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BIO4AFRICA

Diversifying revenue in rural Africa through circular, sustainable, and replicable biobased solutions and business models

Research and Innovation Action (RIA)
Grant Agreement 101000762

D1.3: Catalogue of small-scale bio-based technologies suitable for rural Africa

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Dissemination Level		
PU	Public	X
PP	Restricted to other programme participants (including the EC Services)	
RE	Restricted to a group specified by the consortium (including the EC Services)	
CO	Confidential, only for members of the consortium (including the EC)	

MAIN AUTHORS	
Name	**Organisation**
Marta Macías Aragonés, Carmen Girón Domínguez, Luisa Domínguez del Olmo	CTA
E. Tsagariki, M. Bougiosklis	Q- PLAN
James Gaffey, Helena McMahon	MTU

QUALITY REVIEWERS	
Name	**Organisation**
Marina García	SIE
Capucine Dupont	IHE

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Acronyms

Acronyms	Meaning
AMPU	Autonomous Mobile Processing Unit
BE	Biological Efficiency
BECCS	Bioenergy with Carbon Capture and Storage
FP	Framework Programme
GHG	Green House Gas
MNFC	Micro/Nano Cellulosic Fibre
MRU	Mobile Refinery
NPK	Nitrogen, Phosphorus and Potassium
OPEX	Operating Expenses
PBS	Polysuccinate Butylene
PEF	Polyethylene Furanoate
PET	Polyethylene Terephthalate
TRL	Technology Readiness Level

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Executive summary

The present deliverable gathers the results from Task 1.3. The main objective of this task is to produce a catalogue for small-scale biobased technologies that could be relevant for the rural Africa context (both printable and online versions). This catalogue can be used by technology developers (to know the state-of-the-art and/or identify research and development potential synergy opportunities), by farmers and cooperatives (to identify off-the-shelf solutions to be implemented) and by policy makers (to get information about trending technologies to be incentivised and promoted) among others.

The methodology that has been followed includes the next steps: (1) Boundaries definition, (2) Templates and guidelines production, (3) Information retrieval combining desk work for literature review, interviews, and survey distribution, (4) Information systematization, and (5) Information validation and catalogue production.

Specifically, 27 interviews have been made and 14 answers to the survey for technologies identification have been received. This information has been validated by partners with strong knowledge on bioeconomy and rural Africa areas. So far 72 technologies have been included in the catalogue. It has been agreed among partners that the catalogue will be updated bi-annually to include further technologies that could be identified during the BIO4AFRICA Project implementation.

The printable version includes technology factsheets that have been ordered by process type. The online version, embedded at project website includes fields for filtering the information and a free text search box.

It's worth mentioning two key aspects that can be drafted because of the carried-out work. Firstly, there is a limitation related to the lack of information for market and environmental considerations for some technologies. As for the market considerations, the lack of information was linked to the TRL level (it was difficult to obtain this information for lower TRL level technologies). As for the environmental considerations, even when this information was asked directly to technology owners (private companies) with the technologies included in their product/service portfolio, they didn't have much information. This points out that there is still a lot to do regarding sustainability and environmental impact assessment for bio-based solutions.

Secondly, for most of answers to the survey, the information provided was not enough and, in some cases, it had poor quality. Follow-up interviews were scheduled to retrieve more information. Hence, it can be concluded that the survey as a stand-alone tool might deliver poor results pertaining quality information reception and that it's better to plan for surveys and follow-up interviews, with the corresponding effort allocation.

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1. Introduction

In Africa, the population is projected to reach 2.5 billion by 2050, accounting for about 27% of the global population. Approximately 25% of productive lands are degraded mainly due to the loss of nutrients and soil organic carbon under continuous cropping. Nearly 7% of Africa's GHG emissions are generated from the decomposition of wastes in open dumps. Bioeconomy gathers key elements to promote sustainable, resource-efficient valorisation of biomass in value chains[1]. To support the deployment of the bioeconomy in rural Africa via the development of bio-based solutions and value chains, BIO4Africa aims to diversify revenue in rural Africa through circular, sustainable, and replicable biobased solutions and business models.

Some of those biobased solutions, that are amenable to be implemented in the African context, are gathered in the Deliverable 1.3 (D1.3) presented herein and providing the results from the work conducted through Task 1.3. Main result is a small-scale biobased technologies catalogue that can be used by technology developers (to know the state-of-the-art and/or identify research and development potential synergy opportunities), by farmers and cooperatives (to identify off-the-shelf solutions to be implemented) and by policy makers (to get information about trending technologies to be incentivised and promoted) among others.

Similar small-scale biobased technology catalogues have been produced in other regions, together with roadmaps to introduce and promote bioeconomy. For example, the Inter-American Institute for Cooperation on Agriculture (IICA) (for Latin America countries, specifically in Costa Rica) has conducted a report on *Technologies for the Valorisation of Family Farming Residues in Latin America and the Caribbean (LAC) through Bioeconomy Strategies*[2] which analyses the opportunities and challenges in LAC to valorise large volume of biomass (residues) from family farming.

