Environmental study on cashew waste management of cashew processing

Prepared by Away4Africa

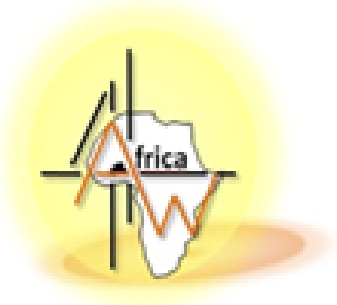
With financing of the project AfTra (African Development Bank)

For the African Cashew Alliance (ACA)

Presentation on the African Cashew Alliance

- Created in 2006 as an association of African and international companies
- Interested to promote the competitive African cashew industry
- ACA put the accent on value addition and lobbies for political reform

Presentation of Away4Africa & Funteni



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Programme

Morning:

- Presentation study results
- Proposed technologies
- CashUCalculator

Afternoon:

- Development of projects
- B2B

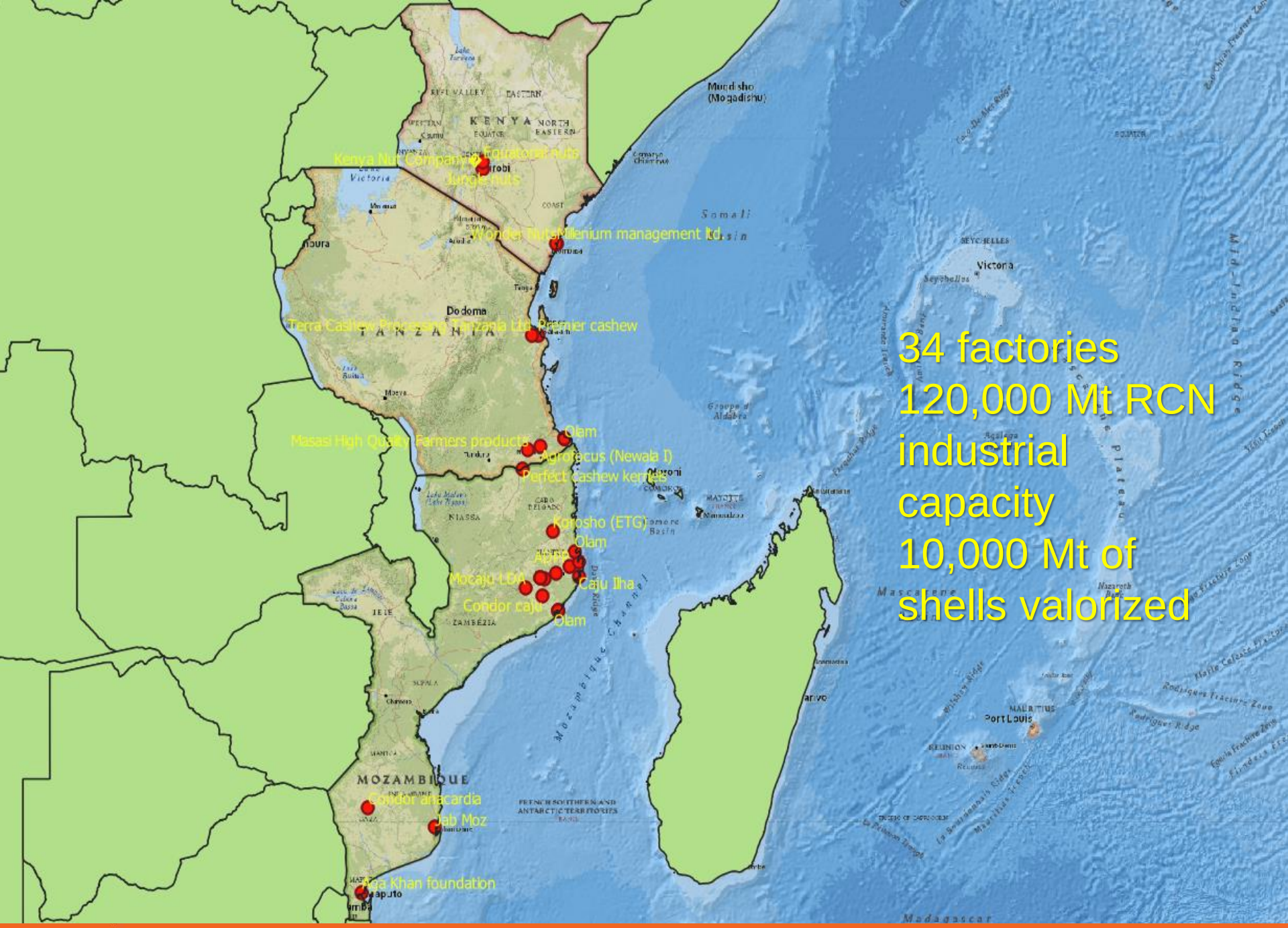
Methodology of the study

- *Identification of sector stakeholders in 8 countries*
- *Visits to factories and institutions*
- *Quantification et qualification of information*
- *Comparative analysis of technologies*
- *Document research on the subjects : energy and carbon*
- *Development of scenarios*
- *Feedback of certain stakeholders*

