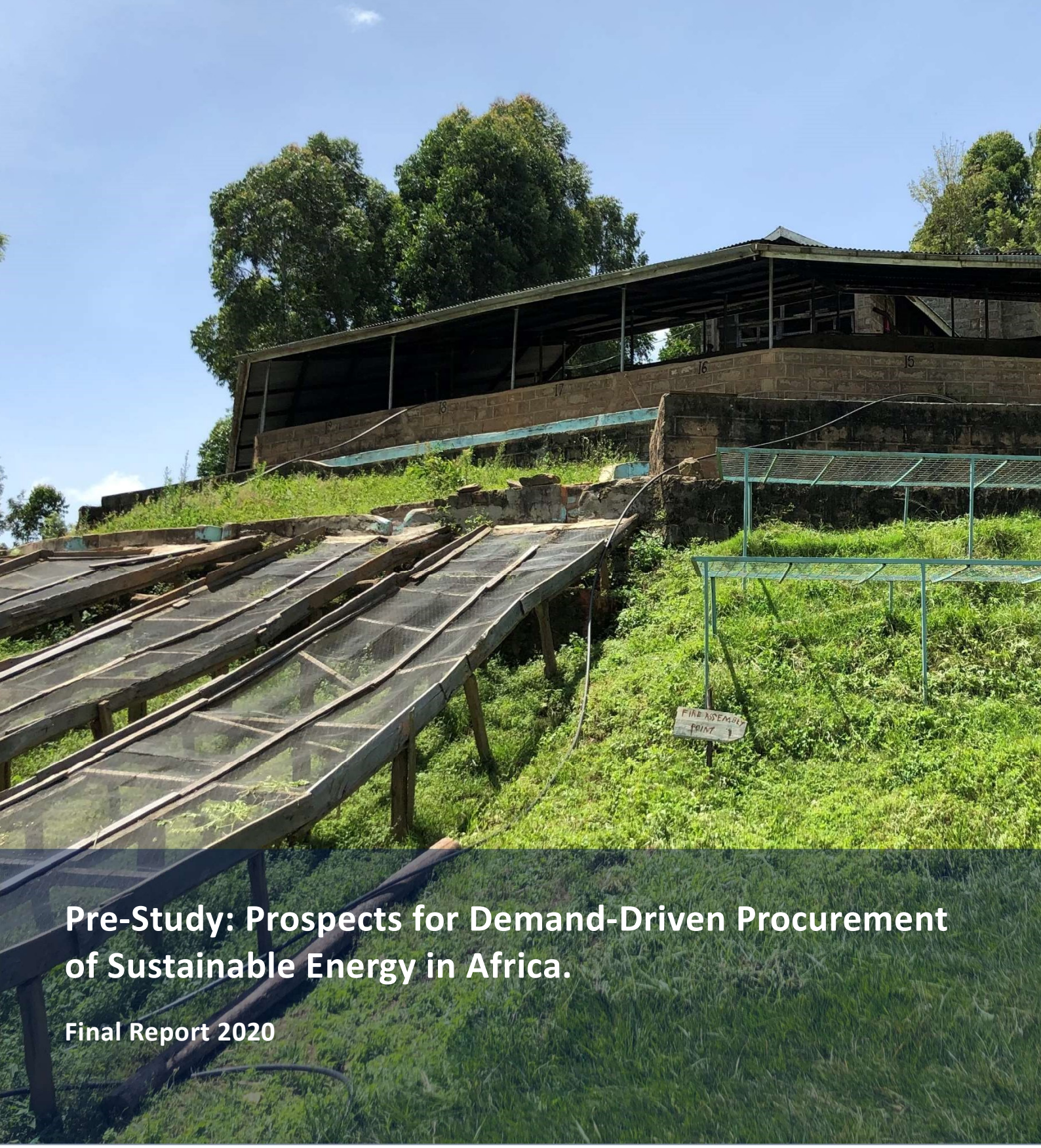

Pre-Study: Prospects for Demand-Driven Procurement of Sustainable Energy in Africa.

Final Report 2020

2020:07

WE EFFECT

Anthesis

Pre-Study: Prospects for Demand-Driven Procurement of Sustainable Energy in Africa.

Final Report

Sida Contribution No. 13830

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CONTENT

Summary

In the 2019 report "Procurement Advice for Sustainable Energy", several areas and possible products were identified for demand-driven procurement in Africa.[1] These include logistic cold chains for milk from farm to dairy, photovoltaic (PV) driven induction stoves, and agricultural equipment. After discussions with We Effect, representatives from the smallholder farming cooperative Machakos Coffee Union, and female and male farmers, we have identified wet mills as a key component in the coffee production process which are managed by farmer cooperatives and represent a major opportunity for improvement.[2] The Kenyan coffee sub-sector contributes an annual average of USD 230 million in foreign exchange earnings and is ranked as Kenya's fourth most important export, after horticulture, tourism, and tea.

Most of the existing wet mill installations in Machakos are outdated. Many of them are a safety hazard and have poor performance in terms of both electricity demand and water usage. An additional problem is that they are not being viewed as suited to women operators, and they cause quality issues for the processed coffee beans. All this together leads to reduced incomes for the farmers and prohibits investments into their farms.

The goal for the main project is to support innovation to enable smallholder coffee producers to access benefits such as improved productivity as a result of efficiency and reduced costs; better coffee quality; help them comply to the legal and environmental requirements (for instance effluent treatment); and increase income for smallholder farmers. Benefits may result from a considerably enhanced performance of the energy performance of motors and pumps; a considerable reduction in water demand; considerable wastewater reduction; significant safety improvement; and gender equality i.e. more work possibilities for women. The possible obstacles for the proposed demand-driven procurement are the risks that come with innovation. The reality of manufacturing in the coffee sub-sector is many innovative products and processes that are hard to protect. One danger cited by possible suppliers is the fear of incurring the initial investment and taking all the risk, only to find that other competitors are also riding on the same innovation.

Financing cooperatives, in particular agriculture-related cooperatives, have also been a concern among the financial service providers. The main problem has been cited as being the difficulty of predicting revenues, mainly due to the volatile nature of the international coffee market and climate change that makes coffee harvests unpredictable.

Regarding gender equality, women currently work in most phases of the coffee production process except as machine operators, which leads to that women are not able to participate all stages of the value chain which excludes them from economic opportunities.

The primary coffee cooperatives are expected to constitute purchaser groups as they are the end users and coffee processing and investment decisions are made at this level. The Machakos Cooperative Union, that is the entry point to this study, includes 28 such primary cooperatives with 61 wet mills. Upgraded coffee wet mills in the country have the capacity to impact on over 700,000 smallholder farmers in Kenya.[3]

To realize the full benefits of a demand-driven procurement project, the need for technical assistance throughout the procurement process is acknowledged, given the limited knowhow that is a characteristic of rural-based primary cooperatives.

Proof of concept

The idea is to apply the method of demand-driven procurement to Kenyan smallholder coffee cooperatives. There are several advantages to doing so. First, there is already a working organization in place, with a common goal and a hierarchy. Second, this method is easily expandable, and it is possible to start in one cooperative or one region with one union, and then increase the scope to a country level and finally to a

[1] In this report 'Demand driven procurement' is used, but there are several other names for this process. Other common names are Innovative procurement, Technology procurement, and Pre-market procurement.

[2] In this report the terminology 'wet mills' is used, but several other terms can be found in the literature such as coffee water mill stations, pulping stations, wet processing stations, and coffee water processing stations.

[3] According to International Coffee Council 124th Session 25 – 29 March 2019 Nairobi, Kenya

multi-country level. Third, this process starts with the cooperatives' needs, In this case, wet mills, and it is then possible to continue with products or systems for the individual farmers.

The strategy is, to begin with, an open call from industry players for proposals and ideas on how to solve the problem. The second step will be to procure the three most promising ideas and demonstrate them in Machakos County with an extensive evaluation. Thereafter, the process will be expanded to the whole of Kenya. Once this process is ongoing, a parallel demand-driven procurement could be started with the cooperatives as intermediates to the individual farmers. Problems to solve would, for example, be to bring down costs for PV systems, tier 3 and 4, by introducing 24 Volt electricity supply systems. Another interesting path in this process is to expand the business for dairy farmers by introducing a cold logistics chain. A third identified interesting product to develop through this process is low voltage induction PV cooking.

During phase two, a buyer's group has been identified, the Machakos Coffee Union with their 28 member cooperatives. Discussions have been conducted with the Union, some member cooperatives, and individual farmers including women farmers.

An expert, the Coffee Research Institute at the Kenya Agricultural Research Organization (CRI-KALRO), has been assisting in developing the performance criteria.

There have been discussions with equipment manufacturers of wet mills represented in Kenya, and other manufacturers have been identified.

95% of the wet mills in Machakos County are more than 25 years old. In the meantime, there has been considerable technical development decreasing the demand for water and energy to one-tenth of the cooperatives' equipment. Demand-driven procurement can decrease the energy and water demand even further.

Gender equality poses a challenge for sustainability in coffee farming, and women are still socially and economically marginalized. Women have an extraordinarily heavy workload, as they have to take care of the family and the household's daily needs, in addition to contributing up to 70 % of the labour in coffee production.

In terms of financing, the major risk identified with demand-driven procurement for wet mills is in financing and in particular the risk that arises from the possibility of the non-payment of loans (credit risk). This risk is known to limit lenders to the cooperatives, leaving only a few cooperative-friendly lenders like the Cooperative Bank, OikoCredit and the Commodity Fund to rely on.

Another risk is the rural to urban migration of the youth in search of further education or employment opportunities. Possibly, efficient wet mills can contribute to better cost efficiency for coffee processing, leading to more interest from the youth to engage in the coffee production process. The effects of climate change and the volatility of coffee prices might also be mitigated by efficient coffee processing.

At the outset, the wet mill manufacturers' willingness to innovate was a concern, but after the discussion with some of the manufacturers this is no longer believed to be a risk.

Lessons learnt: Machakos Cooperative Union has 61 wet mills and only three are less than 10 years old. It is evident that farmers are running obsolete coffee wet mills, and that this is likely to be the situation in the entire country. Further, the upgrading of coffee wet mills is long overdue, and requires innovation so as to meet the 21st century requirements . Finally, climate change is also a threat to the coffee industry, and the coffee industry can also be a threat in terms of climate change, for instance if effluents from wet mills are not properly managed. Overall, there is a clear interest in the methodology of demand-driven procurement from all stakeholders we have encountered during this feasibility study.

Sustainability: The project envisioned by this study i.e. innovatively upgraded wet mills addresses all the four aspects of sustainability namely, political, economic, social-cultural, and environmental.

- Political sustainability: The study and the recommended upgrading of the wet mills is in tandem with the current government initiatives of reviving the coffee sector. The President of Kenya has extended the term of office of the Coffee Sector Implementation Committee he formed in 2016. The extension is for the team to coordinate and provide strategic leadership in the implementation of the reforms recommended by a coffee taskforce. Modernization of coffee processing facilities was one of the recommendations.

- Economic sustainability: This initiative is about coffee processing, which is a critical stage in terms of determining quality, hence better incomes for the farmers. It has been observed that good coffee cherries from the farm may be spoilt if processing facilities are not efficient. The wet processing method involves pulping the cherries, fermentation then drying. This method gives better quality coffee and as such is the main method used in Kenya.
- Social-cultural sustainability: Proposed as part of innovation is ensuring that all genders can equally access employment in operating the coffee processing machineries. Environmental sustainability: the innovation sought is one that supports reduced water and electricity usage as well as effluent and waste management.

Finally, a proposal for the implementation of demand-driven procurement has been drafted.

Working group

The working group behind this report consists of a team from We Effect: George Onyango, Maina Gakuru, Lisa Tistedt and Linnea Karlsson, and a team from Anthesis: Egil Öfverholm and Agneta Persson. Experts from the Kenyan Coffee Research Institute (CRI-KALRO) have also been involved in this study.

1 Background

There is a need to develop new solutions that are simultaneously energy-efficient and cost-efficient in Sub-Saharan Africa (SSA) (e.g. cooling in the diary chain, solar-powered irrigation). There is also a need to develop processes that ensure environmentally, economically, and socially sustainable solutions. The need to develop these processes relates to, among other things, the rapid pace of urbanisation, and the expected modernisation of the agricultural sector. At the same time, these processes must take into account how to adapt to and mitigate the impacts of climate change and build environmental sustainability, as well as ecological and social resilience with a strong emphasis on cooperative development and women's economic empowerment. To pro-actively support the development of new, innovative, and well-tailored energy services, Sida aims to support demand-driven procurement processes, for example, pre-industrial or pre-commercial procurement of technology, or the combination of demand-driven procurement of technology and services. This could include the procurement of an energy service provider based on the specified demand or the proactive and co-creative formulation of conditions for bank guarantees.

In Sweden and similar countries, these are processes that have successfully been applied and that have stimulated new and more sustainable solutions to be developed and enter the market. See for example the Swedish Procurement Agency's (UHM) web-page about pre-commercial procurement. Many countries also increasingly invite bidders to solve semi-defined problem areas in new, innovative, and effective ways. The methodology has however not been tested in developing countries except for India, where it has been implemented after a successful project financed by Sida.

Sida has presented some good examples where targeted procurement has been used, e.g. the social impact procurement model applied in Zambia for the "Beyond the Grid Fund".