Another catalogue of bio-based technologies has been created within the European project POWER4BIO: emPOWERing regional stakeholders for realising the full potential of European BIOeconomy. The catalogue of bio-based solutions is an online database that contains factsheets on existing bio-based solutions with tested potential for market uptake in the fields of bioenergy, biomaterials, biochemicals, and food & feed[3].

Specifically, an identification and classification of existing small-scale bio-based technologies to produce a catalogue of technologies with potential for being successfully adapted and transferred to different contexts across rural Africa has been conducted. A thorough bibliographic review of published and grey literature on bio-based technologies worldwide has been made, as well as consultation of key external stakeholders. At the same time an analysis and systematization of the information gathered has been made. Led by CTA, participating partners have been Q-PLAN, iHUB (Agribusiness Innovation Hub), AFAAS (African Forum for

[1] Feleke S., Cole S.M., Sekabira H., Djouaka R. and Manyong V. (2021). Circular Bioeconomy Research for Development in Sub-Saharan Africa: Innovations, Gaps, and Actions. *Sustainability*, 13(1926), pp 1-20. https://www.mdpi.com/2071-1050/13/4/1926/pdf

[2] https://catalogo-bioeconomia.iica.int/es

[3] https://www.bio-based-solutions.eu/#/

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Agricultural Advisory Services), AATF (African Agricultural Technology Foundation) and FBCD (Food and Bio Cluster Denmark).

Finally, it's worth highlighting that creation and promotion of new businesses models and new value chains through collaborative models is key to introduce innovative mechanisms in society such as bioeconomy. The triple helix model of innovation[1] is an example of collaboration model that promotes innovation as it sets up interactions between academia, industry, and government, to foster economic and social development. In this deliverable, the triple helix model has been considered at a twofold level: as target stakeholder for interviews and information retrieval and as target audience for the technology factsheets catalogue.

2. Methodology

The development of the catalogue of technologies suitable for rural Africa has followed a methodology aimed at identifying the most relevant existing small-scale bio-based technologies that can use waste produced in Africa as feedstock. Thus, the following workflow was designed to be implemented during Task 1.3.

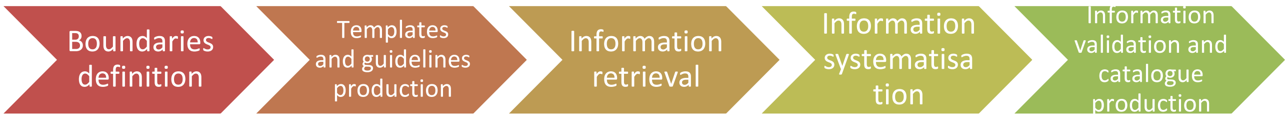

Figure 1. Methodology

2.1 Boundaries definition

The first step was to set and define the boundaries of the screening exercise. Accordingly, the following aspects were discussed and agreed among partners.

- Small- scale technology characteristics: a) simple, low capital-cost (less than 2M€), less investment risk, b) low processing capacity (less than 100 t/day), c) low process complexity, d) using local material and feedstocks near to the source, e) local or in the farm reuse of generated streams such as water, minerals, organic matter, CO2 and heat f) adaptive to seasonality and change location of raw materials g) mostly producing part pure or intermediate products., Solutions where simple pre-processing is conducted at small decentralized level whereas more capital- intensive processing is conducted at large centralized factories could also be considered as such. Easy to operate, mobile and flexibility in used feedstocks is also an important characteristic.[2]

[1] Etzkowitz, H. (2003). Innovation in innovation: the Triple Helix of university-industry government relation', Social Science Information, 42(3): 293-338.

[2] Ait Sair, A.; Kansou, K.; Michaud, F.; Cathala, B. Multicriteria Definition of Small-Scale Biorefineries Based on a Statistical Classification. Sustainability 2021, 13, 7310. https://doi.org/10.3390/su13137310

Felix Colmorgen, Cosette Khawaja "Small-scale technology options for regional bioeconomies", BE-RURAL project, D2.1

Bruins, M., Sanders, J. "Small-scale processing of biomass for biorefinery. Biofuels, Bioprod Bioref 6:135-145

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- Feedstock sources: wastes coming from farming (agriculture and livestock) and from fisheries activities are to be considered.
- Geographical scope: the catalogue is aimed to be relevant for all Africa.
- Information sources: literature review (bibliographic review of published and grey literature, companies' portfolios, results from other European projects, European Commission (EC) reports, etc.), interviews and survey.
- Technology sources: technologies coming from anywhere in the world are to be considered. About the Technology Readiness Level (TRL), preferred TRLs are between 5-9. About the technology owner, although off-the-shelf technologies are preferred, technologies developed by academia are also considered interesting to be included.