Key findings about Cashew by-products in 8 African countries

Benin, Burkina Faso, Côte d'Ivoire, Ghana, Guinea-Bissau, Kenya, Mozambique, Tanzania

Country	Organizations identified	Organizations contacted	Organizations contacted and interviewed	Processors interviewed	Factories visited
Benin	8	8	7	4	4
Burkina Faso	7	7	7	4	4
Côte d'Ivoire	43	28	17	15	12
Ghana	12	11	8	2	2
Guinea-Bissau	13	11	11	4	4
Kenya	6	6	6	5	5
Mozambique	27	25	21	15	13
Tanzania	15	15	7	10	7
Total	**131**	**111**	**84**	**59**	**51**



34 factories
120,000 Mt RCN industrial capacity
10,000 Mt of shells valorized


46 factories
250,000 Mt RCN industrial capacity
14,000 Mt of shells valorized
BURKINA FASO
Ouagadougou
CÔTE D'IVOIRE
GHANA
BENIN
Abidjan
Accra
Porto-Novo
Freetown
Monrovia
Conakry
Bissau
Bight of Benin
Sierra Leone Basin
Guinea Terrace
Arrey Africa SARL
Gebana SARL
Anatrans
Wouol Association
Sotra-B
CAJOU INDUSTRIE SA
Global Cashew Industries
SITA
FIMA
IVOIRE TAHANMAN INDUSTRIE (ITIA)
COCOPRAGEL
ABC
NORD CAJOU
AFRICAJOU SARL
COOBABO
SOBERY
OLAM
KIYO
FASSOU
MIM Cashew
SIMPECO
PYRAMIDE SA
IVOIRIEN DE NOIX DE CAJOU
Tolaro Global
Nad & Co Industry
Afokantan Benin Cashew SA

Current situation per country

RCN Production	Estimated RCN production (Mt)	Processing capacity (Mt)	Quantity of RCN processed in 2017 (Mt)	Estimated quantity of shells valorized (Mt)
Benin	110,000	23,500	14,553	9,136
Burkina Faso	75,000	15,500	4,874	1,400
Côte d'Ivoire	650,000	175,400	52,280	462
Ghana	70,000	23,000	536	375
Guinea Bissau	100,000	12,950	5,950	2,331
Kenya	6,000	30,000	3,440	458
Mozambique	130,000	76,100	56,100	8,687
Tanzania	250,000	13,500	10,900	620
Total	**1,391,000**	**369,950**	**148,633**	**23,468**
% of RCN production	*100%*	*27%*	*11%*	*2%*

Current situation

- Currently, a weak value addition
- Consumption of shells for own thermal energy: 5-25%
- 1.4 million Mt RCN produced → 10% processed → 100,000 Mt of shells
- But, only 25,000 Mt shells are valorized, by 14 factories

3 out of 4 cashew shells go to waste!

By-product flow and technologies

Most efficient strategy requiring significant and sustainable supply of shells

- **CNSL extraction** in combination with **Power generation from direct combustion** of de-oiled shell cake. (ROI ±3yr)
- Alternatively, **gasification of the shells**, with charcoal and electricity as final products.
- Specific **opportunities** that were found and confirmed during this study were the local use for **CNSL** as a **substitute for conventional fuels (DDO/LFO)**, and sale of **shell cake** to other industries (fuel)

