Sustainable alternative fuels from crop for ILC-Calciner Kiln

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Abstract:

*Togolese green clinker plant is one of west-African Industry who is dealing with high energy costs, about **3,74€/GJ** as landed cost, and resources scarcity in Togo, most of the fuels used as heating in pyro-system must be imported from oversea countries. Even if raw material such as oil exist, the countries, like Togo of lacking the processing infrastructure. At the same time, fossil fuels come with negative social and environmental impacts with highest CO2-emissions of about **336 kg CO2/t** clinker, making them also less attractive in the local markets.*
*Therefore, by building sustainable structures around the local production and sourcing of biomass as alternative fuel, the dependency on imports can be substitute by a home-grown energy production sector with **this Pennisetum crops trial project** for **10 ha give us** about **4,25%** of daily raw fuel substitution. This given the lower costs of production arrow **1,87€/GJ**, the co and pre-processing application and logistics expenses was arrow **0,34€/GJ**, the local production has a significant cost advantage.*
*To avoid the **CO and NOX interlock tripping**, the kiln ID-fan damper and cooler has been increased from 75,9**% to 76,5%** and the tertial air duct damper also get some change **57%-64%.***

KEY WORD: **Pennisetum, Co-processing, Pre-processing, ILC-Calciner, crops, clinker plant**

Introduction:

The construction material sector, in Togo, west-Africa and worldwide, has a huge demand for energy. In late 2021, the estimated mass of human-made constructions surpassed the biomass of all living things on earth. One huge tributary to this “anthropogenic mass” is concrete (Elhacham et al., 2020).
Currently, most of the energy demand for cement kilns is being met by energy from fossil fuel sources (coal, diesel, mostly). Innovative concepts for the reductions of this industry sector´s impact on global greenhouse gas emission must be identified, adapted, and implemented. These could range from technical solutions like natural carbon-capture strategies by Pennisetum crops, improvements in the energy efficiency of the clinker plants itself, or by adapting carbon-neutral fuel sources as energy source to replace some of the

high carbon-fuels needed for the clinker production process. With the trialing action presented here, we aim integrating of renewable biomass-based energy resources into the value chain for cement kilns co-processing.

By adapting existing crop management schemes, harvest, and post-harvest technologies to the regional background conditions, Togolese green clinker plant demonstrate the adaptability and conception of these biomass-based renewable energy systems to different scales of implementation, from smallholder-based over cooperative to industrial scale. Pennisetum purpureum crops is to offer possibilities to meet peak demand. Management principles from conservation agriculture aim to increase mid-term buildup of topsoil and soil-

carbon pools, and measures to identify and protect remaining biodiversity hotspots within the landscape context are considered.

The integration of farmers' cooperatives and NGOs into the process facilitated the dissemination processes and support the uptake and implementation of this trial project system.

MATERIAL AND METHODES

- ❖ PENNISETUM AND CASSAVA CROPS PREPARATION

Fertilization treatment:

The fertilizer NPK was used in different dosing in the plot of $18m^2$,

a) F0 (plots with no fertilizer treatment)
b) F1 (plots with 90NPK/ha)
c) F2 (plots with 120NPK/ha)
d) F3 (plots with 300NPK/ha)

Fertilization Application:

The application of the fertilization was on two ways

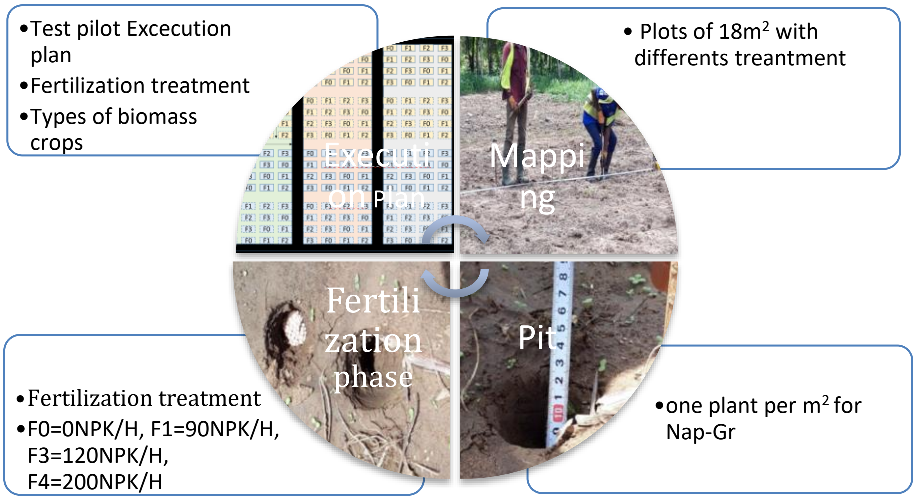
a) Application before planting only one time.
b) Application before planting and each growing season

Irrigation:

The season in the south of have good rain season this was one advantage for no irrigation of the biomass during crops.

Type of biomass crop used:

a) Pennisetum purpureum was crop on 7ha.
b) Mix of Pennisetum purpureum and cassava in 03ha.



Startup of crops of Pennisetum

❖ PENNISETUM AND CASSAVA HARVEST AND POST-HARVEST METHODS.

HAVERST METHOD

We use "Four-stroke small harvester" to cut the Pennisetum plots/plots as define by crops procedure. After cutting we took all Pennisetum to shredded place in respect of plots numbers to shredded and use the laboratory balance to record initial weight of the harvest biomass.

POST-HARVEST METHODS

The drying process was in sunset,

Deferent steps of Pennisetum crops

❖ PENNISETUM AND CASSAVA CO-PROCESS METHODS

CALCINER INJECTION POINT

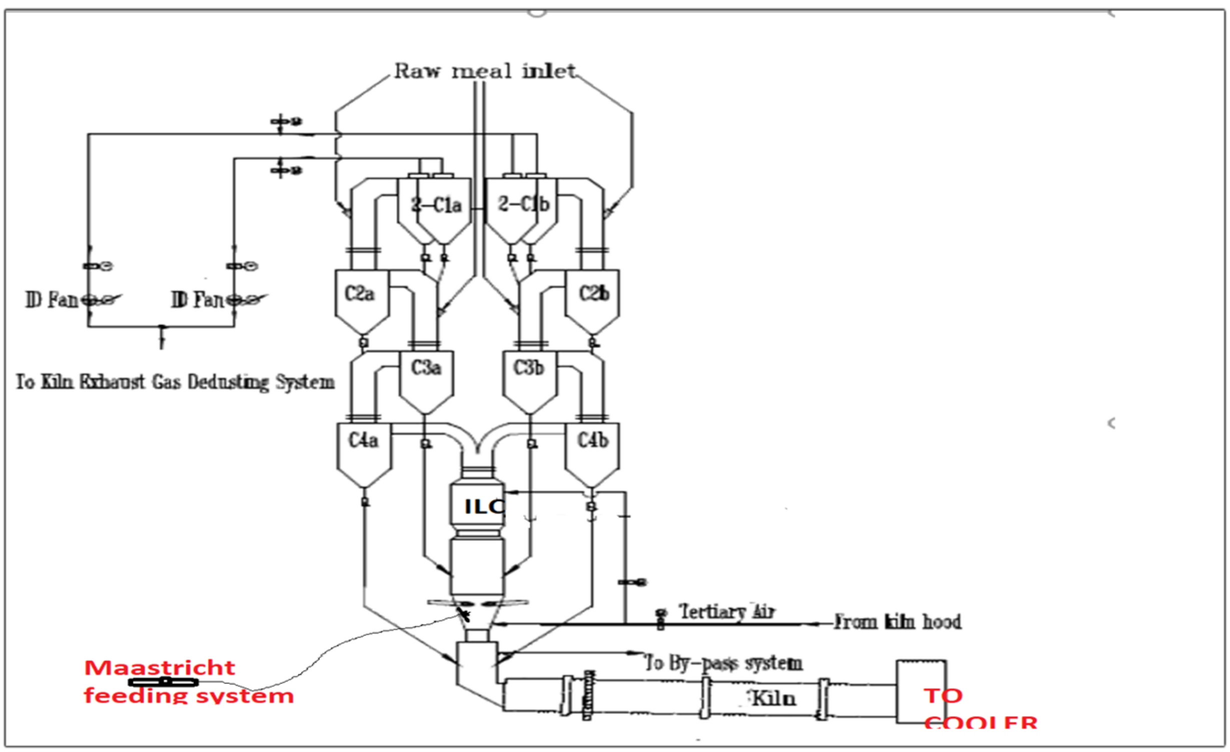
The calciner is In-line calciner (ILC) This type of calciner is usually designed as a big vessel located above kiln inlet area. the designs show extended riser duct, so called tube calciners.