Additionally, since the catalogue will also have an online version, an initial telco was maintained between CTA and FBCD to discuss about the layout of the online version and the IT requirements and considerations.

2.2 Templates and guidelines production

Secondly, a template for information sources gathering was produced. The aim was to compile the different information sources (literature, candidates for interviews, et.) so partners could work in a coordinated manner and avoid overlapping during the information retrieval exercise. This template was validated and then filled by all partners. Moreover, templates for technology factsheet and technologies information repository (excel file, acting as database) were produced and agreed among partners. The last part of this action was to produce the guidelines for interviews to be conducted and shape the survey to be embedded at project website (both documents available in Annex I: Interview guidelines Annex II: Survey for technologies information retrieval, respectively).

2.3 Technologies screening and information retrieval

Thirdly, the process of information retrieval was conducted by all partners. To meet the minimum of 50 technology factsheets, participating partners were requested to provide at least 5 technology factsheet per partner while CTA committed to produce at least 25 technology factsheets. All the information retrieved was included in the technology repository (made available at project intranet). Next sections provide more information about the different information sources considered.

2.3.1 Interviews conducted

The following partners conducted a total of 27 interviews: CTA, MTU, AFAAS, Q-PLAN and AATF. Specifically, CTA contacted 22 entities, managing to meet and interview **9** entities, from which 8 technologies were identified and included in the catalogue. MTU contacted 7 entities, managing to meet **6** of them and from which 5 technologies were identified and included in the catalogue. AFAAS contacted 12 entities, managing to meet and interview **5** of them, from which 4 technologies were identified and included in the catalogue. Q-PLAN has contacted and interviewed **3** entities, obtaining 5technologies from the interviews. AATF contacted 5 entities and interviewed **4** of them, obtaining 2 technologies from the interviews.

Data protection was considered in interviews following the project's Data Management Plan.

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Next table (Table 1: Contacts established for information retrieval through interviews) provides detailed information about the interviews conducted.

Table 1: Contacts established for information retrieval through interviews

Entity name	Country	Interaction	BIO4AFRICA partner
Bioflytech	Spain	Contacted	CTA
Giesa	Spain	Contacted and interviewed	CTA
Biomasa Peninsular	Spain	Contacted	CTA
Bio Industry Park	Italy	Contacted	CTA
Biotech Santé Bretagne	France	Contacted	CTA
Clusaga I+D+i	Spain	Contacted	CTA
Valora Marine Ingredients	Spain	Contacted	CTA
Grupo REVAL	Spain	Contacted	CTA
ENSO INNOVATION	Spain	Contacted	CTA
VAPESCA	Spain	Contacted	CTA
AGROAMB	Spain	Contacted, Interviewed and Technology included	CTA
University of Jaén	Spain	Contacted	CTA
MUNS – Desarrollo Sostenible	Spain	2 people Contacted	CTA
CLEVER - ENVIPARK	Italy	Contacted	CTA
Proplast (co-manager of CGreen)	Italy	Contacted	CTA
POLO AGRI-FOOD IT	Italy	Contacted, Interviewed and 2 Technologies included	CTA
Universidad de Hohenheim	Germany	Contacted	CTA
ITACyL (Instituto Tecnológico Agrario de Castilla y León)	Spain	Contacted, Interviewed and 2 Technologies included	CTA

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ASINCAR	Spain	Contacted	CTA
FOOD MAS D MAS I	Spain	Contacted	CTA
Centro Ricerche Produzioni Animali CRPA	Italy	Contacted, Interviewed and 2 Technologies included	CTA
Bio-Innovations Company Ltd	Uganda	Contacted, Interviewed and Technology included	CTA
BIOWERT	Germany	Contacted, Interviewed and Technology included	MTU
Vieux Manioc BV	Netherlands, Nigeria, Mozambique, Ghana	Contacted, Interviewed and Technology included	MTU
Ghent University and Inagro	Belgium	Contacted, Interviewed and Technology included	MTU
University of Hohenheim	Germany	Contacted, Interviewed and Technology included	MTU
KIT	Germany	Contacted, Interviewed and Technology included	MTU
Prokris technologies	Netherlands	Contacted	MTU
Biomass to Biochar	Ireland	Contacted and interviewed	MTU
NARO	Uganda	3 Contacted, 2 interviewed and 2 technologies included	AFAAS
Makerere University	Uganda	2 Contacted, interviewed none	AFAAS
Gulu University	Uganda	2 Contacted, interviewed and technology included	AFAAS
Bio-innovate Solutions	Uganda	Contacted, interviewed	AFAAS
Ori Bags Innovations	Uganda	Contacted, interviewed and technology included	AFAAS
Oasis Agribusiness	Uganda	Contacted, interviewed none	AFAAS
Bio-gas Solutions	Uganda	Contacted, interviewed none	AFAAS