By-product flow and technologies

Small scale technologies and solutions: carbonization of shells

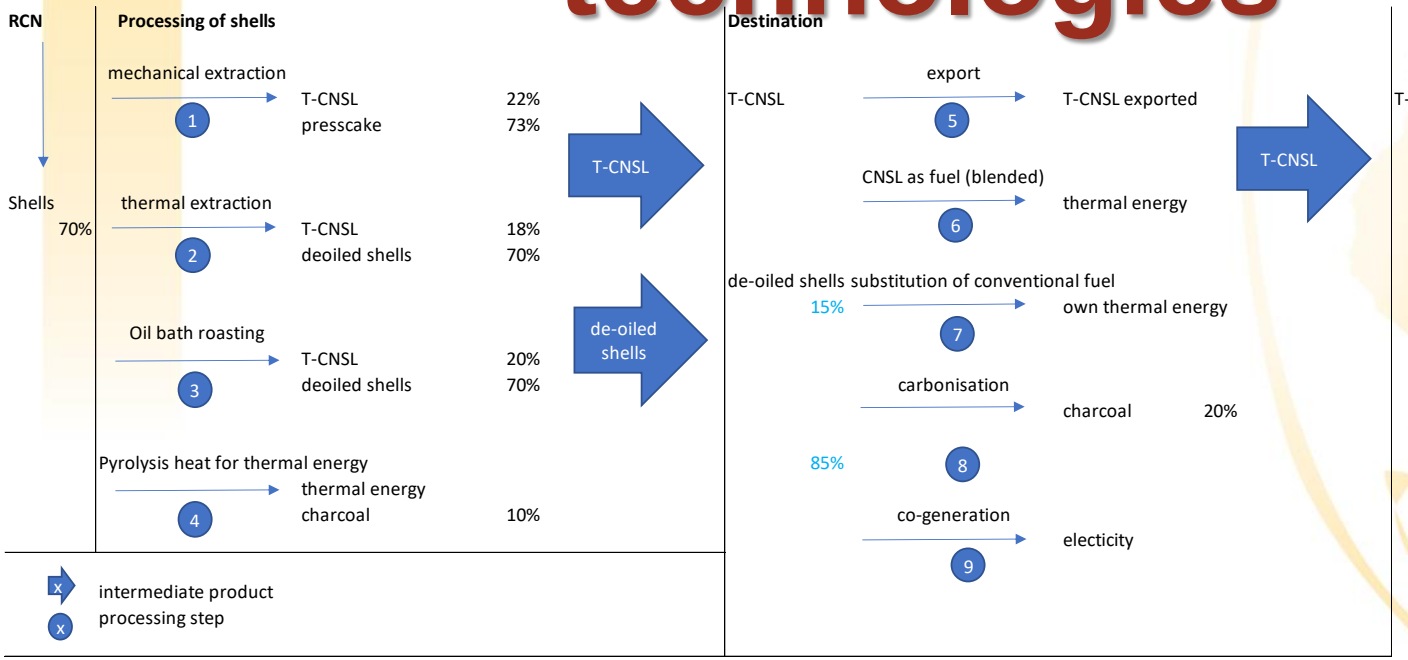
- The **H2CP (High Calorific Cashew Pyrolizer)**, where pyrolysis gas is directly used for thermal energy. Shells are fed intro the pyroliser, and undertake a thermal decomposition thus releasing a combustible gas. Pyrolyser is used as source of heat for steam generation in the boiler.

By-product flow and technologies

Small scale technologies and solutions: carbonization of shells

- Via a **charcoal retort**, shells are pyrolysed and carbonized shells are obtained. (ROI ±3yr)
- Alternatively, de-oiled shells are fuel for boilers, and shells can be composted.

By-product flow and technologies



Business model optimisation

What if 100% of the shells is expelled and …

… of the **extracted CNSL:**

- 50% is exported

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- 50% is sold as fuel for thermal energy

… of the **de-oiled shells**:

- 20% is used for own thermal energy (boilers)

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- 80% is used for co-generation and surplus of electricity sold

Comparison with by-products in India

- Cashew processors tend to concentrate in processing areas, called clusters
- Plus, clusters are in well-deserved areas
- Indian industrial fabric is generally stronger than African, and Indian economy is dynamic
- Research institutions also contributed and still contribute to adding value to the solid by-products
- Indian Government considers cashew industry as a key sector
- Wherever shells are available, CNSL extraction plants are set-up in the proximities, or even in the facilities of the cashew processing plant; CNSL extraction is highly profitable. Cardanol from CNSL distillation is an even higher value-added product.

KPIs on by-product valorisation

- Economic
- Energetic
- Ecologic

KPIs on by-product valorisation

There is potentially a **value addition** of 170 M USD with a rough estimated net profit for the businesses of 39 M USD

- **Increased competitiveness: 125 USD/Mt RCN**

The valorization of the cashew shells can contribute to a **positive energy balance** up to 2,000 GWh

- **Increased energy supply: +30% -> energy supplier**

The valorization of the cashew shells can contribute to a **positive carbon balance** up to 500,000 tCO2eq

- **Increased carbon savings: Intended Nationally Determined Contributions (INDC 2030)**

Valorisation benefits to whom?

➢ Increased competitiveness	➢ Private good
➢ Increased energy supply	➢ Private good / ➢ Public good
➢ Increased carbon savings	➢ Public good

Opportunities and way forward

Private-Public-Partnerships

- Cashew by-product policy (country, ACA)
- Financing schemes for investments and carbon offset: Clean Development Mechanism (CDM)

Conditions to work on:

- R&D technologies: improve efficiencies
- Sustain supply of shells

Way forward: scenario planning of 8 countries

- Scenario 1, a reference of the current situation, based on the processed RCN quantities in 2017.
- Scenario 2, a projected situation, based on the assumption that the same quantity will be processed, but the processing of by-products will be done in an optimized way. And that the necessary investments on by-product processing will be realized for that quantity.
- Scenario 3, a projected situation, based on the assumption that the installed processing capacity will be fully utilized and investments on by-product processing will be realized.
- Scenario 4, a projected situation, based on the assumption that all RCN will be processed and investments for (by-product) processing will be realized.