The Anthesis Study Procurement Advice for Sustainable Energy (December 2018) concluded that it would be possible to implement demand-driven procurement in the Sub-Saharan context. Two examples were given in the Anthesis report, the logistics of milk for dairy production and PV cooking. An inception report (Anthesis and We Effect, January 2020) from the current study financed by Sida reported on the prerequisites for carrying out a demand-driven procurement pilot project in Kenya, aiming at innovative improvements to existing coffee wet mills.

2 The Task

Demand-driven procurement as such aims at a demand-driven development of new products and bringing these products to the market. In a demand-driven procurement, the product for development has been defined by a purchasers' group. This group also identifies the demands on the new product, often with the help of a technical expert. After finalising the requirement specification, a request for tenders is announced, allowing all interested parties to submit their tenders. After the final tendering date, the received tenders are evaluated, and often testing is involved. After the evaluation has ended the purchasers' group chose one or more winners. The demand-driven procurement process is finished first when the desired product/system is commercially viable.[4]

This study aims to bring a product/system to the market using demand-driven procurement. The study has been divided into two parts, phase 1 (prerequisites), and phase 2 (planning).

2.1 Phase 1: Prerequisites

As the first part of this study, a feasibility study was conducted. The aim of this was to prepare for a full-scale demand-driven procurement process in the Sub-Saharan region.

Kenya has been used as a case study for this feasibility study because of the partner organisations that We Effect works with in the country (both rural development and financial services partners). Besides, there is a high demand for different types of renewable energy products. We Effect's partner organisations at different stages of the agricultural value chain are in high demand of systems like solar-powered irrigation systems, PVC cooled milk tanks, replacement of diesel generators with solar panels at coffee processing sites, etc. There was also a demand to collaborate with We Effect's financial services partners. In phase 2 of the study,

[4] See Anthesis report "Procurement advice for sustainable energy" pages 28 to 43.

it has been investigated how these partners can adjust their renewable energy loan portfolio to the demands of the smallholder farmers.

Moreover, this feasibility study has taken a critical approach, and maps out the findings per gender, and how the possible solution impacts women and men differently. It has been especially important to have this in mind during the methodology development stage, when developing the questions for the focal group discussions with the smallholder farmers, and when scrutinising the results.

The first phase of this study dealt with the following tasks:

- Identify and agree on relevant problems to address in the study.
- Define conditions for the demand-driven procurement, obstacles, and possibilities as well as limiting parameters, e.g. potential structural barriers, norms, values, possible resistance, but also costs, etc. Identify suitable technologies, systems depending on the different needs of the farmers' groups (and in particular between female and male farmers).
- Identify purchasers' groups, i.e. the smallholder farmers through cooperatives (also considering We Effect's values, and especially work with gender equality and women's economic empowerment).
- Identify needs, demands from purchaser groups on desired products, services not currently available on the market.
- Develop 'a proof of concept' where a method that can identify relevant needs and that is replicable in other, similar contexts is identified.

During this phase of the work, we found that smallholder coffee farmers' cooperative wet mills would be a good product to focus on in this study. The reasons for this choice are presented in chapter 3 Relevant problems and possibilities. The phase 1 work was reported in an inception report which was sent to Sida on 17 January 2020, and the results were presented at a meeting with Sida on 23 January 2020. Based on the recommendations in the inception report Sida decided that phase 2 would be focused on wet mills in coffee processing.

2.2 Phase 2: Planning

The second phase of the study has been to plan for the proposed demand-driven procurement pilot project on wet mills for smallholder coffee farmers' cooperatives.

In this study phase the following tasks have been dealt with:

- Beginning of talks, through focal group discussions, with potential participants for a purchasers' group, and preparation for the group to start working. This has been done through workshops with the partner organisation Machakos Coffee Union and focal group discussions with a group of the involved female and male farmers.
- Specification of the performance criteria and testing methods for the selected product.
- First discussions with stakeholders and possible organisations to cooperate with, i.e. the Machakos Coffee Union, the Mayuno Farming Cooperative, the Kenyan Coffee Research Institute (CRI-KALRO), the Kenyan Government's coordinator for the National Coffee Sector Development Programme, equipment manufacturers, utilities and financing organisations such as Cooperative Bank of Kenya which has a long-standing relationship with cooperatives. OikoCredit, having received guarantee funds from Sida to catalyse lending to agriculture, is also an institution that takes part in discussions as part of this study. We Effect and Anthesis visited the stakeholders and afterwards We Effect followed up with contacts through e-mail and the phone. The results are presented under the respective heading in this report.
- Analysis of possible implementation - payment models e.g. Pay As You Go, economic, social, and environmental constraints have been investigated. The mode of payments, terms, and conditions for the loans will be checked, and if possible, proposals for adjustments could be made to the financial institutions. Cooperative Bank of Kenya already has a financial product comprising capital assets acquisition. Completion of the loaning process requires a complete report of the installation

of the equipment. OikoCredit also has products with terms and conditions which allow for borrowing. In both cases, user training is part of the deliverables.

- Phase 2 has resulted in a performance requirement specification for wet mills for smallholder coffee farmers' cooperatives. See Appendix 4.
- Suggested ways forward based on conclusions from the report are presented in chapter 7, Proof of concept.

3 Relevant Problems and Possibilities

In this study, we have identified existing coffee wet mills, a key component in the coffee process, managed by farmer cooperatives, as a major opportunity for improvement. There are several reasons why this is an adequate choice, the most important reasons are briefly described in this chapter.

Main challenges to the African coffee industry

The main challenges to the African coffee industry are:

- Urbanisation, where new urban areas displace coffee farms
- Climate change, where among other factors water scarcity and change of weather seasons already have dramatically changed conditions for the coffee farmers
- Financing, new better-performing equipment is expensive and unaffordable for most of the smallholder farmers
- Obsolete coffee processing equipment, with many coffee mills using outdated technology that is also both labour and water-intensive and has a very high power cost
- Gender inequality, coffee farming is very labour intensive and the working conditions for particularly women are very hard in the coffee industry
- Energy supply is expensive, and existing coffee production equipment has a poor energy performance.

The coffee industry is an important sector in Kenya and many other African countries

Agriculture is the backbone of Kenya's economy, and the coffee industry has been one of the key pillars of the country's economic development for decades. The coffee sub-sector contributes annually an average of USD230 million in foreign exchange earnings and is ranked as Kenya's fourth most important export, after horticulture, tourism, and tea. This key role is recognized in the government's efforts to fight poverty and is central to the agricultural sector's contribution towards the realization of Kenya's Vision 2030, which is the country's blueprint premised on three pillars and in the government's Big 4 Agenda. Kenya prides itself in being a producer of superior quality coffee, largely due to positive attributes arising from favourable growing conditions: well-distributed rainfall, high altitude (1,500 – 2,000 metres above sea level), moderate temperatures and deep red volcanic soils. Also, the method of processing coffee for the market contributes significantly to the above-mentioned attributes.[5]

In Kenya, coffee is grown in an estimated total acreage of 110,460 hectares covering 31 counties. The growers consist of an estimated more than 700,000 smallholders who are organized in cooperatives and 4,000 estate growers (coffee estates with five or more acres of coffee). Smallholder farmers contribute to over 60 percent of the country's coffee production. Currently, 1021 wet mills are operated by 525 primary cooperative societies.[6] The role of the primary cooperatives is to receive, process (cherry sorting, pulping, fermentation, drying, and storage) and market the smallholder farmers' coffee after delivering it to licensed millers for dry processing. Presently, most of the drying milling is done in the respective counties and regions through the farmers' coffee mills that are operated under their secondary organizations (Unions). This has reduced some of the milling-related costs with the resultant effect of reducing the coffee milled by commercial coffee millers.

[5] International Coffee Council 124th Session 25 – 29 March 2019 Nairobi, Kenya

[6] Report of the National Task Force on Coffee Sub-Sector Reforms, May 2016

There are 28 cooperatives/coffee processing stations in Machakos County with a total of 60 wet mills. The total number of farmers in Machakos is 31,111, whereof 12,732 are women (see Table 1) If the same proportion of farmers to wet mills farms observed in Machakos is used as an estimate to extrapolate on the rest of East Africa the result is almost 10,000 wet mills. The number of coffee farmers in East Africa is, based on the same assumptions, estimated to be 5 million.[7]

It has not been possible within the framework of this study to accurately calculate the energy demand for these wet mills since we do not know the age of the existing wet mills except for those in the Machakos County (see Table 1). However, if water demand can be decreased to one-tenth of the current water demand with the new equipment, energy demand could also be decreased to at least the same degree.

Governmental focus area

The Kenyan Government has developed a coffee revitalization programme anchored on the recent "Report of the National Task Force on Coffee Sub-Sector Reforms". The coffee revitalization programme seeks to support farm expansion, adoption of improved coffee varieties, increased usage of affordable/subsidized farm inputs, and training of farmers on best agricultural practices. The government is also keen to enhance the availability of affordable credit to coffee growers. These efforts are projected to spur an increase in the Kenyan coffee production to over 100,000 MT of clean coffee in five years.[8]

To actualize this, the government has enacted the Crops (Coffee) (General) Regulations 2019 and revoked the Coffee (General) Rules 2002 through the Coffee Sub-sector Implementation Committee (CSIC). The government is in the process of developing the Capital Markets (Coffee Exchange) Regulations, 2020 which are intended to significantly change the coffee business. Both regulations have placed the County Governments and the Capital Markets Authority as active players in the coffee value chain, which will have a major impact once fully implemented.

Status of current equipment

Many of the cooperatives' existing installations are outdated, with almost all of them being older than 25 and several of them being 50 or older. Many of them are also a safety hazard and are not suited for women operators (see the chapter on Gender equality further down), they cause quality issues for the coffee beans and at the same time, they have a poor performance, both in terms of electricity demand and water consumption.

Table **1**

According to a survey carried out for this study by the Machakos Coffee Union, almost all of the coffee wet mills in Machakos County are 30 or older. The result of the survey is shown in **Fel! Hittar inte referenskälla.**.

Table 1: Age spread of the coffee wet mills in the Machakos County.

	Cooperative society	Number of wet mills	Energy Demand	No of active members			Machine age	Production 2019 Kgs Cherry
				Male	Female	Total		
1	MISAKWANI	1	Electricity/backup DG	61	31	92	Between 20-30 yrs	28,099
2	KASINGA	1	"	781	379	1160	Between 20-30 yrs	663,047
3	MUSILILI	1	"	217	157	374	Between 20-30 yrs	196,093
4	NGOMANO	1	"	751	194	945	Between 20-30 yrs	223,783
5	NEW MITABONI	5	"	2146	1431	3577	Between 30- 40 yrs	1,156,043
6	MUPUTI	1	"	124	48	172	Between 20-30 yrs	15,205
7	KIKIMA	6	"	2008	842	2850	Between 30- 40 yrs	453,347
8	KALILUNI	2	"	758	492	1250	Between 30-40 yrs & 5-10.	620,468
9	MWATATI	2	"	686	344	1030	Between 20-30 yrs	341,672

[7] International Coffee Council 124th Session 25 – 29 March 2019 Nairobi, Kenya

10	MUISUNI	3	"	2180	724	2904	Between 30- 40 yrs	925,037
11	KITHANGATHINI	4	"	8410	2101	10,517	Between 30- 40 yrs	266,412
12	KAWETHEI	2	"	925	455	1380	Between 20-30 yrs	488,285
13	KAKUYUNI	5	"			964	Between 30- 40 yrs	345,565
14	KYAUME	2	"	946	459	1405	Between 20-30 yrs	386,245
15	KWA KIINYU	2	"	845	432	1277	20-30 yrs & less than 5	386,745
16	KINGOTI	2	"	976	512	1478	Between 30- 40 yrs	230,057
17	SENGANI	2	"	624	285	909	Between 30- 40 yrs	86,069
18	ITHAENI	1	"	189	19	208	Between 20-30 yrs	46,025
19	KILALANI	2	"	1204	868	2072	Between 30- 40 yrs	641,034
20	MUKUYUNI	1	"	576	263	839	Between 20-30 yrs	336,349
21	KITWII	4	"	494	169	663	Between 30- 40 yrs	116,634
22	MUNGALA	1	"	346	230	576	Between 30- 40 yrs	152,036
23	KAMBUSU	2		1235	573	1803	Between 30- 40 yrs	878,245
24	MUTHUNZUUNI	1		1119	460	1579	Between 30- 40 yrs	353,177
25	TENDELYANI	1		587	312	889	Between 20-30 yrs	41,415
26	MASOKANI	1		231	126	357	Between 5-10 yrs	60,167
27	KITHUMANI	1		345	258	603	Between 20-30 yrs	40,895
28	MBILINI	3		2347	568	2915	Over 40	345,899

Coffee Wet Mills

Innovations in coffee processing go back to the time of the industrial revolution. Two of the coffee processing companies are more than 100 years old: Marshall Fowler Group (MFG) with their headquarters based in Nairobi, and Penagos Hermanos in Colombia. During the second half of the last century, Pinhalense in Brazil and Vina Nha Trang in Vietnam were established.

The quality of selective picking decreased over time, and partially ripe and unripe cherries started to be picked in larger quantities. Technical solutions to this were the mechanical siphon and mechanizing the removal of mucilage. Originally developed in Brazil, green cherry separation and pulping systems were introduced around the world.

While each company's system differs in the amount of power and water demand, most of them use similar processes and techniques. Wet mill designs now incorporate mechanical or vertical siphons, green cherry separators, screen pulpers, and repassers to optimize water use. Some also use sieves, screens, and screw conveyors.