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Harvest Plus	Uganda	Contacted, interviewed none	AFAAS
Bio2CHP	Greece	Contacted, interviewed and 3 technologies included	Q-PLAN
Wageningen University	Netherlands	Contacted, interviewed	Q-PLAN
Alchemia Nova	Austria	Contacted, interviewed	Q-PLAN
ILRI	Uganda	Contacted, interviewed and 2 technologies included	AATF
Savanet	Ghana	Contacted, interviewed	AATF
AFAAS	Uganda	Contacted, interviewed	AATF
UASZ	Ghana	5 Contacted, 1 interviewed	AATF
INP-HB	Ivory Coast	Contacted	AATF

2.3.2 Survey distribution

In cooperation with FBCD, the survey was created in MS Forms by CTA, reviewed by partners and embedded at project website by FBCD (https://www.bio4africa.eu/news-events/latest-news/survey-on-small-scale-bio-based-technologies/). In the Annex II: Survey for technologies information retrieval, are saved screenshots of the MS Forms survey questions and structure. This was disseminated through project communication channels (e.g., social media) and through participating partners communication channels.

Data protection was considered also in survey following the project's Data Management Plan. In fact, before accessing the survey questions, the forms showed a screen where it was mandatory to accept the BIO4AFRICA terms and data handling policy (Figure 2). The following links were included:

- BIO4AFRICA privacy policy (https://www.bio4africa.eu/privacy-policy/).
- BIO4AFRICA legal terms (https://www.bio4africa.eu/legal-terms/).
- BIO4AFRICA personal data management (https://www.bio4africa.eu/personal-data-management/).
- MS privacy statement (https://support.microsoft.com/en-us/office/security-and-privacy-in-microsoft-forms-7e57f9ba-4aeb-4b1b-9e21-b75318532cd9).

Furthermore, and according to the Data Management Plan, Q-PLAN instructed partners to not to use any personal email addresses in the "contact" section of the catalogue factsheets. Therefore, in the final catalogue the main email address (such as info@XXXXX.XX) or the website link of the organisation that answered the survey has been used.

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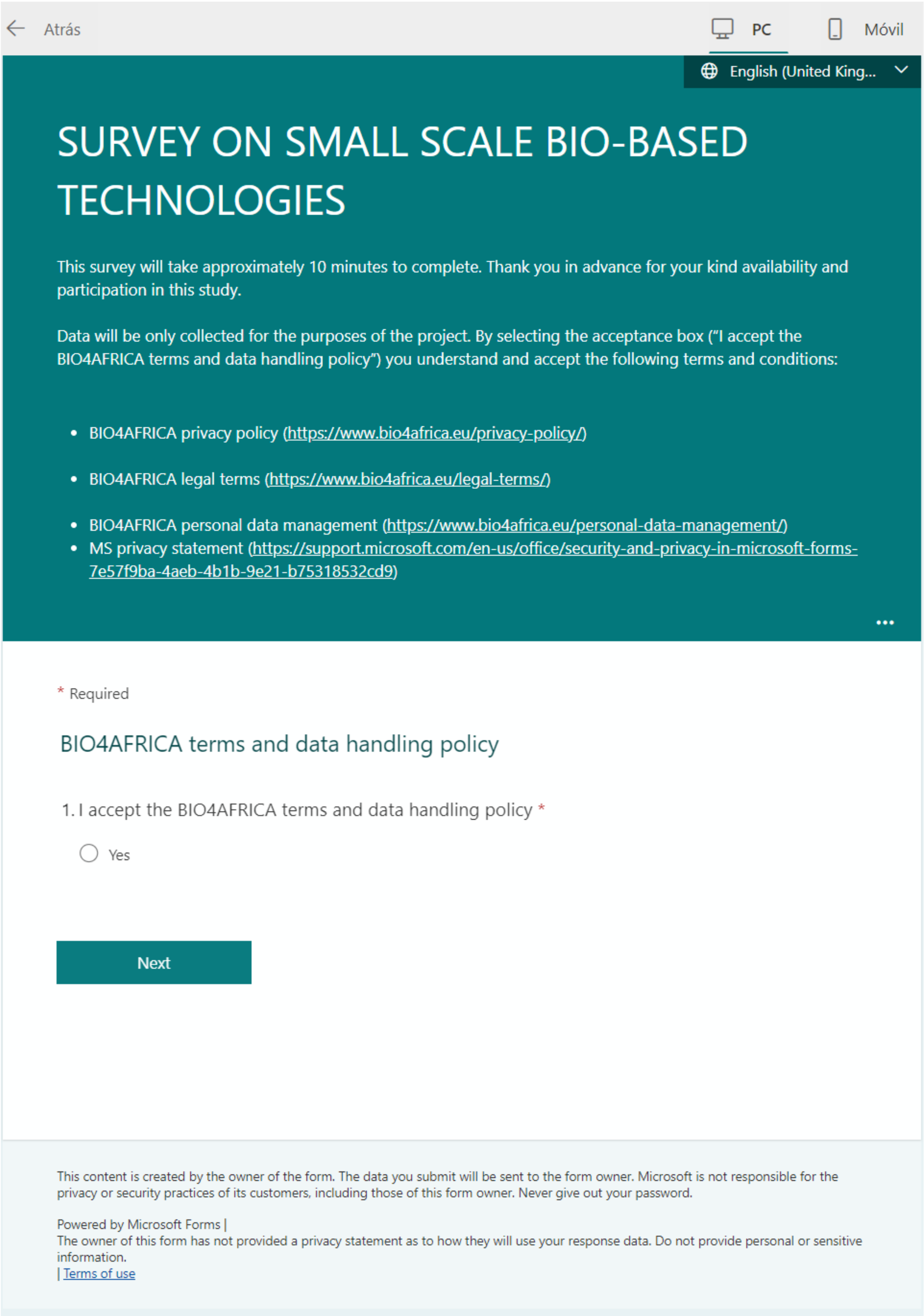