Over the years of calciner development and necessity of burning the alternative fuels resulted in increasing of the internal volume of the calciner. It consists the vessel located in front or behind the preheater tower that ends-up with so called loop (goose) duct. This duct makes a turn very often at the top of preheater tower and lowers onto the bottom cyclones. The ILC calciners are usually contain the following plants: Loop (goose) duct, Calciner vessel, Tertiary air connection including fuels feeding, Connection with kiln inlet including restriction. The Pennisetum injection point is at tertiary air connection including fuels feeding.

MAASTRICHT FEEDING SYSTEM.

The Maastricht feeding systems is design for rubber granules, rice husk, RDF, PKS, the shredded Pennisetum feeding system is supplied by Walter Material Handling system (two unloading bunkers, Gantry crane, Extractor and following one belt dosing systems are discharging the material to the ODM rotary feeder (IZS 800x630 TV, 4 t/h) and by using Aerzen Kompakt 2100 blower (36 m^3/min @600 mbar; 45 kW) to the calciner fuel feeding point.

PYRO SYSTEM CO-PROCESS



LABORATORY ANALYSES METHODES

Description of Analyses from Analytic Center (HTC)

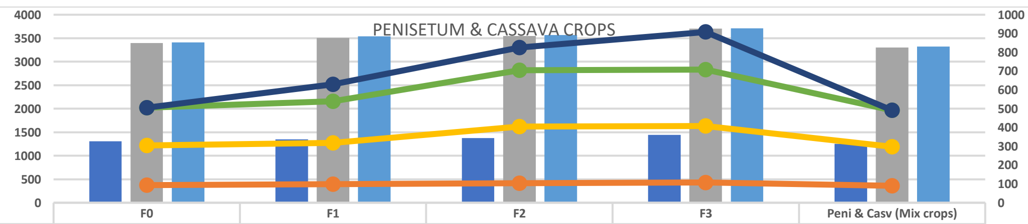
- Fuel analysis acc. DIN 51900 and DIN EN 15400 including CHN determination
- Determination of the chemical composition by XRF (LOI free)

RESULTS AND DISCUSSIONS

CROPS DEVELOPMENT PROCESS

The data collection shows the fast growth of F3 plots, the length in deux month was 1440,8 mm the diameter is 107,9 mm in average, with only with the rain as others.
The mix crops Pennisetum and cassava plots have the slowest growth H=1254,5 mm as length and D=90,2 mm as diameter.
The F0 growth was H=1304,6mm as length and D=94,2mm diameter, from this deux types of plots we can conclude that the fertilization treatments have an impact on the Pennisetum crops.