Way forward: the most optimized way

The “most-optimized” way for value addition, though based on feasible propositions; this is, in brief:

- Shells being split into CNSL and shell cake
- 50% of the CNSL being used as local fuel and the rest going on export
- 80% of the Shell cake produced being converted into electricity, the rest is used for heat purposes at the factory

Scenario 1: current situation

Processing parameters	Input	Unit	Reference value
Processing capacity (in RCN/yr)	148,653	Mt	
The % of shells from RCN	70	%	70%
% of shells for CNSL extraction (mechanical)	12	%	
% of shells for CNSL extraction (thermal)	2	%	
% of shells for gasification	0	%	
% of shells sold directly	5	%	
% of shells for own thermal energy	4	%	15%
Quantity of wood for own thermal energy	0	Mt	
Mechanization level	semi-industrial		
Electricity consumption factory	18,579,125	kWh	125 kWh/Mt RCN

Output	Quantity	Unit
Quantity of shells	104,057	Mt
Quantity of shells (for mechanical extraction)	12,487	Mt
Quantity of shells (for thermal extraction)	2,081	Mt
Quantity of shells (for gasification)	-	Mt
Quantity of shells sold directly	5,203	Mt
Quantity of shells for own thermal energy	4,162	Mt
Quantity of T-CNSL	2,747	Mt
Quantity of electrical energy produced	7,143	MWh

KPIs	Quantity		Added value to RCN (US$/Mt RCN)
Total energy balance	10,906,156	kWh	
Quantity of carbon credits	-9,577	tCO2eq	
Total sales	2,275,170	US$	15
Total net profit	496,251	US$	3
Carbon emission allowance saving potential	-	US$	-

Preliminary conclusions of Scenario 1:

- *There is a positive energy balance of 10,906 MWh per year, needed for (electrical) energy for processing*
- *There is a negative carbon credit balance, with a yearly carbon emission of 9,577 tCO2-eq*
- *There is a value addition of US$2,2m, with a rough estimated net profit for the businesses of US$496k*

Scenario 2: Complete processing of produced shells

Processing parameters	Input	Unit	Reference value
Processing capacity (in RCN/yr)	148,653	Mt	
The % of shells from RCN	70	%	70%
% of shells for CNSL extraction (mechanical)	98	%	
% of shells for CNSL extraction (thermal)	2	%	
% of shells for gasification	0	%	
% of shells sold directly	0	%	
% of shells for own thermal energy	0	%	15%
Quantity of wood for own thermal energy	0	Mt	
Mechanization level	semi-industrial		
Electricity consumption factory	18,579,125	kWh	125 kWh/Mt RCN

Output	Quantity	Unit
Quantity of shells	104,057	Mt
Quantity of shells (for mechanical extraction)	101,976	Mt
Quantity of shells (for thermal extraction)	2,081	Mt
Quantity of T-CNSL	22,435	Mt
Quantity of electrical energy produced	58,332	MWh

KPIs	Quantity		Added value to RCN (in US$/Mt RCN)
Total energy balance	211,081,630	kWh	
Quantity of carbon credits	58,560	tCO2eq	
Total sales	18,534,402	US$	125
Total net profit	4,156,342	US$	28
Carbon emission allowance saving potential	702,721	US$	5

Through CNSL extraction (with 50% substitution of DDO), and 80% of the de-oiled shells used for co-generation, while 20% is used for own thermal energy

Preliminary conclusions of Scenario 2:

- *There is a positive energy balance of 211,081 MWh per year, generated as (electrical) energy, while energy for processing is coming from the by-products*
- *There is a positive carbon credit balance, with a yearly carbon emission saving of 58,560 tCO2-eq*
- *There is a value addition of US$18.5m with a rough estimated net profit for the businesses of US$4.2m*

Scenario 3: All processing capacity will be used

Processing parameters	Input	Unit	Reference value
Processing capacity (in RCN/yr)	369,950	Mt	
The % of shells from RCN	70	%	70%
% of shells for CNSL extraction (mechanical)	98	%	
% of shells for CNSL extraction (thermal)	2	%	
% of shells for gasification	0	%	
% of shells sold directly	0	%	
% of shells for own thermal energy	0	%	15%
Quantity of wood for own thermal energy	0	Mt	
Mechanization level	semi-industrial		
Electricity consumption factory	49,618,750	kWh	125 kWh/Mt RCN

Output	Quantity	Unit
Quantity of shells	277,865	Mt
Quantity of shells (for mechanical extraction)	272,308	Mt
Quantity of shells (for thermal extraction)	5,557	Mt
Quantity of T-CNSL	59,908	Mt
Quantity of electrical energy produced	155,766	MWh

KPIs	Quantity		Added value to RCN (in USD/Mt RCN)
Total energy balance	563,653,966	kWh	
Quantity of carbon credits	156,407	tCO2eq	
Total sales	49,493,051	USD	125
Total net profit	11,099,134	USD	28
Carbon emission allowance saving potential	1,876,886	USD	5

Through CNSL extraction (with 50% substitution of DDO), and 80% of the de-oiled shells used for co-generation, while 20% is used for own thermal energy