Atrás PC Móvil

English (United King...

SURVEY ON SMALL SCALE BIO-BASED TECHNOLOGIES

This survey will take approximately 10 minutes to complete. Thank you in advance for your kind availability and participation in this study.

Data will be only collected for the purposes of the project. By selecting the acceptance box ("I accept the BIO4AFRICA terms and data handling policy") you understand and accept the following terms and conditions:

- BIO4AFRICA privacy policy (https://www.bio4africa.eu/privacy-policy/)
- BIO4AFRICA legal terms (https://www.bio4africa.eu/legal-terms/)
- BIO4AFRICA personal data management (https://www.bio4africa.eu/personal-data-management/)
- MS privacy statement (https://support.microsoft.com/en-us/office/security-and-privacy-in-microsoft-forms-7e57f9ba-4aeb-4b1b-9e21-b75318532cd9)

* Required

BIO4AFRICA terms and data handling policy

1. I accept the BIO4AFRICA terms and data handling policy *

Yes

Next

This content is created by the owner of the form. The data you submit will be sent to the form owner. Microsoft is not responsible for the privacy or security practices of its customers, including those of this form owner. Never give out your password.

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Figure 2. Screenshot of the survey data management screen Microsoft Forms

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Table 2: Survey distribution

Entity/networks	Channel	BIO4AFRICA partner
Bioswitch EU Project	Email to partners	CTA
AgroBRIDGES EU Project	Email to partners	CTA
TRACK EU Project	Email to partners	CTA
DIVA EU Project	Email to partners	CTA
Pole-Innovalliance	Direct contact email	CTA
VEGEPOLYS Valley	Direct contact email	CTA
EXCornsEED EU Project	Email to partners & communication manager	CTA
CTA Newsletter (+6.000 contacts)	Newsletter	CTA
MPowerBIO partners	Email to partners	CTA
Steinbeins Europa	Direct contact email	CTA
Renetech	Direct contact email	CTA
Plana Compost	Direct contact email	CTA
Q-PLAN professional network	Direct contact email	Q-Plan

To the date (November 12th, 2021), the survey has 14 answers, from which 9 technologies have been implemented in the catalogue (see Table 3: Entities that have answered the survey and that have been included in the catalogue). Five survey answers were discarded due to several reasons, such as: topics about urban wastewater, duplicate answers and technologies that produce more than 100t/day (therefore not considered as small-scale technology). Two of the fourteen survey answers were relevant, but more information was needed, so follow-up interviews were scheduled. The gathered information from those two interviews was then included in the catalogue as interviews, therefore are not included in the Table 3.

Table 3: Entities that have answered the survey and that have been included in the catalogue

Entities	Country
Hya Bioplastics	Uganda
ORIBAGS Innovations (U) Ltd	Uganda
Makerere University Kampala	Uganda

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Hochschule Flensburg, University of Applied Sciences	Germany
GreenPower Ltd	South Africa
Zayn Agro Industries Limited	Kenya
Hydro-Victoria Fish Hatchery Farm LTD	Kenya
Mana Biosystems	Nairobi and London
PyroGenesys LTD	UK

2.4 Information systematisation

The technologies identified were compiled in the technology repository (database) that contains information on several criteria covering different aspects. These criteria include the basic ones identified during the proposal writing process: (i) scale (farm, village, community, etc.); (ii) technological readiness level (clearly distinguishing fundamental research to more applied and over to commercial applications); and (iii) market deployment level (incl. important non-technical deployment barriers, if any). In addition, other fields of interest were considered necessary. These fields are listed in the Table 4. Fields included in the technology repository (database) during the development of the catalogue.

Table 4: Fields included in the technology repository (database) during the development of the catalogue

Database fields		
Field name	**Expected info**	**Expected format**
Number	A numeration field for data management	A number
Technology name	Name of the technology or process identified. The name must describe understandably the technology or process.	Short text (5-10 words)
Problem statement	Context of the technology (Example: does the technology help reduce wastes in a specific sector? Is it a new process or technology that improve traditional industry?)	Short text (30 words max.)
Executive summary	Descriptive and short summary of the technology	Short text (50 words max.)