The benefits of the latest generation of pulpers include less loss of parchment coffee in the pulp, little to no physical damage to parchment, and lower water consumption. Also, less physical space is needed for many models. As a result of less water demand the electricity demand for the pump can also be reduced. In addition, the efficiency of pumps has increased considerably.

Coffee research centres and equipment manufacturers continue to look for ways to improve coffee processing techniques. Trial projects and production-ready deployments continue in coffee-growing regions around the world. The major technical challenge is reducing water demand and at the same time maintaining the quality of the coffee beans. However, the main obstacle for the equipment industry is the reluctance for wet mill owners to invest in new technology.[9]

See Appendix 5 for information on wet mill producers.

[9] https://stir-tea-coffee.com/features/wringing-best-wash-drier-wet-milling-quality/

Water demand

The installed wet mills in Kenya have very high water consumption. According to the Kenyan Coffee Research Institute, it is common to have water consumption as high as 12 litres/kg coffee cherries.[10] A rough calculation based on estimated hours in operation and the pump capacity for the cooperative in Mukuyuni, Machakos County, gives 21 litres/kg coffee cherries. Also, the large water consumption causes problems with the treatment of the effluent, and it also has severe impacts on people's quality of life downstream of the coffee washing station. Wastewater from coffee processing remains a persistent polluter, affecting waterways, soil, health, and the entire coffee-growing community. Coffee wastewater often contains large quantities of organic matter, which is extremely acidic and has a high biochemical oxygen demand.[11]

Already today, coffee farmers are experiencing large problems with water supply, and these problems will increase if actions are not taken. According to the Machakos Coffee Union, two of their cooperatives have already had to close down due to lack of water supply, and several other cooperatives are facing the risk of having to do the same.

The proposed demand-driven procurement performance specification, see Appendix 4, would lead to both reduced water consumption and the need for wastewater treatment, and hence contribute to both climate mitigation and adaptation.

Metering water from the source to end will have to wait for the next phase. The assumption, for now, will be 10 to 20 l/kg.

Energy demand

In the worst case, the energy supplying the wet mills comes from diesel generators. In Machakos County, however, all energy for the wet mills comes from the electricity grid, whereas diesel generators are only used as a backup.

Most, if not all, of the wet mill's energy demand is used for pumping water. Therefore, decreased wet mill water demand is the most important measure to reduce its energy demand. There have been considerable advances in pump efficiency, particularly in smaller sizes, in recent years. It is also important to choose the correct pump dimension and adapt it to varying demands. The European Union's Ecodesign Programme has identified energy-efficient pumps as a major efficiency technology with an estimated saving of 3.3 TWh per year in Europe.[12] The energy-efficiency potential for pumps is large in Africa too, and pumps are the major energy users in wet mills.

Drying of the coffee cherries is usually done in the sun, but varying weather caused by climate change might decrease this possibility (see climate change further down). An alternative might be infrared drying.[13] However, this would increase energy demand.

There is also the potential to use residuals from the process as an energy source, which could be used in the process.[14]

Energy and peak demand

The existing coffee wet mills have a high electricity demand. They also have a high peak electricity demand, which poses an extra problem if PV electricity supply is to be considered in the future. PV is not suited for peak demand, but if the electricity peak demand of the wet mills can be reduced, it should be possible to connect them to a PV microgrid system. All of the existing wet mill stations in Machakos County are equipped

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[10] Monitoring of water consumption is planned to take place at the Mayono Coffee Cooperative if this study continues.

[11] Coffeelands, 2018-01-24

[12] https://ec.europa.eu/info/energy-climate-change-environment/standards-tools-and-labels/products-labelling-rules-and-requirements/energy-label-and-ecodesign/energy-efficient-products/water-pumps_en

[13] ://www.sciencedirect.com/science/article/pii/S096195341830299X

[14] *Characterization of residual biomasses from the coffee production chain and assessment the potential for energy purposes*, Clara Lisseth, Mendoza Martinez, Elém Patrícia, Alves Rocha, Angélica de Cassia, Oliveira Carneiro et al., Elsevier 2019

with a diesel gen-set for back up. According to the Kenyan Coffee Research Institute (CRI-KALRO) an energy demand of 4.5 kW from the water pump to repasser is not uncommon.

The proposed demand-driven/innovative procurement would lead to significantly reduced energy and peak demand, and hence contribute to climate mitigation.

PV microgrids and wet mills

For coffee processing stations without connection to the main electricity grid, the only option has been to run the wet mill with diesel gen-sets. As the wet mills are only used for a limited period of the year, it is hard to motivate photo voltaic (PV) driven systems. The PV system can of course be used for other purposes in a microgrid for e.g. water pumping or domestic demands when the coffee processing equipment is not operated. However, you would then have a conflict when coffee processing starts. A prerequisite for a PV microgrid with wet mills would be to reduce the peak power needed for the mill to a level where its demand for power is reduced to a level that will not conflict with other users. If a wet mill using 4.5 kW can be reduced to one-tenth, then it would be much easier to integrate it into a PV microgrid.

As noted below (New Technology), a reduction in water demand of at least 90 percent and a similar reduction in power demand is possible.

New technology

There has been much progress concerning efficiency for wet mills over the years. Most efforts have been focused on water demand reduction, which in turn has reduced pumping demand leading to reduced energy demand. This has been acquired partly by recirculating the water for up to two days and refining the process. However, recent developments of motors, variable speed drives, pumping, and control technology are yet to be explored. There seems also to be opportunities to reduce water demand even further. Technologies for reducing water demand from 12 to 1 litre per kg coffee exist today.

Demand-driven procurement could be a method to unleash the potential.

Climate change

Quote: “Now, we are suffering from diseases we have never seen before,” said Mutisya, 67, Machakos. [15]

Average Kenyan temperatures have risen by 0.3 degrees per decade since 1985, according to USAID. More erratic rainfall and long spells of drought are reducing quality and yields. In the 1960s, Kenya averaged one storm day - more than 50 mm of rain in 24 hours - per year. In 2017, five storm days occurred. The storm days damage fragile roots and throw off the ripening cycle.

The ongoing climate change will increase the problems with water scarcity. Apart from this the coffee farmers and cooperatives will also face climate change challenges from changes in weather seasons. In addition, low coffee prices mean farmers cannot invest in planting shade trees, disease-resistant seeds, or new irrigation.[15] The proposed demand-driven procurement main project may also equip the farmer cooperatives to better cope with these changes.

Safety

As already stated, the farming cooperatives’ current equipment is old and outdated. The equipment has numerous uncoated parts and poses a safety risk to its operators. Additional safety concerns for women are explained below.

The proposed demand-driven procurement would lead to safer equipment and increase workplace safety for all coffee cooperative workers.

Gender equality

Sustainable Development Goals underpin the significance of gender equality in realising sustainable development. This proposition has been noted as very important, especially because women make up half of the world’s population, and yet they are systematically discriminated against in most sectors including the

[15] Reuters

agricultural sector which is the main source of livelihood for over 80 percent of the population living in conditions of poverty in rural areas of Sub-Saharan Africa. The situation is worse for women in rural areas due to entrenched patriarchal and patrilineal practices in inheritance, leadership, and general control of resources. The cooperative sector, particularly cash crop-related cooperatives, is heavily patriarchal as the cash crops provide the main source of income for households, so men take charge of the incomes as dictated by patriarchal beliefs and practices in the communities. This can be demonstrated clearly by the fact that women form the majority of the world's estimated 25 million coffee farmers, yet coffee is seen as a man's crop.[16] Women provide over 60 percent of the workforce on farms and at coffee wet mills, therefore women are present as providers of labour but absent as active players in the processing, marketing and control of the benefits that arise.

Women are often barred from becoming a member of cooperatives because they are not landowners, cannot afford the cost of membership, do not deliver the prerequisite number of kilograms (usually high) for them to qualify to vie for leadership or the circumstances of leadership are patriarchal, so they do not conform to expected gender norms for women, which means that they shy away from leadership to avoid societal backlash. The coffee sector falls under this category of cooperatives mainly dominated by old men. It has been postulated that it is because of the lack of gender equality and involvement of young people that the coffee sector has been beset by a rapid decline in the Eastern Africa region. In Kenya, land ownership is culturally dominated by men, and old men in particular. The average age of Kenyan coffee farm owners is 60 years. Presently, women who own farms are largely those who have been widowed as those who are single or married are not allowed to own land, based on existing patrilineal practices of inheritance. Without access to credit, which is the case for most women, they have difficulties purchasing land, and even when land is obtained, they lack the resources to farm and maintain it. All these conditions of inequality pose a challenge for sustainability in the coffee sector.
When it comes to leadership, women are rarely included as cooperative leaders and in cases where women do obtain leadership positions, sometimes the traditional patriarchal systems still exclude them from primary decision-making processes as they are assigned peripheral roles. This leaves out women from the executive organ of cooperatives so their influence is still limited.

Although the cooperative sub-sector has made efforts to improve this, women are still marginalised in various ways, which make it difficult for them to engage maximally and receive meaningful returns from the sub-sector. For instance, women typically have an extraordinarily heavy workload, as they have to take care of the family and the household's daily care needs, in addition to contributing up to 70 percent of the labour in coffee production. Unfortunately, the arising monetary benefits are controlled almost fully by male "heads of households", who most often do not allocate substantial benefits to family needs. This is a common source of gender-based violence and family conflicts.

The importance of enhancing women's participation in the agricultural sector has been emphasized in various studies, for example, FAO (2010) argues that "if women had the same access to resources as men, they would produce 20-30 percent more food on their land". This is a fact that We Effect recognises and it has been working on enhancing meaningful women's involvement in the various sectors that are targeted.

In terms of employment in the coffee sub-sector, 75 percent are men and 25 percent are women. Casuals and part-timers constitute 21 percent of the total, of whom 20 percent are men and 24 percent women.[17] Regarding employment in wet processing plants, for instance within Machakos Cooperative Union, none of the machine operators are female. Outdated and heavy equipment with safety concerns were observed at the processing sites.

Women interviewed in this project felt that safety in wet mills appears to be designed by men and for men. They complained of ill-fitting personal protective clothing and equipment, and they observed that clothing or equipment that is not sized properly or does not fit properly can compromise personal safety. There was a false assumption at the start of this project that women were unable to use the machines due the size and

[16] *Sustainable coffee as a Family Business*, Published in October 2014

[17] Inventory on Women Friendly Tools. ICAR (2016)

unsuitability of these machines. However, based on the data collected it emerged that women were able to use the machines, but the machines posed significant safety risks for both men and women. However, the risk is greater for women because as stated in the interviews the machines were 'designed by men'. Women have for instance complained that protruding components of the machinery can get caught on their clothing and this means the women are reluctant to use the machines. The study highlighted that based on the age of the machines and the design they are viewed not appropriate for women by men. This study also emphasised that the attitudes and norms of the male farmers about what was and was not appropriate for women means that women are being excluded from these economic opportunities.

This issue needs to be addressed in two ways. Firstly, it is critical to work on gendered norms to address these barriers to ensure that women can be involved in more stages of the value chain. In addition, machinery and protective clothing needs to be designed by women and being appropriate for women. As a result, it is necessary to ensure that women are involved in the procurement of the machines, training in use of the machines as well as ongoing support in handling the machines.

Generational problem

The coffee sector struggles with a generational problem. As earlier stated, studies undertaken in Kenya indicate that the average age of a coffee farmer is 60. This implies that the youth have opted to abandon coffee farming in pursuit of other more appealing enterprises such as dairy and horticulture. Additionally, the youth experience many challenges like lack of ownership of land, coffee trees, access to training and finance, and benefits derived from coffee. As a result, those who can find jobs in towns leave rural areas, looking for employment in urban areas.

The lack of young coffee farmers is a threat to the future of the coffee industry. Continuation of coffee production by the 'next generation' is therefore at stake and this poses a great risk for the coffee sector as a whole which requires intervention.

The volatility of the coffee market

The volatility of the coffee market with significantly fluctuating prices is also a major challenge for the coffee farmers, and female farmers in particular.

The volatility of the coffee market (prices) is an important factor. Until 1989, the coffee market was regulated by a series of International Coffee Agreements which were intended to manage supply and maintain price stability. This system subsequently collapsed, and since 1990 the coffee market has been subject to the free market forces of supply and demand.[18] Coffee price volatility is detrimental to the sustainability of the coffee sector because coffee producers can't possibly react in a timely way to short-term price signals. Coffee is a perennial crop, while the C-Price (futures contract price) fluctuates daily. The C-Price is known for being extremely volatile, and this volatility negatively affects the coffee sector, where farmers and farm workers suffer the most.

When farmers face price uncertainty, especially prices that do not cover production costs, they reduce investments, creating a downward spiral of poor production and low income, effectively negating any initiative expected to promote coffee farming such as upgrading coffee wet mills. The solution approaching a holistic approach to uplifting smallholder coffee farming is agreed to be the encouragement of direct sales of coffee and coffee certification to attract minimum pricing agreements like the one offered and guaranteed by Fairtrade. Fortunately in Kenya, there are two coffee marketing systems created by law. The central auction system, where coffee is bought by the licensed coffee dealers through competitive bidding, and the direct sale, commonly referred to as "second window", that requires that a marketing agent directly negotiates with a buyer. There are two notable categories of Marketing Agents, namely Commercial Marketing Agents who offer their services purely for commercial purposes (and through which price volatility thrives), and the Grower Marketing Agents who are growers marketing their coffee (like the Machakos Coffee Union). To realize the full benefits offered by the upgraded wet mills, the study proposes the use of the direct marketing of coffee.