Preliminary conclusions of Scenario 3:

- *There is a positive energy balance of 536,653 MWh per year, generated as (electrical) energy, while energy for processing is coming from the by-products*
- *There is a positive carbon credit balance, with a yearly carbon emission saving of 156,407 tCO2-eq*
- *There is a value addition of US$49.5m with a rough estimated net profit for the businesses of US$11m*

Scenario 4: All present RCN will be processed

Processing parameters	Input	Unit	Reference value
Processing capacity (in RCN/yr)	1,391,000	Mt	
The % of shells from RCN	70	%	70%
% of shells for CNSL extraction (mechanical)	98	%	
% of shells for CNSL extraction (thermal)	2	%	
% of shells for gasification	0	%	
% of shells sold directly	0	%	
% of shells for own thermal energy	0	%	15%
Quantity of wood for own thermal energy	0	Mt	
Mechanization level	semi-industrial		
Electricity consumption factory	173,875,000	kWh	125 kWh/Mt RCN

Output	Quantity	Unit
Quantity of shells	973,700	Mt
Quantity of shells (for mechanical extraction)	954,226	Mt
Quantity of shells (for thermal extraction)	19,474	Mt
Quantity of T-CNSL	209,930	Mt
Quantity of electrical energy produced	545,837	MWh

KPIs	Quantity		Added value to RCN (in US$/Mt RCN)
Total energy balance	1,975,167,317	kWh	
Quantity of carbon credits	548,135	tCO2eq	
Total sales	173,435,122	US$	125
Total net profit	38,894,403	US$	28
Carbon emission allowance saving potential	6,577,622	US$	5

Through CNSL extraction (with 50% substitution of DDO), and 80% of the de-oiled shells used for co-generation, while 20% is used for own thermal energy

Preliminary conclusions of Scenario 3:

- *There is a positive energy balance of 1,975 GWh per year, generated as (electrical) energy, while energy for processing is coming from the by-products*
- *There is a positive carbon credit balance, with a yearly carbon emission saving of 548,135 tCO2-eq*
- *There is a value addition of US$173m with a rough estimated net profit for the businesses of US$39m*

KPIs on by-product valorisation

There is potentially a **value addition** of 170 M USD with a rough estimated net profit for the businesses of 39 M USD

- **Increased competitiveness: 125 USD/Mt RCN**

The valorization of the cashew shells can contribute to a **positive energy balance** up to 2,000 GWh

- **Increased energy supply: +30% -> energy supplier**

The valorization of the cashew shells can contribute to a **positive carbon balance** up to 500,000 tCO2eq

- **Increased carbon savings: Intended Nationally Determined Contributions (INDC 2030)**

Conclusions on by-product processing

- The extraction of CNSL is done by a few processing factories (± 10%). T-CNSL production from shells is destined for the export market
- In terms of global by-product solutions in the cashew sector, Benin is considered as the most advanced, along with Guinea-Bissau (mainly on co-generation)
- In Burkina Faso, the cashew processing sector has a relative big experience in R&D and testing of technologies (H2CP, charcoal retort, CNSL-fuel option)
- In Kenya, there are opportunities in terms of policy and access to biomass technologies, but the cashew sector suffers from unreliable RCN supply
- Côte d'Ivoire has the largest potential to apply the by-product solutions and businesses and create value addition, taking into account the largest RCN produced quantity and the potential industrial growth
- Having the biggest processing capacity, Mozambique still has an unexploited potential for cashew by-products. Average factory size is big, meaning that CNSL extraction and even power production from excess shells/cake is possible.

Cashew by-products reframed

Drivers: Energy demand Climate responability

Problem

Opportunity

A cashew nut

1 kg RCN of which						
0.24	kg of kernels (including moisture)			Sales price product (US$/Mt)	Added value on RCN (US$/Mt RCN)	Value share
0.70	kg shell	0.49	De-oiled shells	18	9	7%
		0.154	CNSL	609	94	75%
0.03	kg testa	0.027	Composted testa	92	2	2%
0.03	kg rejected	0.008	Kernel press cake	111	1	1%
		0.021	Kernel oil	922	19	15%
Total					**125**	**100%**

Local sales, with reference 50% of the local fuel price; in the current situation, exported CNSL at sale prices of US$350-400/Mt CNSL CIF decreases the added value.