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Technology description	Longer description of the technology, explaining the technology principles. Mention equipment requirement and other resources required (minimum volumes, specialized knowledge needed for the technology, …)	Long text (200 words max.)
Technology feedstock	Few words stating the biomass used by the technology	Short text (1-5 words)
Type of process	Few words stating the kind of process. E.g.: physical, biological and/or chemical (or other)	Short text (5-10 words)
Technology output	The final product produced by the technology. A suggested list of outputs is provided on the right. Other outputs are also possible.	Short text (1-5 words)
Scale	Farm, village, community…	Short text (1-5 words)
TRL (technology readiness level).	Choose a TRL level from the drop-down list. Please, read EU TRL description here (https://ec.europa.eu/research/participants/data/ref/h2020/wp/2014_2015/annexes/h2020-wp1415-annex-g-trl_en.pdf)	Drop down list
Market deployment considerations	Important non-technical deployment barriers if any	Short text (1-20 words)
Stakeholder *Drop down list*	Choose from the drop down list the type of stakeholder that has developed the technology	Drop down list
Environmental considerations	Environmental impact or handicap associated to the technology	Short text (1-20 words)
Country / Region	Country or region where the technology was developed	Short text (1-2 words)
Year	Year of the source where the information about the technology was found	A number
Technology owner/developer	Name of the organisation that has developed the technology	Short text
Contact	Contact person for the technology / organisation web…	Short text
Link	Link to the detailed info of the technology	A web link

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Once all the partners identified the different technologies, a careful review of the different fields from the technology repository was conducted to ensure homogeneity of the information provided pertaining length and quality, asking partners to revie/amend the corresponding information when needed.

It's worth pointing out that for some technologies there was not information available about environmental considerations and therefore this field is blank. This does not mean that there is no environmental impact linked to the described technology but that no solid, concise information has been found.

2.5 Information validation and catalogue production

The information systematised was used to produce the "Catalogue of small-scale bio-based technologies suitable for rural Africa" following the technology factsheet templates produced. This first version of the catalogue was circulated to other BIO4AFRICA partners not participating in T13 but with strong knowledge of the African context to validate that the described technologies are suitable for the African countries (i.e., that the selected feedstocks can be found in Africa). Feedback was provided by Ziguinchor University, IHE and CIRAD, with further discussions maintained online. Overall, positive feedback was received with the recommendation of organising and grouping the printable version of the catalogue according to the main process for each technology factsheet. Thus, a new version of the catalogue was produced.

Final version of the technology repository (database) was used by FBCD to produce the online version.

It was also discussed with FBCD that it would be nice to have the catalogue in a printable version as a stand-alone document, to be used for dissemination and communication purposes (i.e., to have it in a brochure/book style pdf as a separated output aside from the current deliverable). This printable version will be available at project website as a downloadable file.

Finally, it was discussed and agreed among partners that both printable and online version could be further updated (on a biannual basis) in case more technologies are identified during the lifetime of the project.

3. Additional technologies information

During the screening exercise, two technology catalogues that are outputs from EC funded projects were identified. There are the catalogues produced in the frame of POWER4BIO and BE-Rural projects. Those two catalogues were crosschecked against the boundaries defined in the Methodology section to analyse whether the provided technologies are: (1) small scale, and (2) use as feedstock waste from agriculture, farming and fishing.

The BE-Rural project (https://be-rural.eu/) will explore the potential of regional and local bio-based economies and support the development of bioeconomy strategies, roadmaps, and business models. To this end, the project will focus on establishing Open Innovation Platforms (OIPs) within selected regions in five countries: Bulgaria, Latvia, North Macedonia, Poland, and Romania. From the BE-Rural technologies catalogue[1], all of them are small scale so criteria 1 would be fulfilled. However, from the 16 technologies, only those for agriculture and fishery would fulfil the criteria 2 (not sure about forestry). These are:

[1] https://be-rural.eu/wp-content/uploads/2019/10/BE-Rural_D2.1_Small-scale_technology_options.pdf

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- Agriculture
    - Disposable tableware and packaging
    - A sustainable micro fibrillated cellulose material
    - Greener plastics from hemp
    - A mobile green biorefining concept
    - Ecologic insulating materials
    - Turning medicinal mineral water into a gluten-free functional drink
- Fishery
    - A mobile fish waste processing unit
    - Food and feed from fish processing residues

The POWER4BIO project (https://power4bio.eu/) aims at increasing the capacity of regional and local policy makers and stakeholders to structure their bioeconomy and to support the emergence of a thriving bio-based sector. Adequate knowledge and best practice exchange and networking within and among regions, across the EU is pursued. The catalogue of bio-based solutions is an online database that contains factsheets on existing bio-based solutions with tested potential for market uptake in the fields of bioenergy, biomaterials, biochemicals, and food & feed. An interview with one of the POWER4BIO partners was conducted by Q-PLAN to know more about the catalogue. Specifically, from this catalogue, the technologies presented have a much broader scope since they target also large-scale technologies so after cross-checking against criteria 1 and 2, the following technologies could be interesting for being implemented in Africa.

