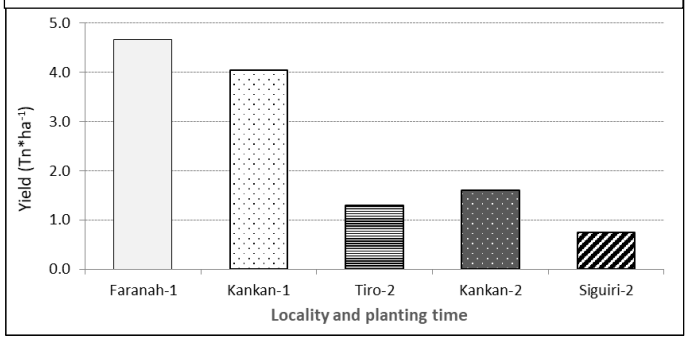
Another issue worth to mention about soybeans is that rhizobia inoculants performed well all across the four localities as it could be observed by good activity and proper amount of nodules regardless of soil characteristics of different sites.

Graph 3. Soybean yields by site and planting date.



Regarding maize yields by locality and planting dates, graph 4 shows that planting date seemed to have a higher effect on yields. It could be observed that any of the plots planted later than first week of august could reach physiological maturity before November, the crop being then exposed to finish its growth cycle during the dry season. It could also be established that, despite the late plantings, number of grain*m^{-2} was the most determinant yield component even when the grains weight also has influenced.

Graph 4. Maize yields by site and planting date.

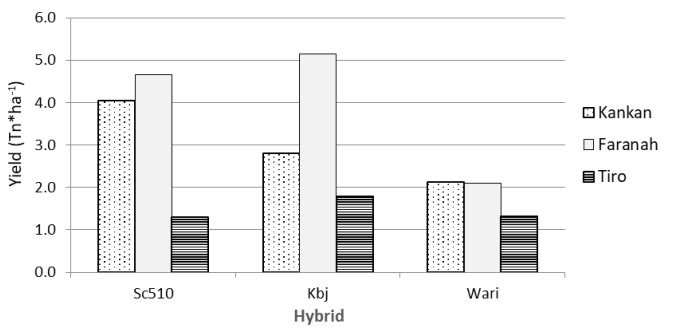


In this sense it should be noted that a key determinant for the number of grains was incidence and severity of Fall Army Worm (FAW) pest, its effects are related to plants stand damages, ears per plant number and also direct damages on the grains per ear (Image 2)

Image 2. FAW direct effects on grains per ear.

Lastly, it might be interesting to present the different behaviours that maize cultivars showed across different sites. Hybrids outperformed OPVs especially in those high yield potential localities. Among hybrids, it can be stated that there is interaction on their performance and the site characteristics, graph 5 summarizes these observations over the three sites where the all three cultivars were cropped.

Graph 5. Maize cultivars yields by site.



CONCLUSIONS:

This article has had the aim of summarizing the work of many professionals from very different areas and institutions over the course of more than a year in order to establish a starting point for the incorporation of no-till Conservation Agriculture in the Upper Guinea region.

A key dimension of the implementation program was the local actors' engagement, including small scale farmers, suppliers, government agencies, and university students for the transfer of skills and knowledge. This dimension focused not only on sharing good agricultural practices for maize and soybean production under no-till Conservation Agriculture but also on improving the commitment of local stakeholders to their environment.

The expected outcomes were achieved: a dialogue between machinery producers, seed companies, inputs dealers, commercial farmers and the government of Guinea was established; the quality and competitiveness of the inputs market was evaluated; key knowledge on agronomic conditions (soil/crop nutrition, planting dates, seed density, and pests and weed identified) was compiled; and agriculture research partners, commercial farmers, young agripreneurs, extension agents were capacitated.

Also, the results of the first year of work proved that agricultural systems are and should be multidisciplinary. Therefore, for the successful adaptation of Conservation Agriculture as a farming system some factors, which are not strictly agronomic, should be considered.

To conclude, Upper Guinea is suitable for agriculture, and it is possible to develop a commercial farming model in the region. Although there were challenges, the region has agricultural potential that should be exploited. In order to improve the results, all stakeholders should work jointly to find solutions and resolve the main challenges faced during the exercise. AAPRESID is committed to continue working with the African Development Bank and local actors in developing sustainable agricultural production in Guinea.

SOURCES FOR FURTHER INFORMATION ON THIS PROJECT:

- Dynamic Crop Simulation Models as a Support to Guinea Agriculture
  https://www.youtube.com/watch?v=m_mG1Jw4Cjk
- Exporting Argentine Knowledge: Experiences in Africa
  https://www.youtube.com/watch?v=mcsbo_9LmIY

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Image 3. Different stakeholders knowing the Argentine no-till planter at Bourenfe. Siguiri, Guinea.

Image 4. AAPRESID's and IRAG technicians at the entrance of a soybean field at IRAG Research Center at Bordo. Kankan, Guinea.

Image 5. Sites´ location in Upper Guinea (red dots)