Market for by-products

Product	Market	Client	Price/delivery	Examples
T-CNSL	International	Phenolic compounds industry and cardanol manufacturers	US$300-350 /Mt FOB	• Cardolite • Alkyde industry • Epoxy manufacturers
T-CNSL	Local/national	Local industry with burners (substitute for DDO/LFO)	50-80% of the actual fuel price	Industries with boilers and furnaces : breweries, bakeries, steel manufacturing…
Shells	Local/national	Industries with fuel needs for heat	10-15 USD/MT	• Thermal conversion through pyrolysis reactor (H2CP) • Small industry • CNSL processors
Friction particles (from t-CNSL)	Nigeria, and International	Manufacturers of friction materials (e.g. brakes)	To be determined	Road Master LAGOS
Testa	Leather tanning industry (local & international) Pharma-chemical industry (international)	International fashion brands (SCADA, Adidas,…) using innovative and eco-friendly leather Poultry growers (bed) Pharma-chemical industry (extraction of anti-oxidants for cosmetics and food industry)	Given for free to local tanners (Kenya) Dried testa for cosmetics (India) 615 USD/MT	Alisam Products (Kenya) Catechins cosmetics

Market for by-products

Product	Market	Client	Price/delivery	Examples
Rejected kernels	Local/national	Breeders or animal feed mix manufacturers	CFA 50-200 per kg	Local clients: Breeders of cows, pigs, poultry (reference: Burkina Faso)
Discarded bits	Local/national		CFA 60 to 100 per kg	Local clients: poultry breeders
Indirect				
Fuel for electricity	Local/national	Electricity companies OR Independent Power Producer		Côte d'Ivoire, Benin (both in project phase)
Charcoal and briquettes	Local	Fuel for domestic use	CFA 70 to 100 per kg	Local use of shell charcoal in domestic furnaces
De-oiled shell cake	Local/national	Fuel for boilers and furnaces	20-30 USD/MT	Cement factory Benin
Carbon offset	International	To be determined	8-12 USD/tCO_2	

In a nut shell…

- Potential in 1 Mt RCN:
- **125 USD** value addition
- **900 kWh** energy
- **500 kg CO_2eq** savings

Contributions to the SDGs

Increase substantially the share of renewable energy in the global energy mix through valorisation of cashew by-products

Achieve higher levels of economic productivity through diversification, technological upgrading and innovation, which is particularly applicable for the high-value added and labor-intensive cashew sector
Promote of a development-oriented and supportive policy at regional level

Promote inclusive and sustainable industrialization and significantly raise industry's share of employment and gross domestic product, including access to financial services, innovation and R&D combining international and domestic expertise

Reduce food losses along production and supply chains, including post-harvest losses
Recycling and reuse of cashew waste and contribute to mitigation actions and integrate sustainability information in reports with KPIs

Become a carbon compatible cashew value chain
Integrate climate change measures into cashew-oriented policies, strategies and planning of participating project partners, to prospect models for multiplication and upscaling

Strengthen resource mobilization of the region to improve domestic capacity for tax and other revenue collection through the increase of the processed cashew exports
Implement an effective public-private partnership, building on the experience and resourcing strategies of partnerships

Recommendations (1)

Towards governments and the para-public sector

(i) first, **secure supply of shells** for viable CNSL production and co-generation,

(ii) enhance **applied research** on the adaptation of technologies for the cashew by-products and alternative (local) applications of the derivates

(iii) facilitate spreading the **existing knowledge by exchange** on by-product practices

(iv) improve **investment climate** for waste recycling

(v) enable the **CDM financing instruments** for the biomass-to-energy projects

(vi) develop a **coherent vision and strategy** on cashew by-products on national level

(vii) link the carbon emission reduction, due to the value addition of the cashew by-products to the **Intended Nationally Determined Contributions**

Recommendations (2)

Towards sector organizations

(i) facilitate **exposure** to and **exchange** on the technologies for processors and governmental bodies and stimulate interactions

(ii) provide an **assessment** of the energy and carbon emission reduction at national and even regional level

(iii) reform of the **national cashew sector agencies** so that support to processors becomes a priority, and the focus on by-products is given as means to secure financial stability for them

(iv) advocate for an **extension of these measures** to the by-products

Recommendations (3)

Towards private sector actors

(i) **explore** the different available solutions for by product development

(ii) be **compliant** with the environmental standards

(iii) conduct further the **assessment** of the opportunity of energy from by-products

(iv) start **collaboration** between processors to create scale and a regular supply of shells for operation that require larger quantities: CSNL extraction and co-generation. Common investments or third-parties can be a next step. Private-public partnership seems to be a convenient setting for by-product investments, as the outcomes benefit private and public interest

(v) realize the **investments** in by-product processing capacity, including the technical competences of staff

Recommendations (4)

Towards African Cashew Alliance

(i) assist **the factories to abide** by the national regulations, because lack of observance can become a big issue in the future

(ii) develop a specific cashew by-product **policy** with the necessary instruments and facilitation of incentives for the ACA members

(iii) support the countries' **sector associations/agencies** to improve their organizational abilities and strengthening the processors representatives. One idea would be having one ACA representative in each country

(iv) develop **documentation on environmental impact reduction** methods, addressed to processors and environmental authorities

(v) integrate the assessment of energy from biomass and carbon emission (reduction) into the assessment criteria of the **ACA seal**

Potential of “My shells”

- Calculate your by-product potential with the

CashUCalculator

For:
- Factories
- Sector / public

Away4Africa

www.away4africa.nl/CashUCalculator

The CashUcalculator model

- Set the parameters of your entity (factory, country level)
- Set your processing parameters