- Sustainable insulation and construction material made by using hemp hurds, https://www.bio-based-solutions.eu/#/project/140
- Bioconversion of organic side streams by black soldier fly - producing insects, lipid & protein for feed, https://www.bio-based-solutions.eu/#/project/148
- Biogas production from cattle manure via anaerobic digestion, https://www.bio-based-solutions.eu/#/project/102

4. Catalogue

After following the steps provided in the Methodology section, the catalogue for small scale biobased technologies has been produced.

4.1 Factsheets for printable version

The list of the technologies factsheets is provided below. The factsheets have been ordered according to the process type.

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Table 5: List of technologies included in the BIO4AFRICA catalogue

Nº	Technology name	Technology feedstock	Type of process	Technology output
1	Novel bio-based products from meadow grass	Grass silage for fibre-based products, food waste for biogas production	Anaerobic digestion	Bio-composites, Bio-based Insulation Material, Fertiliser, Biogas, electric and thermal energy
2	Agricultural anaerobic co-digestion of grass clippings and manure	Grass, separated pig manure	Anaerobic digestion	Biogas and biofertilizer
3	Ethanol production from sorghum milling wastes	Sorghum milling wastes	Anaerobic digestion	Bioethanol
4	Biogas production from macroalgae wastes	Processing wastes of Laminaria japonica	Anaerobic digestion	Biogas
5	Decentralised production of high purity biogas from pig slurry	Pork slurry	Anaerobic digestion	Biogas
6	Anaerobic digestion	Manure, orange peels, olive pomace, *Opuntia* spp., *Moringa oleifera*, *Chrysopogon zizanioides* (vetiver), *Pennisetum purpureum* (Napier grass), and other graminaceae waste	Anaerobic digestion	Bioenergy (biogas and/or biofuel)
7	Biogasdoneright®	Manure, orange peels, olive pomace, *Opuntia* spp., *Moringa oleifera*, *Chrysopogon zizanioides* (vetiver), *Pennisetum purpureum* (Napier grass), and other graminaceae waste	Anaerobic digestion	Biofertilizer
8	Compression of Agri-residues	Coffee husks, rice husks, ground nuts shells maize cobs	Anaerobic digestion	Biochar, pellets and biogas.
9	Biooxidation of livestock manure and GHG emissions reduction	Organic waste from livestock, forestry, agriculture	Aerobic digestion	Biofertilizer
10	Use of waste from cardamom production in the cultivation of the edible mushroom	Cardamom	Biological treatment	Biomaterial
11	Valorisation of Jatropha curcas waste by composting	*Jatropha* pruning wastes	Biological treatment	Biofertilizer
12	"Cold Composting" to increase soil fertilization and reduce emissions and waste	Grass mowed grass	Biological treatment	Biofertilizer
13	Extraction of bromelain from pineapple wastes by enzymatic pre-treatment and membrane process	Pineapple waste	Biological treatment	Bromelain
14	Reuse of vine pruning waste (vine shoots) for the production of biofertilizer	Wine pruning waste	Biological treatment	Biofertilizer
15	Karnal Process	Straw, Crop Residues	Biological treatment	Animal Feed
16	Biofertilizer with fish wastes	Fish offal, potato and mango peelings, maize stalks	Biological treatment	Fish Feed, Poultry Feed, Organic fertilizer, Bar Soap, Pharmaceuticals

This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 101000762.

17	Briquetting of dry biomass	Straw, stalks, wood chips, bagasse, coffee husk and more	Briquetting	Biomass briquettes
18	Valorisation of grass, pasture and plant wastes using the biorefinery concept	Grass, pasture, and plant wastes	Cascade processing	Feed
19	Production of 5-HMF (5-Hydroxymethylfurfural) from inulin-containing wastes	Inulin-rich wastes, e.g., chicory	Cascade processing	Furfural
20	Use of crustacean shells for gourmet dressings and biofertilizers	Crustacean shells	Cascade processing	Biopolymers
21	Production of bactericidal peptides from beef residues	Beef by-products	Cascade processing	Bactericidal
22	Aflasafe® (Biopesticide)	Sorghum	Cascade processing	Aflasafe® (Biopesticide)
23	Multistage anaerobic digestion process	Manure, plant residues, leftovers, faeces, etc.	Cascade processing	Compost, liquid fertilisers, fresh water, gaseous fuels
24	Gas permeable membranes at atmospheric pressure	Livestock effluents	Cascade processing	Biofertilizer, bio substrate
25	Antcare	Apple seeds, peels, and other wastes	Cascade processing	Biocosmetic
26	Production of polymeric biocomposites from rice endosperm	Rice endosperms	Chemical treatment	Biopolymers
27	Waste sanitation to produce alkaline biofertilizer adapted to acidic land	Organic waste (animal by-products not intended for human consumption)	Chemical treatment	Biofertilizer
28	Production of natural dye from the seed of *Bixa orellana* (achiote)	Seeds of *Bixa orellana* (achiote)	Chemical treatment	Natural dyes
29	Use of banana leaves to produce nano/microfibres	*Musa acuminate* (banana) leaves	Chemical treatment	Biofilms, Biodegradable films
30	Conversion of agricultural waste fibres into biodegradable food packaging	Banana fibres, starch from maize, *cassava* or potatoes	Composting	Biodegradable food packaging
31	Paper production from tomato and pepper crop wastes	Tomato and/or pepper waste	Drying	Paper
32	Production of an eco-insulating material using tree bark	Wood bark	Drying	Biofilms, Biodegradable films
33	ORIBAGS Ecopulping&Packaging Technology	Agricultural waste	Drying	Paper, Gift bags, Gift boxes, Stationary, Paper board, etc
34	Obtaining high value-added active compounds from olive grove biomass	Biomass from the olive grove	Extraction, concentration, and purification	Fortified food ingredients
35	Biorefining of sugar beet for food, feed and biochemical applications	Beetroot	Extraction, concentration and purification	Purified effluent