[18] Daily Coffee News by Roast Magazine, September 2018

4 Concept

As a solution to the issues and problems presented in chapter 3 (Relevant problems and possibilities), we suggest using the 'demand-driven procurement' concept.

Demand-driven procurement means that a group of buyers together with experts and a leader (agent or facilitator) define a product or system that does not exist on the market. It could provide better performance or new functions. The concept is further described in Annex 6.

Demand-driven procurement refers to a procurement process where a third party, such as a government agency or similar actor, supports a process where supply meets demand.[19] The method as such is simple and well established. The challenge at hand is to apply the methodology in Kenya. A demand-driven procurement scheme is a complete tendering process, with the purpose to develop and implement new technology with functionalities desired by the end-users.

An essential part of a procurement process is the development of the specification. The Performance specification, Appendix 4, has been discussed with female and male farmers, the farming cooperative in Mukuyuni, the Machakos Coffee Union, and the CRI-KALRO).

Main requirements:

- Coffee bean quality (sustained income)
- Water demand (climate change adaptation, decrease in wastewater and lower operating cost)
- Energy demand (climate change mitigation and operating cost reduction)
- Electric power demand (making PV possible)
- Gender friendliness
- Digitalisation possibilities in next step (to innovate and modernise)
- Simple to operate
- Naturally, also cost efficiency

The specification in Annex 4 can be used as it is already today by professionals in their purchasing activity. It is however strongly recommended that a pilot phase is carried out so that improvements can be made. The verification of performance also needs to be addressed.

A step by step approach can be applied with possible future additions such as digital weighing, digital sorting, PV electricity supply, standby power (all stations currently have diesel gen-sets for standby).

We propose the Machakos union with its primary cooperatives as a purchaser group, see below.

Technical expertise is essential in the main project like this. CRI (KALRO), the Kenyan Coffee Research Institute, has experience and local knowledge in coffee processing. CRI (KALRO) has installed an eco-pulping facility in one of its stations. There are important possible synergy effects between the demand-driven procurement proposed here and KALRO's eco-pulping project. Therefore, we propose that the monitoring and verification methods should be developed together with KALRO.

We Effect is also managing other projects promoting producers, and those projects will go hand in hand with this demand-driven procurement. The projects will strengthen each other and strengthen the smallholder farmers, purely as commercial development.

Manufacturers and their ability to innovate may pose a possible bottleneck and could cause reluctance. Priority will be given to manufacturers with a local presence (at the same time observing the law of procurement). As a next step in the process, all potential manufacturers should be informed at a common meeting.

[19] See e.g. Persson A and Öfverholm E, *Procurement advice for sustainable energy*, December 2018, Anthesis report

The result of this demand-driven procurement will be a modernisation of the coffee cooperatives which will improve the lives of the farmers.

5 Conditions for Demand-driven Procurement

A demand-driven development process is often referred to as "the art of buying what's not available on the market". The main factor of the process is innovation, since the process aims to create new products, new designs or new services. The way to spur innovation through demand-driven development is to put together a requirement specification based on the end users' interests. A requirement that always is a part of a demand-driven development project is that the product/design/service has to be economically viable. This is often the most difficult requirement to achieve in a demand-driven procurement process.

In this particular case the market does not offer any solutions tailored to the coffee cooperatives needs for upgrading their existing wet mills, this is obvious based on the discussions the project team members have had with representatives from the Union, the Machakos cooperative, and the manufacturers. In addition, the cooperatives cannot afford the equipment available on the current market. Therefore this demand-driven procurement project is focusing on both the technical development of equipment and the need to develop financing solutions suitable for the cooperatives.

The willingness to innovate, both from the purchaser's and the manufacturer's side, can in some cases imply an obstacle. The discussions held with all kinds of stakeholders in the value chain in this study give the impression that this is not the case for Kenyan smallholder coffee farming cooperatives. On the producer side, there are manufacturers in Kenya, with international competitors located in Brazil, Columbia, and Vietnam. It may be difficult to stimulate the major equipment producers abroad to innovate if they cannot immediately foresee a significant order. On the other hand, producers in Kenya may not have the required engineering expertise. If we can create a market by gathering enough 'purchasing power' through Kenyan cooperatives, equipment manufacturers would likely be interested in developing the equipment we are asking for.

No restraints related to structural barriers, norms, values, or possible resistance have been found. For a development project of this kind costs are crucial, both investment costs and operating costs. The goal for the main project, from an economic point of view, is to reduce the operating costs so much that they by far outweigh the financial costs for procured machinery.

There are various ways to achieve this:

- Water demand may be decreased from 12 to 1 litre per kg coffee with existing products from the main equipment manufacturers. With demand-driven procurement, the performance could be improved even further. This in turn would reduce the need for wastewater treatment. It would also reduce the electricity needed for pumping.
- More efficient pumps and motors. Both have seen considerably increased efficiency in recent years.

If the existing manufacturing industry in Kenya takes on this challenge it may also have positive side effects. A newly formed government action plan is chaired by the president. The timing of this demand-driven procurement could coincide with the governmental coffee sector programme.

We Effect's network with the stakeholders has been established over a long period of time, and this will make implementation quicker and more efficient.

Technical coffee production expertise exists within Kenya, one example is the Coffee Research Institute, (CRI at KALRO).

Financing

Financing the investment could be the major obstacle for the introduction of energy and water-efficient wet mills in the smallholder farming cooperatives.

The banks are cautious with giving loans to agricultural cooperatives. The banks are hesitant for multiple reasons, including the difficulty for the cooperatives to provide collateral and the uncertainty of the loan's repayment, which leads to high-interest rates for the loans granted. The challenges in meeting loan repayments arise due to reduced yields, fluctuating market prices and the high cost of inputs. Due to the anticipated risks, the banks only approve small loans which often cannot cover the purchase of modern

processing equipment for the cooperatives. However, cooperatives in Kenya have a cooperative friendly bank, namely the Cooperative Bank of Kenya, which can be approached to support the upgrading of coffee wet mills through Machakos Coffee Union. The Union is a shareholder of the bank.

OikoCredit is also a financial service provider in the country which the purchaser groups can approach for funding. OikoCredit is a social impact investor and worldwide cooperative. Loans are provided to partner organisations which aim to contribute to improving the lives of low-income people and communities. OikoCredit seeks to provide loans of between € 500,000 and € 10 million to organisations who are active in financial inclusion, agriculture, and renewable energy. The loans typically mature in 3-4 years.

Another possible source for funding for upgrading wet mills is the 'Commodities Fund'. The mandate of the Fund is to provide sustainable and affordable credit and advances to the agricultural sector for inter alia, agricultural infrastructure development, support for agricultural value adding initiatives, and price stabilization which can be used to mitigate the volatility of coffee prices. The earmarked facility is the long term loan for 'Coffee Machinery and Equipment Loan (CMEL)', meant to facilitate the acquisition of machinery and equipment for borrowers. The loan runs for a period of up to 60 months. This type of funding has not been used by the cooperatives We Effect is partnering with before, but the funding is known to be cheaper than the regular bank loans so this could also be an alternative to look into. One more advantage of this type of funding is that it also offers more possibility to adjust the repayment period of the loans. Regular bank loans are built on the idea that the loans should be repaid with the same regularity over the year, which can be a challenge for farmers whose income is often not regularly distributed over the year. The Commodities Fund offers more possibilities in adjusting the repayment scheme to when the farmers are getting income from their crops, which is sometimes dictated by weather patterns. The Commodities Fund is highly recommended and should be prioritized for being a government facility whose lending terms are not as stringent as the terms in the purely commercial market.

Given that the specifics of innovation have not been finalized by the purchaser group (demand-driven), the actual cost elements have not been agreed upon. The specific cost elements will be identified in the next phase to enable computation of Capital Expenditures (CAPEX) and operating expenses (OPEX). It is the computation of these specific cost elements that will dictate the rate of return/repayment period including the accruing benefits to the primary cooperatives and their farmers. However, experience shows a cost of about SEK 500,000 for a new wet mill (3-4 discs processing machinery). It should be noted that no new construction of the building will be expected, instead there will be adjustments to the existing facilities to accommodate any innovation, hence very minimal extra-costs.

6 Purchaser Groups

Cooperatives are generally well organized in Kenya. They typically form a union covering one or two counties. The proposed purchaser groups for the first phase of this demand-driven procurement are two to three coffee cooperatives in the Machakos County. The selection of Machakos County as the host for the first purchaser groups is based on the fact that the Machako County borders five other coffee-growing counties, namely Kiambu, Embu, Makueni, Muranga, and Kirinyaga. It will therefore be easy for coffee farmers from the other five counties to travel to the suggested three showcasing sites in the Machakos County, which will increase the possibility of showcasing the project.

The purchaser groups are expected to be constituted of primary cooperatives whose members are the individual farmers. It should be noted that the cooperative law governs cooperatives in Kenya. The rules recognize primary cooperatives as the decision-making units, which here is a cooperative union. Procurement (upgrading) and ownership of the wet mills will therefore be handled by the individual primary cooperative and members of each of the primary cooperatives will have to approve the upgrading including any borrowing of funds.

The cooperatives own and run processing equipment a single farmer cannot afford on his/her own. In this case the equipment is the wet mill with additional components. A cooperative is organized by a board, normally consisting of 9 to 12 people. The size of such a group is ideal for a demand-driven procurement according to experience from Sweden. It should also be noted that it is not uncommon for a purchaser group to deal with more than one demand-driven procurement (product) at a time. If this wet mill procurement works well, the methodology could be implemented on other technologies such as dairy farm logistics or

cooking using PV and induction stoves. An important issue is commitment and ownership from the purchaser group, and taking proper minutes from the meetings and documentation is necessary and important.

Financing of the new equipment is one of the challenges faced by the cooperatives who wish to procure the new equipment. This is due to their inability to predict revenues given the volatile nature of the international coffee market. Furthermore, there are only two harvests per year and climate change is taking its toll in unpredictable ways. Another need for the farming cooperatives is technical assistance through the procurement process.

With good result and sharing of benefits from the upgraded wet mills it is highly likely that all the other coffee cooperatives in Kenya (250 – 300) will also take up the innovations/technology impacting 700,000 smallholder farmers.[20]

7 Proof of Concept

Several problems might arise during the demand-driven procurement process. The procurement specification, see Appendix 4, might be too demanding or uninteresting for the manufacturers, the financing might be too limited, or the cooperatives might be too conservative or uninterested in the new product. However, so far after contacts with most kinds of stakeholders including manufacturers, there only seems to be one major hurdle, and that is financing. In the previous chapter financing solutions were elaborated, but before it is worth commencing a demand-driven procurement a method of financing of coffee wet mills in general has to be established.

In order to test the concept, we propose that two to three pilot procurements using the specifications in Appendix 4 are carried out. Such a test run would verify the specification, identify the cooperatives' acceptance of the new technology, define testing methods, and test the acceptance by banks to finance the initiative. The primary coffee cooperative affiliated to Machakos Coffee Union is the proposed buyer group.

Proposed process

In the proposed ongoing process, provided further funding for the main project is secured, the plan is that the coffee-producing primary cooperatives in the Machakos County will be organized by Machakos Coffee Union to join a purchaser group for upgrading their wet mills.

The purchaser group together with the experts led by CRI and Anthesis have developed a specification including performance criteria such as litres of water, energy and peak power needed to process the cherries, see Appendix 4. In addition, demands have been set on safety, noise level, capacity, maintenance, gender equality, etc. Provided the next phase is funded, the next step will be to revisit the requirement specification and finalise it. This will be followed by a request for tenders by the purchaser group under Machakos Coffee Union. One to three manufacturers will be selected after the evaluation phase of the tendering process and asked to deliver prototypes for testing according to a testing protocol included in the request for tenders. After the pilots have been tested by CRI at KALRO, the cooperatives and the farmers will deliver their input to an updated performance specification. Then follows the large-scale procurement.

There are several advantages to using this approach. First, there is already an established working organization with a common goal and an established hierarchy. Second, the working method is easily expandable, the main project starts with one smallholder farmer cooperative or one region with one union and can then scale up to country level and finally to a multi-country level. Third, this demand-driven procurement main project takes its starting point from the cooperatives' needs, in this case, coffee processing wet mills, and can then continue with additional systems such as PV and other products and/or systems for individual farmers, for example, 24-volt electricity supply systems. Relevant needs can be identified by interviewing all stakeholders in the value chain, i.e. the union, the cooperatives, and the individual farmers. This main project needs identification to be done for each product group (tea, dairy, etc).

A Project Manager for the main project is necessary. When demand-driven procurement is used in Sweden this function is called the "Agent". That term can be ambiguous, so our proposed wording for the African

[20] International Coffee Council 124th Session 25 – 29 March 2019 Nairobi, Kenya

context is 'Facilitator'. In the pilot and main project, the Facilitator is suggested to be We Effect. If a suitable person cannot be found within the organization, a suitable person could be recruited, or a consultant could be hired. The requirements for a facilitator are good organizational skills, experience of managing projects, good local knowledge, and preferably some basic knowledge of the technology the innovation procurement is focusing on. Support from a technical expert is needed throughout the whole process.