Processing parameters	Unit
Processing capacity (in RCN/yr)	Mt
The % of shells from RCN	%
% of shells for CNSL extraction (mechanical)	%
% of shells for CNSL extraction (thermal)	%
% of shells for gasification	%
% of shells sold directly	%
% of shells for own thermal energy	%
Quantity of wood for own thermal energy	Mt
Mechanization level	
Electricity consumption factory	kWh
Average distance between RCN suppliers - factory	*km*
Distance between factory and harbor	*km*
Distance between harbor and client	*km*
Total distance by car per year	*km*

Mechanization level is categorized in 3 'factory types':

- Atomized: with more than 50% atomized shelling, peeling and grading
- Semi-industrial: with atomized peeling (and grading)
- Manual: with manual peeling and grading

The CashUcalculator model

- Set your by-product parameters

1

Direct sales of shells		
Quantity of shells sold directly	-	Mt
Direct combustion at third parties	0	%

CNSL extraction from		Mt shells
Quantity of shells	111,720	Mt
% of T-CNSL from shells	22	%
% of de-oiled shells	73	%

2

Destination T-CNSL		
Quantity of T-CNSL	24,578	Mt
T-CNSL for export	50	%
T-CNSL for substitution of DDO	50	%

Destination de-oiled shells		
Quantity of de-oiled shells	81,556	Mt
De-oiled shells for own thermal energy	20	%
De-oiled shells for charcoal production		%
De-oiled shells for co-generation (electricity)	80	%

The CashUcalculator model

- Other parameters of the model: energy

•*Lower Heating Value (LHV) for the selected fuels (MJ/kg)*

Fuel	LHV (MJ/kg)
Cashew shells	18,9
CNSL	36,1
Shell cake	17,4
Shell charcoal	29,9

The CashUcalculator model

- Other parameters of the model: energy

•*Average electricity tariff per country*

Country	Average electricity tariff (US$/kWh)	Index
Benin	0.30	118%
Burkina Faso	0.43	169%
Côte d'Ivoire	0.23	90%
Ghana	0.27	106%
Guinea-Bissau	0.24	94%
Kenya	0.28	110%
Mozambique	0.08	31%
Tanzania	0.21	82%
Average	**0.26**	**100%**

The CashUcalculator model

- Other parameters of the model: energy

•*Diesel prices (USD/L) per country (July 2018)*

Country	US$/L	Index
Benin	0.95	93%
Burkina Faso	0.93	91%
Côte d'Ivoire	1.08	106%
Ghana	1.05	103%
Guinea-Bissau	1.11	109%
Kenya	1.05	103%
Mozambique	1.05	103%
Tanzania	0.95	93%
Average	**1.02**	**100%**

The CashUcalculator model

- Other parameters of the model: carbon
- *GHG Emission factors in tCO2eq/MWh generated per country*

Country	GHG Emission factor (tCO2eq/MWh)	Index
Benin	0.683	132%
Burkina Faso	0.700	135%
Côte d'Ivoire	0.408	79%
Ghana	0.150	29%
Guinea-Bissau	0.518	100%
Kenya	0.393	76%
Mozambique	0.683	132%
Tanzania	0.607	117%
Average	**0.520**	**100%**

The CashUcalculator model

- Other parameters of the model: carbon
- *GHG Emission factors in tCO2eq/kg per combustible*

Combustibles	GHG Emission factor (tCO2eq/Mt)
Waste Oil / Lubricants	3.1
Wood	4.6
HFO	3.12
Cashew shells (when burnt)	0

Potential of “My shells”