CROPS EXPENSES ANALYSES FIGERS



	F0	F1	F2	F3	Peni & Casv (Mix crops)
H-02- Month (mm)	1304,6	1350,1	1375,9	1440,8	1254,5
H-05- Month (mm)	3400,2	3503,8	3550,1	3702,1	3300,1
H-06- Month (mm)	3410,2	3540,5	3570,3	3708,1	3320,9
Fertilization Treatments (NPK(kg/ha))	0	90	120	200	0
D-06- Month (mm)	200,3	220,7	300,1	300,2	193,8
D-05- Month (mm)	210,7	220,6	300,9	300,1	207,5
D-02- Month (mm)	94,2	98,1	104,1	107,9	90,2

H-02- Month (mm) H-05- Month (mm) H-06- Month (mm) Fertilization Treatments (NPK(kg/ha)) D-06- Month (mm) D-05- Month (mm) D-02- Month (mm)

COST ANALYSES

The different treatment of the sol let us have a variation in expenses.
F0=2,39 euro/Gj is the lowest expenses because of no treatment of the sol with fertilizer and no mix growth.
The mix culture is the highest expenses, 4,48 euro/Gj, by considering the cassava ou tput which is about 3,7kg/m^2 the mix plot crops was lowest expenses. Considering our data, the growth of the mix crops (Pennisetum and cassava) is the suitable for scarcity of the food in Togo.
The tree types of plots F1, F2, F3 expenses are 2,55euro/Gj, 2,40euro/Gj, 2,92euro/Gj all plots have good output due to soil fertilization with no combination, this let us have a scarcity of food in the society, same as F0 plots

Pennisetum	Fertilization degree	Biomass crops expenses	Harvast + sherdded cost	Sherdded Penisetum (kg/m2)	Sun drying (kg/m2)				Biomass crops Landed cost without laboratory moisture (Euro/Gj)		
	Kg/ha	Euro/m2	Euro/m2	Plot A	Plot B	Plot A	Plot B	% moisture	Plot A	Plot B	AVG
F0	0	0,085	0,046	7,45	8,05	3,85	4,52	46,09%	2,33	1,99	2,39
				7,15	7,75	3,64	3,45	52,29%	2,47	2,61	
				8,05	8,12	4,01	3,34	54,53%	2,24	2,69	
F1	90	0,11	0,052	8,05	8,05	4,34	4,54	44,84%	2,56	2,45	2,55
				8,25	8,73	4,59	4,76	44,92%	2,42	2,34	
				8,11	8,14	4,01	4,02	50,58%	2,77	2,77	
F2	120	0,12	0,054	8,45	8,65	4,65	4,56	46,13%	2,39	2,44	2,40
				7,95	7,95	4,95	4,79	38,74%	2,25	2,32	
				8,35	8,19	4,85	4,65	42,57%	2,46	2,57	
F3	200	0,14	0,067	9,45	8,05	3,95	4,06	53,88%	3,02	2,94	2,92
				8,15	8,75	4,92	5,01	41,19%	2,43	2,38	
				8,65	8,25	4,45	4,03	49,85%	3,19	3,52	
Penisetum + Cassava	0	0,092	0,041	4,36	4,05	2,01	2,04	51,76%	4,54	4,47	4,48
				3,15	3,75	2,1	1,90	41,33%	4,35	4,80	
				4,05	4,15	2,05	2,15	48,79%	4,45	4,24	