Funding could be done in steps, but it is essential that funding is credible in the eyes of the desired manufacturers and that it will persist over time. In the main project, we suggest that the funding of the actual procured products should correspond to the difference between the annualized cost for financing and operating costs of the procured product and the annual operational costs of the existing installation. This means that the cooperatives' annual costs will be the same before and after the procurement. These costs have to be covered by the main project financing organisation (Sida).

Once a cooperative has repaid its basic loan the cooperative will benefit from much lower operating costs than before.

8 Conclusions

The proposed demand-driven procurement study of existing smallholder coffee farmers' wet mills (a key component in the coffee process, managed by farmer cooperatives) provides many major opportunities for improvement. Many of the existing installations are outdated, many of them are a safety hazard, they have a poor performance both concerning electricity demand and water consumption, and they are not being viewed as suited for women operators. The new equipment to be developed will improve the quality of the coffee beans, lead to increased incomes for the farmers, improve gender quality, contribute to climate mitigation as well as adaptation and can potentially also contribute to solving the coffee industry's generational problem.

9 Recommendations and the Way Forward (Future Role of We Effect)

The overall objective of this study was to inform coffee producer cooperatives in the region of how to upgrade their ageing wet mills in the most innovative and affordable ways. The next step will be for We Effect to develop a pilot project to realize the upgrading or development and installation of two to three pilot centres.

The following steps will be taken to prepare the envisaged pilot project:

- We Effect will develop a project document to help seek funding to actualize the upgrading or development and installation of two to three pilot centres. The pilot centres are mainly to enable verification of the specification, cooperatives' acceptance of the new technology, define testing methods, and test banks' acceptance to finance the initiative. The pilot centres are also to be used as reference points and demonstration sites to market the innovations to the coffee farmers and the other coffee cooperatives in the region. Other than Sida, We Effect could for instance approach the Embassy of Sweden in Kenya for funding.

Upon approval of the project and funding of the next phase (development of the two to three reference points), We Effect will oversee the project implementation, and specifically facilitate the following steps:

- Machakos Coffee Union Ltd as the secondary level organization and a We Effect partner organizing the primary coffee cooperatives into zonal purchaser groups equal to the number of pilot projects.
- Machakos Cooperative Union Ltd and CRI to come up with criteria for selecting the pilot project sites and together with the participating purchaser groups settling on the most appropriate sites.
- A final review of the requirement specification, which will be used as a check list to see whether the developed/produced wet mills meet the set standards.
- A tendering procurement process will be conducted, based on the specification, to identify the most qualified supplier to provide the prototype equipment for testing.
- The winner(s) will be asked to deliver prototypes for testing and verification. Review of the prototypes will be done based on a testing protocol, that will be included in the request for tenders. If the testing is successful, the production of the final version of the wet mill will commence. If the

testing fails discussions will start with the manufacturers, and improvements are proposed. Input from the purchaser group and experts is essential at this stage.

- During the pilot project, We Effect will also broaden the outreach of the project to include three more coffee unions that We Effect are already partnering with; the Kipkelion coffee union, the Meru Coffee Union and the Gusii coffee union, to involve them in the demonstration sites to market the innovations to the other coffee cooperatives in the region. The aim is that this will create a critical mass of purchase groups which makes economic sense for a continuation of the demand-driven procurement groups beyond the pilot phase. The unions have together around half a million coffee farmers. The plan is thereafter to also engage the National Coffee Sub-sector Implementation Committee (CSIC) to commit to the upgrading of coffee wet mills as a priority.
- Consultations will be held with County Governments and other industry players to seek political support and buy-ins to upgrade the ageing wet mills within all of the counties.
- We Effect will facilitate discussions with cooperative friendly financial service providers/leaders (Cooperative Bank, OikoCredit and the Commodity Fund) for the establishment of a special loan product to enable upgrading of the outdated coffee factories/wet mills for all of the unions that might be interested in the next phase of the project.
- We Effect's plan is to take charge of the pilot stage (including overseeing financial management) up to the level where the demand-driven procurement process will either result in the desired product/system becoming commercially viable or unviable. If viable, We Effect will promote the innovations in other partner organizations engaged in coffee within the region. If it against all odds proves to be unviable, We Effect will document lessons learnt and share them with all the stakeholders.

Appendix 1 Unions, Mills and Farmers, Two Visits Down the Value Chain

In December 2019 and February 2020, We Effect and Anthesis undertook their scouting and fact-finding mission to the Machakos County, two hours south-east of Nairobi.

On 17 December 2019, Maina Gakuru from We Effect and Egil Öfverholm from Anthesis, visited and had discussions with the Coffee union in Machakos County, the cooperative in Mukuyuni and an individual farmer in Mukuyuni. A second visit was paid in February 2020 by Maina Gakuru from We Effect and Agneta Persson from Anthesis.

The Union in Machakos

The union was represented by CEO Martin Malila, Project Manager James Ndeto, and Project Leader Jecinta Nduku.

The union is an umbrella organisation with board members from 15 co-ops. There are 60 pulping stations and the union covers two counties. It was set up in 1972, and t has been collaborating with We Effect since 2010. Of the 60 pulping stations in the union, all have electrical grid access, and 50 of them have diesel gen-sets as a backup. There are to date no PV installations. The main costs for the cooperatives are electricity, water, transport and maintenance of machinery. The average age of the machinery is 50 years (dating from when many of the cooperatives were started).

The cooperatives need to achieve the highest possible quality of processed coffee cherries since the quality affects price considerably. The quality levels are AA, AB, PB, C, T, TT, and E, where AA is the best. The quality is affected on the farm by many factors. The wet mill machinery affects the coffee bean's quality, and recently climate change has been added to this list of factors.

IT systems with newly developed software will be linking the farmers with the unions. The main purpose of this is records and accounting.

The cooperatives are often indebted, and access to financing is limited due to the price volatility on the international coffee market, and only two harvests per year. Thus, it is difficult to assess the risk for the financing institutions, and the consequence for the farmers and cooperatives is no credit or high interest rates.

As an example of innovation, the Ecopulping machine pilot project was mentioned. The machine is manufactured in Colombia and is currently being tested by the Coffee Research Institute in Transnzoia County.

The Cooperative Mill in Mukuyuni

On 17 December 2019, Maina Gakuru from We Effect and Egil Öfverholm from Anthesis also visited the cooperative mill in Mukuyuni. They were welcomed by Gideon, the director, board member Checzah and Victor, a farmer. They were accompanied by James from the union. A second visit was paid by Maina Gakuru from We Effect and Agneta Persson from Anthesis in February 2020. They met and had discussions with seven farmers (five males and two females).

The Mukuyuni Cooperative was founded in 1989. It has 1203 members, whereof 889 are active and 563 are males. The advisory committee consists of 15 members, whereof three are women.

They have a three-year production planning layout. Their major concern was the price decline from $50 to $30/kg.

In addition to coffee, they grow tomatoes and farm chickens, and dairy products are planned for.

Most of all they need a new coffee processing wet mill. There were concerns about the safety of workers handling the machinery, and accidents had occurred. Only men operated the machine. Another problem is maintenance, including the high cost of exchanging the rotary discs for grinding (20,000 Kenyan Shillings). Water usage is another problem. The time that has to be allocated for fermentation and the labour intensity are also concerns. Damage to the coffee beans in the wet mill machine are too frequent and result in a lower price for their harvest. The diesel gen-set for backup is seldom used, and the cost of electricity from it is double compared to electricity from the grid. They were aware of the eco-pulp machine.

From a farmer's perspective, income from the coffee beans is most essential. Related to that is the risk of theft. Securing the harvested beans is essential.

Fact-finding Mission in February 2020, Agneta Persson, Anthesis, and Maina Gakuru, We Effect

The Union in Machakos

The first visit was to the union in Machakos. Seven board members participated (six males and one female), and for the most part these were the same people who attended the December scouting tour. The wording wet mills was questioned. The board suggested Coffee washing stations or wet processing instead. After having sorted out the linguistic misunderstanding, a good discussion took place. The union members had a series of additions and comments on the draft requirement specification on quality, weight, digital weighing, that the coffee beans should not be damaged in the process (reduce friction so that the beans do not get damaged), gender equality, safety for both men and women, ability to recirculate water, use the pulp, reduce the power requirement and drying.

It was mentioned that there are approximately 60 coffee washing stations in the Machakos Coffee Union, and they promised to compile a list of the ages (in intervals) of the stations and ensure that we would receive copies of the electricity bills for two or three cooperatives.

The Cooperative Mill in Mukuyuni

One of the Union board members then joined us on the visit to the Mukuyuni farming cooperative. There a meeting with seven farmers (five males and two females) was held. They were very positive and benevolent. The visit started with a tour of the mill. Their machinery dates from 1989.

The farmers' main thoughts on the need for new equipment concerns water use (the pulp will be difficult to handle without water), reduced damage to the beans in the process, electricity supply (they are strongly interested in PV), and safety.

During the meeting, a lot of other ideas and thoughts were brought up, particularly when they were asked to think completely freely:

- They would like a completely closed machine (self-contained) where you only see the coffee cherries at the beginning and end
- Density and depth are correlated
- Can you separate without water?
- Labour demand is a major issue, labour costs are 10 times higher than electricity costs (1 million vs 100,000 for a normal harvest). Is it possible to automate sorting?
- Is a mechanical/electronic machine that detects damaged beans possible?
- Two cooperatives have had to close down due to water scarcity (climate change), several others risk having to do the same
- The drainage system should be closed so that rainwater does not enter (and affect the quality of coffee) when it rains.

When asking how the current machine affects the quality of the beans, the answer was that most of the damage is done in the pulping machine. The manager promised to send us a report.

Women interviewed felt that safety in wet mills appears to be designed by men and for men. They complained of ill-fitting personal protective clothing and equipment, and they observed that clothing or equipment that is not sized properly or does not fit properly can compromise personal safety. It was raised that the machines posed significant safety risks for both men and women. However, the risk was believed to be greater for women because as stated in the interviews the machines were 'designed by men'. Women did for instance complained that protruding components of the machinery can get caught on their clothing and this means the women are reluctant to use the machines.

There was also a discussion on weighing incoming beans at a lower level and having some kind of conveyor belt for transport (e.g. driven by PV) and 'double-decker' drying beds, shorter drying time without reduced quality, and the reuse/recirculation of water.

Furthermore, training farmers and their employees was discussed. This is carried out In a separate project between them and We Effect.

In conclusion, they were very positive about a demand-driven procurement of wet mills and their main interests are:

- Cheaper labour costs
- Shorter drying periods
- Less damage
- Making work easier and safer for all

Coffee Research Institute in Kiambu County

A visit was also paid to the Kenya Agricultural and Livestock Research organization's Coffee Research Institute (KALRO-CRI) in February 2020. The visit was paid by Agneta Persson from Anthesis and Maina Gakuru from We Effect. KALRO was represented by the Institute Director of CRI Dr Elijah Gichuru, Mr. Joseph N Mburu and Mr. Nelson G Njau, who are centre staff.
The meeting was very fruitful, and the draft requirement specification and cooperation were discussed.

Kenyan Government Coffee Sector programme

A visit was also paid to Professor Joseph Kieyah, the Chairman of the Kenyan Governmental Coffee Sub-Sector Programme in February 2020. The visit was paid by Agneta Persson from Anthesis and Maina Gakuru from We Effect. A discussion was held on the governmental programme and the proposed demand-driven procurement, and all participants found the programme and the proposed project to be complementary and mutually strengthening.

Swedish Embassy, Nairobi

A visit was also paid to Mr. Anders Arwidson at the Swedish Embassy in Nairobi in February 2020. The visit was paid by Agneta Persson from Anthesis and George Onyango from We Effect. George and Agneta informed Anders about the progress of the project.

Manufacturers

Finally, a meeting was held between Mr. Ulf Kusserow, a representative of Msumbi Africa (JM ESTRADA), Agneta Persson from Anthesis and Maina Gakuru from We Effect in February 2020. The meeting was an open discussion on possible requirements on wet mills for smallholder farming cooperatives.

A similar meeting was held as a Skype meeting between Readon Sakwa of Brazafic and Egil Öfverholm of Anthesis in February 2020.

Appendix 2 Kenya and Coffee

Most of this text is based on input from KALRO.[21]

Kenya's rich volcanic soils, altitude, rainfall, and temperatures enable the country to produce high-quality coffee, Arabica, that is rated among the best in the world. The coffee sector consists of about 3,000 large estates and over 700,000 smallholder growers clustered under 500 cooperative societies. However, as occurred in many other African coffee-producing countries, the end of the export quota system of the International Coffee Agreement coincided with a sharp decline in Kenyan coffee production from an annual average of 1.7 million bags in the 1980s to current levels of less than 1 million bags. The coffee sub-sector contributes annually an average of USD 230 million in foreign exchange earnings and is ranked as Kenya's fourth most important export. However, Kenya's contribution to the world market is only 0.5 %.

The coffee is planted during the rainy season from April to October with two harvest periods (from April to June and from October to December). Coffee is grown without shade and the average yield is estimated at 302kg/ha for smallholder farms and 556kg/ha for estate farms. After harvest, farmers deliver their cherries to their primary societies for processing. The timeframe until farmers are paid is largely dependent on the efficiency of the marketing agents and the availability of buyers. Cooperative societies are required by law to pay farmers at least 80 % of the total upon delivery of their cherries. However, cherry repayment rates differ from region to region, ranging from 84.6% to 10.2 %.