- Calculate your by-product potential with the

CashUCalculator

For:
- Factories
- Sector / public

Away4Africa

away4africa.nl/CashUCalculator

Tanzania

Country	Guinea-Bissau	Kenya	Mozambique	Tanzania
Installed capacity (2017)	12,950 MT/year	15,000 MT/year	76,100 MT/year	40,500 MT/year
Real quantity processed (2017)	5,950 MT	3.500 MT	56,100 MT	12,200 MT
Shells	Shells are collected by a sugarcane liquor processor nearby, and mixed with sugarcane bagasse. The biomass feeds a steam engine, running a power generator (130 kW).	No CNSL production, but burning of shells (blended with other biomass) for thermal uses for industries; sales of shells at US$10/MT; experiences with co-generation, CDM projects	The only processor extracting CNSL is Condor caju, others are currently burning shells in open pits. INCAJU recently developed a composting technique adapted for shells; to produce commercial compost in the next months.	One example of artisanal CNSL extraction found; currently, not working. Processors burn their shells in open pits
Testa	Burnt into boiler or disposed	At Kilifi, one buyer procuring testa for leather tanning	Burnt in open pits	Burnt in boiler or in open pits
Rejected kernels	Sold to poultry growers, or disposed	Disposal at 100%	Sold to poultry growers, or disposed	Sold to poultry growers, or disposed
Smoke	Shells are used as fuel Basic smoke treatment (cyclone) installed in the biggest factories Height of the chimneys is correct but fumes still are a nuisance to population in some cases. Environmental laws are not enforced	Air pollution is reduced, because of blended combustibles for boilers. An environmental study is required. NEMA has worked out the norms and protocols of verification; verification is done by NEMA regularly	Shells are burnt in the boilers; smoke treatment is not installed in most cases. Environmental authorities not enforcing existing regulations	Shells are burnt in the boilers; smoke treatment is not installed in most cases. Environmental authorities not enforcing existing regulations
Waste water	Water is not in contact with product in the active factories; the rest don't have any particular water treatment system	Use of septic tanks or discharge to the ground	Use of septic tanks or discharge to the ground	Use of septic tanks or discharge to the ground
Interest	Techniques to reduce environmental impact and nuisances caused by fumes/burning. Training on best practices to national cashew body & authorities Re-launching power generation in Safim	Processing units are open to get informed about the technologies (H2CP, charcoal production, carbon emission reduction)	Work on joint solution for CNSL extraction Appropriate technologies for smaller processors Several institutions would like assessment on biomass power project from cashew shell Training on best practices to national cashew body & authorities	Work on joint solution for CNSL extraction Training on best practices to national cashew body & authorities

Tanzania

Processing parameters	Current	Potential	
Processing capacity (in RCN/yr)	10,900	13,500	Mt
The % of shells from RCN	70	70	%
% of shells for CNSL extraction (mechanical)	-	100	%
% of shells for CNSL extraction (thermal)	-	-	%
% of shells for gasification	-	-	%
% of shells sold directly	-	-	%
% of shells for own thermal energy	8	-	%
Quantity of wood for own thermal energy	-	-	Mt
Mechanization level	mechanized	mechanized	
Electricity consumption factory	1,907,500	2.362.500	kWh

Output	Current	Potential	
Quantity of shells	7,630	9,450	Mt
Quantity of shells (for mechanical extraction)	-	9,450	Mt
Quantity of shells (for thermal extraction)	-	-	Mt
Quantity of shells (for gasification)	-	-	Mt
Quantity of shells sold directly	-	-	Mt
Quantity of shells for own thermal energy	620	-	Mt
Quantity of T-CNSL	-	2.079	Mt
Quantity of electrical energy produced	-	5,405,592	kWh

KPIs	Current	Potential	
Total energy balance	-1,907,500	18,920,142	kWh
Quantity of carbon credits	-1,929	6,137	tCO2eq
Total sales	-	3,398,881,506	TZS
Total net profit	-	763.369.700	TZS
Carbon emission allowance saving potential	-	168,084,528	TZS
Added gross value to RCN	-	251,769	TZS /Mt RCN
Added net value to RCN	-	56,546	TZS /Mt RCN

Electricity consumer -> Electricity producer

Tanzania

- Legal textes

• Environmental Management Act, 2004 • Environmental Management (Fee and Charges) regulations, 2008 (amendment 2016) • Environmental Management (Air Quality Standards) Regulations, 2007 • The water resources management Act, 2009 • TZS 860:2005 Tolerance Limits for Municipal and Industrial Wastewater • TZS 845:2005 Air Quality – Specification	Cashew nut processing is subject to Environmental Monitoring and audit annually

Tanzania

Sector actors:

15 organisations:

- CBT (Cashew nut Board of Tanzania)

11 factories (of which 5 are functional)

Tanzania

- SWOT factories

Strengths	Weaknesses
– Some clusters being formed: in Mtwara and Masasi – Experience in CNSL extraction and use as a fuel	- Little co-operation and share of information amongst processors, and to the public
Opportunities	**Threats**
– Mtwara may soon host a CNSL extraction and power generation unit, with waste from several factories – Some old, idle CNSL extraction equipment may be available for adoption by a new entrepreneur – Local market for CNSL as protective wood coating – Local market for de-oiled cake, as household fuel	- Little support from institutions - When dealing with administration, procedures are reported to be tedious

Tanzania

- SWOT institutions

Strengths - Actively searching investment and eager to create a regulatory frame to attract investors	**Weaknesses** - Institutional response is slow - CBT is not focused on cashew processing - Industry in general is not a priority
Opportunities - Promotion of by-products and of good environmental practices can give a new and positive image of the cashew industry	**Threats** - The regulatory environment is not enforced in many cases - RCN production and export regulation remains the government's priority, for cashew sector - Lack of proper project planning & monitoring has led to bad experiences

Tanzania

- The Cashew nut Board needs to be renovated, just like its homologue in Mozambique. Given the big average size of the processing units, the key in Tanzania would be to attract investment to implement big-scale solutions; and help the smaller ones to join efforts so that they can give value to their waste as well
- Experience in CNSL extraction and use as a fuel: to be concretized in new projects (use experience from Kenya on the CDM)

Thanks

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