COST ANALYSES FIGERS

OPERATION ANALYSES

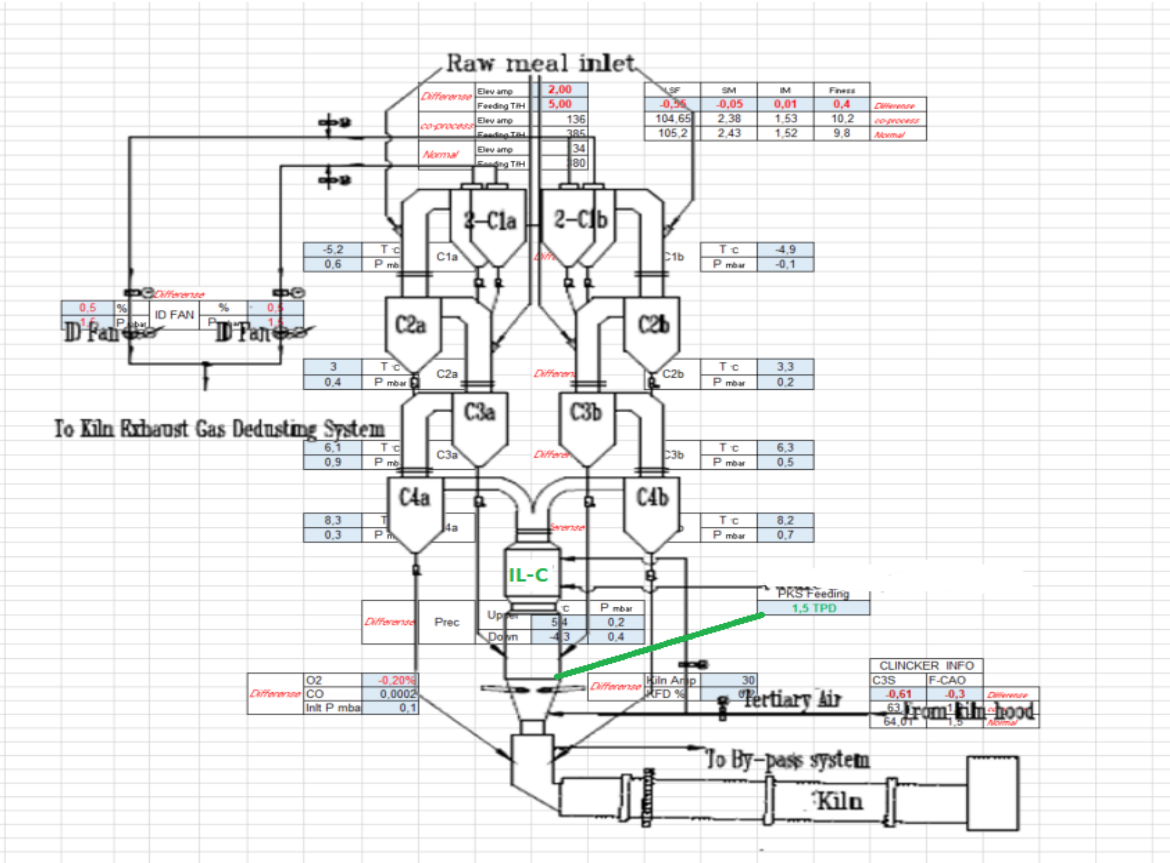
The co-processing of Pennisetum give some perturbations due to high CO at the kiln inlet, the situation was control by increasing the ID-fan motors speed, this have increased the power consumption of 2,3kwh during our co-processing trying.

The oxygen in the system gets small change to avoid the cooling of the pyro-system we adjust the dampers to have a smooth operation situation.

The NOx at kiln inlet and calciner has be adjusted based on fuel co-processing, the range of the NOX at kiln inlet (1000÷1500 ppm)

The optimization of our clinker cooler was an important task in Pennisetum co-processing as alternative fuels usage. We have observed about 1000°C of secondary air temperature.

The consequence of coprocessing in overpower consumption can be expressed as 0,21euro/Gj



CONCLUSION

As populations increase in TOGO, so having scarcity of the food, energy and so does the need for more cement and concrete for housing and the infrastructure of development. The properly managed use of alternative fuels in cement kilns can help home done energy while contributing to the sustainable development of our country.

The mix crops of energy end food are the suitable project that can deal with technical, and social- environmental aspect.

The start-up used of Pennisetum as alternative fuel, it was necessary for us to eliminate its negatives and bottlenecks related to their co-processing this help us to minimize negative impact on clinker quality and kiln performance.

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