In Kenya coffee is marketed through a central auction system managed by the Nairobi Coffee Exchange Management Committee, which consists of representatives of the industry stakeholders. Direct sales to buyers from importing countries have been authorized as a second window. The main export destinations are Germany (15.8 % of total exports in coffee year 2017/18), the United States of America (15.7 %), Belgium (14 %), Republic of Korea (12.1 %), and Sweden (8.2 %). In terms of value addition, 25 registered local roasters process 138,500 bags of coffee.

The Kenyan coffee sector is mainly funded by national and local governments. One of the major challenges of the sector is climate change, which affects production due to unreliable and erratic rains with shorter seasons.

Coffee-growing areas are located within the Western, Rift Valley, Central Kenya, and Mt Kenya regions. Coffee is grown in the high potential areas between 1,400 and 2,200 metres above sea level, with temperature ranging from 15 to 24° Celsius, in red volcanic soils that are deep and well-drained.

[21] International Coffee Council 124th Session 25 – 29 March 2019 Nairobi, Kenya,

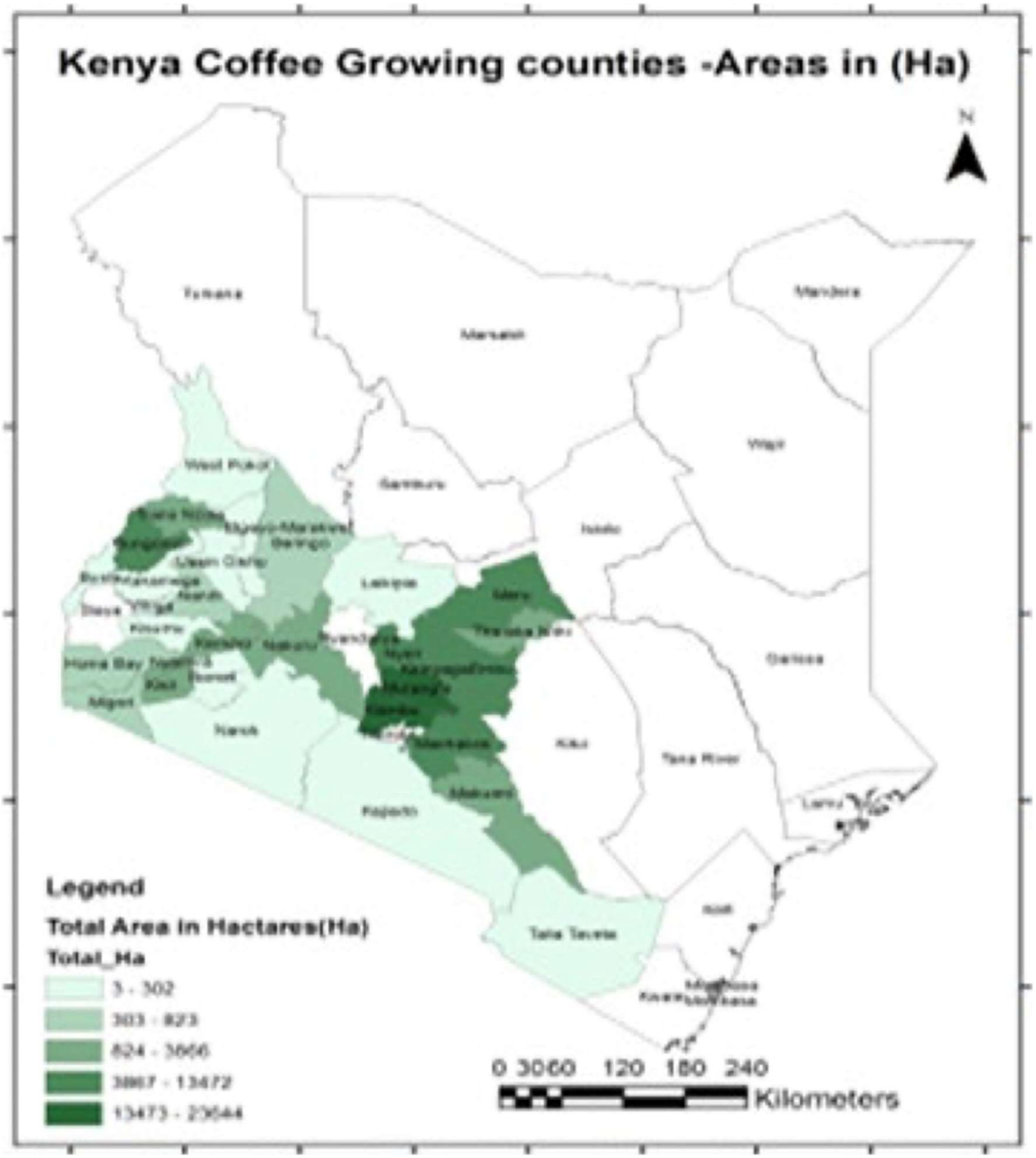

Figure 1 Map over Kenya Coffer Growing counties

Gender gap

Land ownership is culturally dominated by men. However, women provide over 60 % of the workforce in farms and coffee wet mills. This situation is gradually changing as a result of the affirmative action stipulated in the Kenya Constitution 2010. Women who own farms are largely those who have been widowed.

Research

Coffee research in Kenya is undertaken by the Coffee Research Institute (CRI) of the Kenya Agriculture Research and Livestock Organization (KARLO). The Institute has made several recommendations with regard to Good Agricultural Practices (GAP) and Good Manufacturing Practices (GMP). In addition, the Institute has conducted major research aimed at ensuring the sustainability of production through an efficient value chain and climate mitigation measures.

Coffee extension services

The Coffee Directorate of the Agriculture and Food Authority, in collaboration with other relevant stakeholders, provides capacity building to the counties' agricultural staff and other coffee value chain players. The collaborating private agencies include Technoserve, Solidaridad, certification bodies (UTZ, 4C, Fairtrade), and management services providers. The Coffee Research Institute develops technologies, releases new coffee varieties, and carries out research on disease and pest management.

Stakeholders

The coffee value chain comprises a variety of members, namely: ministry, government agencies and departments, coffee growers, millers, marketing agents, management agents, warehouses, transporters, and financial institutions. Table 2 contains categories and a number of the stakeholders who have been registered by the Agriculture and Food Authority (AFA)-Coffee Directorate.

Table 2

No	Category	Size
1.	Smallholder farmers	700,000
2.	Estates	3,000
3.	Co-operative societies	500
4.	Cooperative Unions	14
5.	Pulping stations-co-operatives	1,001
6.	Pulping stations-estates	3,000
7.	Coffee millers	17
8.	Commercial marketing agencies	10
9.	Nairobi Coffee Exchange	1
10.	Grower marketers	25
11.	Warehouses	24
12.	Management agents	4
13.	Coffee dealers	77

Farmers' associations/cooperatives

Coffee growers and some service providers are organized into associations for purposes of self-regulation and lobbying for facilitative policies and regulations. There are about ten growers' unions, a Commercial Coffee Millers and Marketing Agents Association, the Kenya Coffee Traders Association (KCTA), and the Kenya Coffee Producers Association (KCPA) within the coffee value chain.

Financing

The coffee sector is funded by the national government, County governments, banks, SACCOs, and development partners. Specifically, the Commodities Fund (former Coffee Development Fund) was established to provide affordable credits to coffee farmers, this fund's benefit has been extended to other crops since 2014, following the establishment of the AFA. It is estimated that 100,000 farmers have received loans since the credit facility was established.

Employment generated by the coffee sub-sector

The coffee sub-sector is estimated to employ 30% (five million people) of the labour force in the Kenyan agriculture sector.

The future

The country has developed a coffee revitalization programme anchored on a recent National Task Force Report on the Coffee industry. The coffee revitalization programme seeks to support farm expansion, adoption of improved coffee varieties, increased usage of affordable/subsidized farm inputs, and training of farmers on best agricultural practices. The government is also keen to enhance the availability of affordable credit to coffee growers. These efforts are projected to spur an increase in Kenyan coffee production to over 100,000 MT of clean coffee in five years.

Appendix 3 Coffee Processing

Harvesting of coffee starts as early as May, for those farmers who have managed to irrigate during the flowering stage, and it may go on until as late as the end of August.

Coffee processing starts after harvesting of ripe red cherries which are handpicked. Arabica coffee is usually wet-processed and goes through a fermentation process which requires good quality water to produce the best coffee. It is important to use clean water during wet processing to prevent a negative effect on the cup quality of the coffee (Espindola et al., 2009). The beans are transported to a nearby CPU, which can process coffee cherries in bulk. The main operations of the wet processing of coffee are the reception of the ripe cherries, the removal of the pulp, the fermentation, the washing, the sorting, and the drying. The efficiency of the wet processing is 20 percent i.e. 5 kg of ripe cherries are needed to produce 1 kg of parchment. The remaining 80 percent represents the outer skin, the pulp, and the inner skin which are discarded as organic waste and in the form of wastewater. In some cases, organic waste can be transformed into compost.

Table 3: Operations of the wet processing and recommendation regarding the use of water (source UTZ, 2015)

Operation	Function	Recommendation
Reception	To verify the quantity and quality of cherry coffee used in the process.	The coffee should ideally be deposited dry (without water). This is why it is important to harvest 100% ripe coffee (red), which also improves its quality. If water is used, the coffee is sorted by quality (floating beans) and the water should be reused for up to two days for the same operation before it is replaced.
Removing the pulp	To remove the pulp from the bean	If the coffee is received dry, the pulp can also be removed by means of a dry process. If water is used to help remove the pulp, only very small amounts should be used, just enough to "help" the bean.
Fermentation	To remove the mucilage from the coffee by means of natural enzymes while the beans are kept in tanks or other containers.	Let the coffee dry in fermentation stacks, which allows the honey water to drain naturally at a steady pace during the process.
Washing and sorting	Elimination of the digested mucilage is the only process where the use of water is essential. This is done when the coffee has reached an adequate level of fermentation.	The first washing of the coffee should take place in the fermentation stack, removing the honey water right before the treatment. The second washing can be done in the sorting channel. Try to make full use of the available capacity by placing as much coffee as possible in the channel or pipe, filling up the whole space.

The large quantities of clean water needed during the wet processing and the generated wastewater are the main environmental challenges of this stage of the value chain. The water use in wet processing has three functions which are the transport of the coffee beans, the sorting of the cherries by the quality, and the cleaning of the coffee by removing the mucilage (Sanchez Hernandez et al, 2015). A new generation of pulping machine (Eco-pulping) reduces both the water and fuel consumption in comparison to conventional pulping machines. This new technology allows a reduction in the loss of cherries during the processing and a

water of consumption of less than 1 litre per kilo of cherries, which is considered as efficient by UTZ (

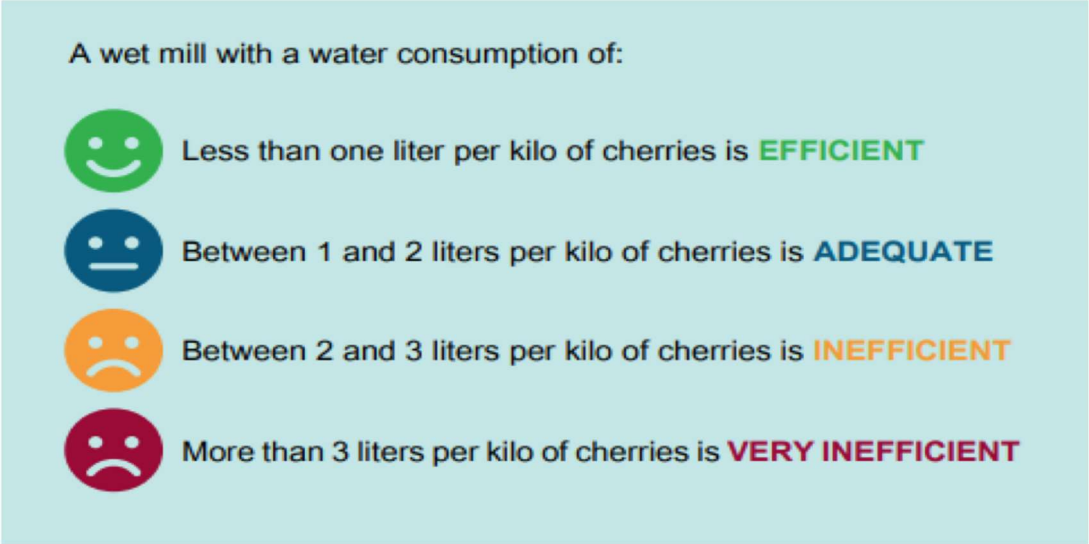

Figure 2). Of equal importance to wet processing is the potential impact of the generated wastewater on the flora, the fauna, and water sources (and indirectly on human health). The organic matter contained in this wastewater can lead to a high acidification impact on the soil and freshwater sources (rivers, lakes).

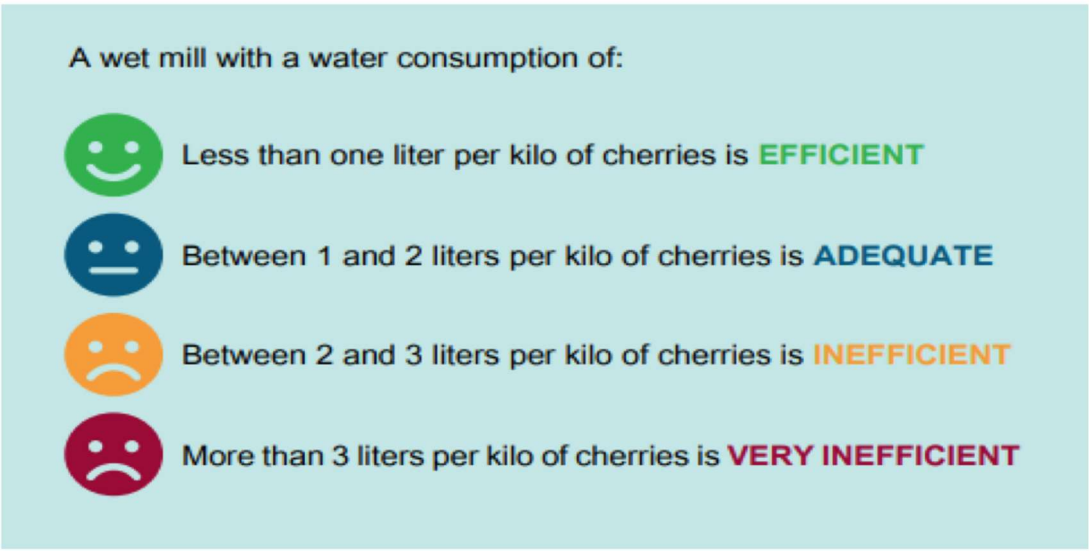

Figure 2: Assessment Water consumption during wet processing (Source UTZ, 2015)

After wet processing, which removes the outer coffee bean flesh, the coffee is then fermented in fermentation 'sinks' for about 2 or 3 days, and thereafter, it is washed to remove any mucus. It is then dried in the sun, spread out on tables. The sun-drying process takes about 8 to 12 days depending on the sunshine.

Thereafter, coffee in the form of 'parchment', is packed in 60 kg bags and sent to the curing factory. Before milling, the parchment is first inspected and weighed and then stored in the warehouse. The coffee curing itself starts with cleaning processes (pre-cleaning and destoning) to remove the impurities which may be present in the bags of parchments. Once pre-cleaned, the coffee beans are then hulled to remove the husk and graded according to their shape, size, and density.

Smallholder coffee farmers in Kenya harvest and deliver cherries to their respective mills for primary processing, comprising the removal of pulp and the consequent transformation of the final product into parchment. Parchment coffee is then delivered to over twenty licensed millers for processing to produce clean coffee grades.

Most Kenyan coffee (90 %) is wet-processed at washing stations owned by cooperative societies and estate farmers, whereas less than 10 % of coffee is dry processed into Mbuni (dried coffee that has not undergone pulping). The parchment coffee from washing stations is graded into Parchment 1, 2, 3, and lights, ready for onward transportation to a dry mill. Every coffee cooperative society has its members and jurisdiction. Members should not move from one society to another because of commitments (e.g. loan recovery). Therefore, movement from one society to another is discouraged since this may lead to loan defaults. In situations where mismanagement exists, members move without seeking permission from authorities.

Quality control

Coffee quality begins with selective picking on the farm, followed by sorting, pulping and careful sun-drying. Parchment coffee is analysed for moisture content to ensure adequate drying before it is milled into seven primary grades of clean coffee and two grades of buni in conformity with the International Coffee Standard. Mills and exporters also carry out coffee cupping to ensure conformity with quality standards.

Appendix 4 Performance Specification

The simplest performance indicator for a wet mill is litre of water per kg of cherries. Less than 1 litre of water/1 kg of cherries is considered efficient. Our measurements will show how close typical Kenyan mills are to this performance.

Also, 1 kWh of energy/1kg of cherries could be used.

Coffee wet mill specification:

PRODUCT NAME AND DESCRIPTION			
SUPPLY, INSTALLATION AND COMMISSIONING OF A COFFEE WET MILL) IN XXX COUNTY, COOP YYY			
SPECIFICATIONS	USER REQUIREMENTS		TENDERER OFFER
1.Country of origin	YES	Tenderer to indicate the Country of Origin	
2. The processing capacity of the system will be XXX Kg of coffee cherry per hour (Base 1500kg)	YES	Tenderer to indicate the capacity per hour	
3. The system shall comprise the functions of a floater screen separator for light cherry, mechanical unripe/green bean separator, vertical drum pulper, rotary screen, demucilager, and a pulp screw press conveyor, Other solutions to the functions may be proposed.	YES	Tenderer to specify the provisions available	
4. Power rating and adaptation shall be compatible with the local supply of 415V for 3 phase motors and 240 V for single-phase motors at a frequency of 50 Hz. The power demand should be low to facilitate the establishment of PV microgrids.	YES	Tenderer to indicate	
5. The processing system should be a self-cleaning system that avoids the retention of pulped beans or pulp inside the enclosed parts of the machine.	YES	Tenderer to indicate their offer	
7. The processing system must ensure minimum damages to the pulped beans to a tolerable limit of 0.1% after completion of post-installation technical adjustments, setting, and training of operators.	YES		
8a.The machine water consumption shall not exceed 1.0 l /kg of coffee cherry	YES	Tenderer to specify l/kg of coffee cherry	
8b. The machine desired water consumption is 0.2 l/kg of coffee cherry		Tenderer to specify l/kg of coffee cherry	
9. The electricity demand should be low	YES	Tenderer to specify kWh/kg of coffee cherry	
10. The processing system must tolerate acidity of 5.0 - 6.0 in the operating medium without succumbing to corrosion.	YES	Tenderer to indicate the level of acid tolerance	
11. The supplier must provide information in the form of manuals or otherwise clearly indicate installation, commissioning, operation, maintenance, and decommissioning.	YES		
12. Desired maximum dimensions, L, W, H, and weight, kg.	YES		

13. The supplier must provide training to clients/ operators on the operation and maintenance including cleaning and decommissioning of the machine. This should be done during Installation and Commissioning.	YES		
14. The supplier must provide adequate safety guards on all rotating components of the machine i.e.: I. The location of the controls should be generally at a height between shoulder and waist level II. The layout and shape of the control should be smooth without sharp edges or point.	YES		
15. Gender friendly machinery- including tools and equipment.	YES		
16. Noise - low noise level desired.		Tenderer to specify	
17. The supplier must provide any other information on the machine that the supplier feels the client should know before procuring.	YES	Tenderer to indicate	
18.The supplier must provide at least a 1-year warranty and have a local service centre to conduct repairs and maintenance.	Yes		
19. The supplier must have a local agent in Kenya to conduct repairs and services as the need arises.		Tenderer to indicate	
20. The supplier must demonstrate innovation towards adaptation and mitigation to climate change (especially mitigation).	YES	Tenderer to indicate	
21. Quality – separation efficiency and minimum physical damage are desired.		Tenderer to indicate how this can be achieved	
22. Maintenance requirements and corrosion risks.	YES	Tenderer to indicate	

(based partly on a tender from KENYA AGRICULTURAL AND LIVESTOCK RESEARCH ORGANIZATION)

Appendix 5 Producers of Coffee Wet Mills

Manufacturers

Linkage, Kenya,

Agent for Palini & Alves LTDA, Brazil

http://www.linkage-africa.com/coffee-milling/

Marina Machineries, Kenya,

Sells a range of coffee processing machines including a combined pulper and washer with a capacity of 500 – 550 cherries per hour.

The hand-driven baby pulper is below.

http://www.marinakenya.com/coffee_two.html

Waynas Kenya, agent for Penagos Hermanos Colombia

Waynas has not yet delivered to cooperatives in Kenya.

According to Penagos, the ecologic coffee wet mill -ECOLINE – integrates 4 stages of the benefits process into a single machine:

Pulps the ripe cherry coffee without using water.

Sorts the pulped coffee by separating the bad and defective beans that affect the in-cup quality.

Mechanically removes the coffee mucilage, washes the coffee beans without spoiling them, and delivers them ready for the drying.

Moves the coffee pulp or peel through the auger. The pulp and the mucilage can optionally be mixed for their use as an organic fertilizer.

And has the following advantages:

- It occupies minimal spacing due to its compact design
- Easy to set up and to maintain
- Minimal water consumption in the pulping machine. Considerably reduces contamination
- Requires low power; therefore, electrical power or fuel consumption is low
- Zero grain loss in the pulp
- The pulping machine is equipped with stainless steel breasts, easy to change
- The pulping machine breast is easy to remove and calibrate
- It is provided with three kinds of breasts to be selected according to the different bean sizes
- Resistant and lasting

Penagos has created a line of pulpers called DCV, 'green sorting pulper', and another called UCBE, 'compact ecological benefit unit'. Each incorporates features designed to use less power and water

Waynas has sold one Ecoline and 16 of the UCBE type wet mills.

https://waynaysafrica.co.ke/service/coffee-wet-mills/

Brazafric

Information from Readon Sakwa. Brazafric has 80% of the market and sells all over East Africa. Their HQ is in Kenya and they have local offices in other East African countries.

Pinhalense, the Brazilian company they buy their machines from, has a considerable R&D division and they deliver worldwide. Brazafric has only one wet mill on their homepage, but they deliver all the machines Pinhalense produces.

Brazafric installs and services the wet mills and trains personnel.

The major market problem they see is financing. Especially in Kenya where there are so many cooperatives. The reason is the difficulty for the cooperatives to give collateral. As a consequence, the banks only offer 20% interest. Sakwa mentioned the possibility of social loans, where instead of interest payment is made with coffee beans and no collateral is needed.

The cost of each mill could be reduced significantly if several mills are ordered at the same time. (Transportation from South America)

Another problem is water, especially wastewater downstream.

Sakwa pointed out that there are a couple of advantages to the Morden drum pulper's ECOFLEX over the conventional Disc pulpers:

- Low water consumption during pulping
- Low and efficient power consumption
- Less physical damage to the coffee as the drums are gentle to the coffee
- Easy to operate and maintain

8 units have recently been supplied to a group in Kenya and they soon intend to add 4-6 more units.

Also, labour intensity can be decreased, particularly pre-sorting before pulping to remove impurities, fermentation, and washing.

https://brazafricenterprises.com/product/coffee-washer- separator-lsc-05-mechanical-siphon/

Pinhalense, Brazil, https://www.pinhalense.com.br/ingles/cafe/beneficio-umido/descascadores-de-cereja/eco-super/

Marshall Fowler, Kenya

Manufactures an 'Eco disc pulper' with a recycling pump and a screw conveyor system among other products. Capacity of 3500 kg of coffee beans per hour.

https://www.marshallfowler.com/marshall%20-%20coffeepage/Eco%20Disc%20Pulper.pdf

Vina Nha Trang Engineering JSC, Vietnam,

One of the major manufacturers. Has several new coffee processing machines. No information on sales in Kenya.

http://www.vinanhatrang.vn/wet-coffee-processing-system/296

Cimbria and Bühler

Cimbria and Bühler in Germany also manufacture electronically advanced machines for coffee. No information about sales in Kenya.

https://www.cimbria.com/products/seed-processing/machines-for-green-coffee-processing

https://www.buhlergroup.com/content/buhlergroup/global/en/industries/coffee.html

Alibaba

Alibaba, China has some manufacturers with coffee processing equipment, mostly small scale manual equipment but also one portable all-in-one unit:

Appendix 6: The Manual – Proof of Concept, Demand-driven Procurement

Demand-driven procurement, Innovative procurement, Co-operative procurement, Catalytic procurement and Technology Procurement roughly mean the same thing. A group of buyers together with experts and a leader (agent or facilitator) define a product or system that does not exist on the market. It could be giving a product or system a better performance or new functions. The concept as such has been described and tested in earlier Sida projects.[22,23]

Demand-driven procurement refers to a procurement process where a third party, such as a government agency or similar actor, supports a process where supply meets demand.[24] The method as such is simple and well established and tested in Sweden, India, and internationally through the International Energy Agency (IEA) in Paris. A demand-driven procurement scheme is a complete tendering process, with the purpose of developing and implementing new technology with the functionalities desired by the end-users.

The aim of demand-driven procurement is also to improve the dissemination of a new service that satisfies market demand better than what is already available on the market. Hence a market-driven procurement is a way to enhance the market forces.

The demand-driven procurement process is illustrated in Figure 4Fel! Hittar inte referenskälla..

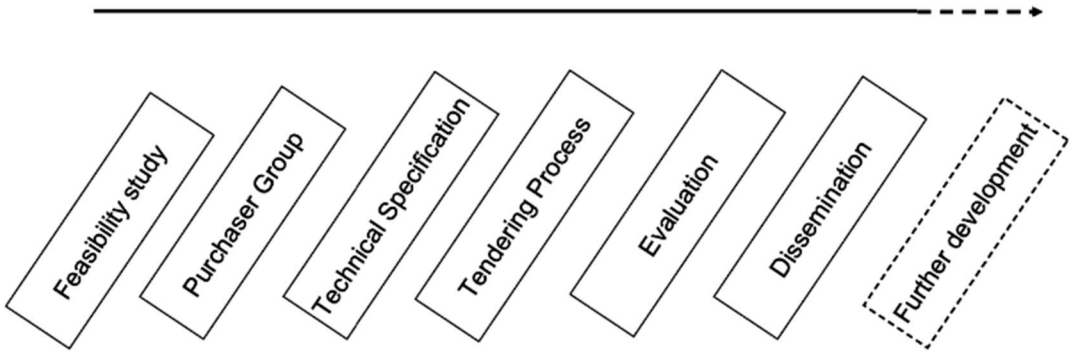

Figure 4: Schematic illustration of the demand-driven procurement process.

A purchaser group with common demands is gathered with the help of an agent/facilitator. The group decides on problems that need to be solved, performance criteria for the product of interest, produce the request for proposals, and carry out the procurement including the evaluation of the tenders. Thereafter a third party can take over the dissemination in order to make the products that meet the performance criteria commercially attractive.

When to use demand-driven procurement?

If the local, regional, or global market lacks a product, or the available products do not meet desired performance specifications, and it is possible to gather enough purchasing power, then the prerequisites for a demand-driven procurement are met. If these conditions are not met, use other tools, such as research, contests, minimum energy performance standards (MEPS), labelling information campaigns etc.

What should the goal be of a demand-driven procurement?

The goal of a demand-driven procurement process should be to introduce the desired product on the market in a sustainable way. This means that after the initial procurement process the product should be able to exist on its own merits. Meaning that the cost of the product versus the purchasing power in the designated market must be in balance. A goal cannot just be meeting the technical performance of the desired product, it should

[22] Sida, *Catalytic procurement of energy services for rural businesses* by Gullberg and Bakiri

[23] Sida, *Feasibility study catalytic procurement of renewable energy Zambia* by Persson & Gullberg

[24] See e.g. Persson A and Öfverholm E, *Procurement advice for sustainable energy*, December 2018, Anthesis report

also meet requirements of affordability for designated customers, for example, poor people in the countryside. When you set the requirements, you must be aware of a possible increase in manufacturing cost.

Do standards for testing and verification exist?

Standards for testing and verification do not always exist. If they do not exist it becomes important for the demand-driven procurement agent/the organization carrying out the procurement to provide a transparent verification process before the procurement process is started and to communicate this method in the procurement documents.

Procurement rules

Most countries have rules for government purchasing implying, among other things, that there should be a fair bidding process so that competition among manufacturers is not restricted.

Several demand-driven procurement projects have been carried out in Sweden and internationally by the Swedish Energy Agency and before them NUTEK, all within the national procurement legislation ("State aid rules"). In the report titled "Procurement Advice for Sustainable Energy"[25], three Sub-Saharan countries were investigated, Zambia's Public Procurement Act, and Kenya's and Uganda's Public Procurement and Asset Disposal Act. They are rather similar and nothing contradicting demand-driven procurement has been found in these documents. Probably the rules in these three countries are not more prohibitive towards demand-driven procurement than the Swedish national procurement legislation ('State aid rules'). And Swedish law permits demand-driven procurement.

The process

For Sida, the process needs to start by scanning the region for products in need of development and or cost reductions. Some proposals for suitable products are presented in the next section. Sida also needs to decide if demand-driven procurement is the right tool to use. The questions to be answered include:

- Can awards, like the Global Leap award, or an information campaign be used?
- Are there Minimum Energy Performance Standards (MEPS) and labelling activities going on in the region? All MEPS in Africa are listed in the *Procurement Advice for Sustainable Energy* report.
- Is Research and Development (R&D) needed or are pilot projects enough?

Then, after a tender process, an organization (agent) for the pre-study has to be selected. One organization that may be suitable as an agent is We Effect.

Pre-study

A demand-driven procurement needs to be preceded by a study that identifies the possibilities and hurdles.

An agent/leader/facilitator needs to be identified and asked to: define products/systems, the performance of the products/systems currently available on the market, possible performance increase in relation to cost, the market situation, buying power, affordability for the target consumer and standards for testing. In addition it has to be clarified which activities are needed to reach a point in market penetration were the product will exist on its own merits. Examples are market campaigns, training, labelling, information activities, financing of the first series, etc. Other important knowledge to acquire is how the market works, who are the stakeholders and influencers (retailers for example), and how product information is disseminated. In the pre-study possible purchaser groups should also be suggested. In some cases, where major products are contemplated such as white goods, including freezers and fridges, and where substantial volumes have to be secured, Sida would also have to look for financing partners. They could come from other countries or organizations.

How to build up purchasing power, purchasing groups

For the type of products envisaged here there is not one buyer but many thousands or millions, so finding mayor buyers who work together or representatives of buyers will be necessary.

[25] Sida, Persson A and Öfverholm E, Procurement advice for sustainable energy, 2018

The type of product envisaged will, of course, determine relevant end consumers. They are often too many and they are too scattered and fragmented to form a purchaser group. To solve this problem it is necessary to find deputies. These could, for example, be organizations consisting of building owners, hospital owners, or school owners. Sub-Saharan countryside cottage hospitals (light and medicine cooling), schools (lighting) and offices for local administration (lighting, PC power) are some of the products that might be considered.

In regions where there is cooperation between villages there is the possibility of forming a purchaser group with participants from each of the villages. Off-grid PV is an obvious system to purchase, other examples are PV-street lamps, and PV water pumps.

Cooperatives should make an ideal purchaser group as they together could assemble adequate purchasing power.

How to organize, finance, and incentivize purchaser groups?

The organization of the demand-driven procurement project should be taken care of by the agent/project manager. Some demand-driven procurement projects in Sweden have been carried out with the government financing nothing, while for others the government has offered reimbursement for lodging and meals at meetings and an occasional field trip. Over time the governmental input has been reduced to only cover meals at purchaser group meetings.

In a Sub-Saharan context reimbursement for lodging, meals at purchaser group meetings, travel costs and filed trips might be justified at least in the start-up phase. See e.g. rules for Sida contribution to attendees of the TREESPA Project. To incentivize and add credibility to the demand-driven procurement, it is also important that the financing organization is present at the first project meeting and then follows up with occasional attendance.

The selection of participant organizations in purchaser groups should be made by Sida based on proposals by the agent/project manager. Organizations should be selected based on the procurement power they possess, but also on their interest in innovation. The personal qualifications of a person representing her/his organization are also important. It needs to be a person with technical insight, but the person also needs to have a clear mandate and be fully backed up by his/her organization. In the first meeting, it could be advantageous to invite the participating person's CEO or corresponding manager. The incentive for the buyer is to get the product/system they need.

Capacity building is an important side effect of innovating procurement that should not be forgotten. During the process, the participant simultaneously can learn a lot, get access to expertise, and get to know other people in the same situation – networking.

For Sida and the agent/project manager, endurance is of the essence. The time needed to get a purchaser group working should not be underestimated. However, if constellations already are in place, such as cooperatives coordinated by a regional union and the agent/project manager is already working with the union, the preparation time can be short. More meetings are required during the start-up phase of a demand-driven procurement project than later in the process. In addition to buyers, at least one technical expert should attend all purchaser group meetings. The expert should be impartial with no ties to the industry but understand manufacturing processes and have insight into testing and standards. The success of the procurement will very much depend on this expert. This expert must of course be financed. It is up to the agent/project manager to find the expert. The purchaser group size should not exceed 15 people to keep it manageable.

A purchaser group could be formed around a single product, for example, wet mills for coffee processing or PV-solar home systems, tier 4 as defined by Sida and others. However, it could also be formed around a whole group of products such as agricultural products, incorporating milk coolers, egg incubators, crop drying, and PV water irrigation.

Combining or coordinating purchaser groups from different countries can be successful. They do not need to meet all the time, but often enough, depending on project complexity, to jointly build significant purchasing power. Another concept is to form a small 'core' purchaser group and offer products from the first series to other buyers in the country/region, with or without grants from Sida. The reason for this is that the core group might not have enough purchasing power or the financier might like to have a rapid spread of the product.

Creating a purchaser group is the most difficult task of a demand-driven procurement. It takes time and demands perseverance for all parties involved. There are some lessons to be learnt from the Sida financed TREESPA Project in southern Africa. Here it took a long time to get the purchasing group working. One solution to this problem is to create 'permanent'/solid purchaser groups which last over time with different products. Another is to find constellations that already work. One of the largest Swedish purchaser groups has been operating since 1991 and is still very active. Another of the large Swedish purchaser groups have been active since 2000.

Requirements for an agent/project manager: basic technical knowledge, but also insights into economics, legislative matters, and regulations, local conditions, and marketing. The agent/project manager should have good organizational skills. Financing level varies with project size and experience, possibly some hundred working hours per year may be needed but more time during the start-up phase of the demand-driven procurement is necessary. The agent manages the purchaser group meetings, develops the specifications with functional and administrative requirements for the demand-driven procurement together with the buyer group and the expert, keeps in contact with all relevant stakeholders in the process, compiles and analyses the incoming tenders, and administers all follow-up actions. The administration also includes chairing purchaser group meetings, keeping minutes, and sending out invitations to meetings and reporting to the main organization and financier, in this case, Sida. In short, the agent/project manager handles all of the project administration.

Specification and functional requirements

The specified requirements should be expressed on a functional level for tendering companies to work out the details. In this way, the desired product can be adapted to suit the manufacturers' production processes and hence meet the requirement of low cost. Usually, the requirement is expressed in benefit/kWh. For example, the benefit of a fridge could be litres of cooled volume. For coffee wet mills it would be litres of water per kg of processed coffee beans.

It is often the case in innovating procurement projects that there is uncertainty whether a functional requirement is cost-effective or not. In these cases, a division between mandatory and desired requirements can be used. Using both mandatory and desired requirements is also a method of distinguishing tenders from each other.

The requirement specification can include requirements other than energy performance requirements. These requirements should be essential or desirable for the consumer or society. For example, they should regard noise, water consumption, certain chemicals, ease of use, low maintenance costs, online features, ergonomics, etc.

Industry discussions

It is of utmost importance to treat tendering companies equally. The same information must be given at the same time to each company participating in the tendering process. However, in the early stages of a demand-driven procurement process, it is important to gather information from the manufacturers on which level to set the performance criteria. The reason for this is that the desired product must be possible to manufacture, and often it is only the manufacturers who know if it is possible to meet the criteria in a cost-effective way. Information gathering therefore must be done, but with some caution.

After a winner of the demand-driven procurement project has been selected the purchaser group works closely together with this manufacturer to agree on details. (In case more than one winner was selected, the purchaser group works with all of them.) The reason for working closely together is both to keep manufacturing cost down and to ensure that the purchasers' demands are met.

The prototype

In most cases, the winner(s) will be asked to deliver a prototype for testing and verification. When testing and analyses of the results are agreed on the production phase of the first series starts. If the testing of the prototypes fails discussions start with the winner(s), and improvements are proposed. Input from the purchaser group expert is essential at this stage. If the prototype still does not meet the requirements the demand-driven procurement process will have to be started all over again. This is very rare, and it has never happened in the Swedish projects so far.

In demand-driven procurement projects dealing with large systems, laboratory tests are not possible, instead, verification needs to be done through monitored and analysed pilot installations. Thereafter production of the first series can commence.

The first series of products

The buyers in the purchaser group agree on how many products they are prepared to purchase. This is the most difficult part of the process since buyers will seldom commit themselves to buying a product one to two years in advance and with unverified specifications. If the case is a coffee wet mill which should have been replaced years ago but is still functional there is no problem. But if the product is for example a ventilation system in an office building with replacement every 15th year it can be hard to get a commitment. Grants to the buyers become essential to convince buyers and indirectly manufacturers to accept a demand-driven procurement. The solution is to, in the contract with the winner, say that the intention is to buy a specific amount of the product. At the time mass-production starts, the buyers usually come to a decision and buy the products. In Sweden, it has only happened in one case that the buyers did not buy the winning product. The size of the first series of products is also dependent on the winning company's development costs, the initial higher manufacturing cost, and the type of market.

The idea is that the grants from the financing organization should compensate the buyers for the higher cost of the first series. Thus, the grant will, indirectly, compensate the manufacturer for some of their development costs. Once the tenders have been analysed and compared to a conventional product the size of the grant can be determined. Note that no monetary grants should be given directly to the manufacturer.

Information

Information activities are an important part of a demand-driven procurement project and should be integrated into the project. Information is needed to attract buyers to the purchaser group, before the tendering to make companies aware of the project, to announce the winner(s), and then for the rest of the project to attract more buyers. Articles in trade journals and technical journals are also advised.

Training

In cases where installations are made by local contractors, not the manufacturer, training courses are advised for the contractors. It is advisable to include this in the contract with the manufacturer.

Schedule/Timetable

A demand-driven procurement project could last from two to five years. It is important to give the industry enough time (but not too much time) to develop the product. It happens that manufacturers already have plans for, or have discussed, the type of product specified, but this is usually impossible to know in advance. If this is the case and if it is not a product dependant on large volumes the process can be shorter.

Budget

The cost of a demand-driven procurement project varies depending on the type of product, market matureness, possibilities to coordinate, etc. A rough estimate of the cost for a typical demand-driven procurement project is:

- Pre-study: 100 – 500 hours
- Agent/project manager: 200 to 500 hours per year
- Testing: SEK 0 to 500,000
- Purchaser group: SEK 50,000 to 100,000 per year
- First series of products: SEK 0 to 1,000,000
- Dissemination of information: SEK 100,000 to 200,000
- Project evaluation: SEK 100,000 to 300,000
- Unforeseen costs: 15 percent of total cost, and
- Sida staff: 50 to 100 hours per year

The pre-study should include a cost estimate for the whole project.

Follow-up and evaluation

The evaluation of the demand-driven procurement project should always be performed by an expert with experience from similar projects.