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36	Production of biodegradable bicycle lubricant from sheep hair	Sheep's wool	Extraction, concentration and purification	Lipids
37	Farm-based lignocellulosic biorefinery	Lignocellulosic farm residues (wood, grass, straw)	Fermentation	Hydroxymethylfurfural (HMF), Furfural, activated carbon
38	Use of Ligninolytic Micro organisms	Straw, Crop Residues	Fermentation	Animal Feed
39	Vegetable Granules for Vibratory Finishing, Polishing, Sandblast	Hazelnuts, almonds, corn cobs, etc.	Grinding	Biomaterial, bioadditive, biofertilizer
40	Removal of synthetic dyes from wastewater using rice biomass	Rice husk	Grinding	Purified effluent
41	Making of packaging materials from zero carbonisation process	Agricultural waste	Griding	Biodegradable bags
42	Fish protein hydrolysate from fish farming wastes	Fish farming waste	Hydrolysis	Protein
43	Livestock feed production from fish by-product silage	Fish viscera	Liquefaction	Silage
44	Feed formulation/mixing	Cowpea, sorghum	Milling	Livestock feed (protein supplement)
45	Tableware made from sugar cane waste	Sugar cane bagasse	Moulding	Bioplastics
46	Packaging and disposable tableware solutions from agricultural waste	Agriculture waste: tomato, banana, wheat, etc.	Moulding	Bioplastics
47	Development of functional materials from natural fibres	Natural fibres from agricultural waste (straw, coconut...)	Moulding	Biofibres
48	pelletizing- Use of cassava in livestock and aquaculture feeding programs	Cassava peels	Pelletizing	Livestock feed for monogr053stics and polygastrics
49	Densified Total Mixed Ration Blocks	Straws of wheat, soybean, mustard, and cotton	Pelletizing	Animal Feed
50	Uromin lick (UML)/urea-molasses-multi-nutrient blocks (UMMB)	Agricultural waste	Pelletizing	Nutrient Supplement/Animal Feed
51	Refining water void of heavy metals	Coffee husks and cotton feed stocks	Physiochemical	Purified clean water
52	Valorisation of non-food-grade milk by casein extraction and conversion	Milk not fit for consumption	Polymerisation	Biopolymers
53	Melt compounding of agri-food wastes biomass	Rice husks, corn combs and hemp scraps from hemp fibres.	Polymerisation	Biopolymer or bioplastics
54	Decentralized refinery for local processing of cassava	Cassava	Refining	Cassava Starch Cake (product/intermediate), Cassava Flour
55	Bioliq	Straw and other "dry" biomass residues	Refining	Syngas, converted to synfuel
56	Conversion of cotton waste into biodiesel and animal feed	Cotton seeds	Refining	Biodiesel and animal feed

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57	Production of Biodiesel from eggshells	Egg shells	Refining	Biodiesel
58	BIO2CHP	Organic residues with moisture <50% (agricultural, food industry, woodchips, sewage sludge etc.)	Thermal process	Electricity, heat, biochar
59	BIO2SYN	Organic residues with moisture <50% (agricultural, food industry, woodchips, sewage sludge etc.)	Thermal process	Syngas, Biochar
60	SMARt-CHP	Organic residues with moisture <20% (agricultural, food industry, woodchips, sewage sludge etc.)	Thermal process	Electricity, heat, biochar
61	BIO2Pyr	Biomass, plastics, tyres (dry, granular form)	Thermal process	Bio-oil, biochar, syngas, heat
62	Valorisation of mango waste for healthy bakery products	Mango by-products after pulp extraction	Thermal process	Fortified food ingredients
63	Torrefaction of wheat stubble into pellets for solid biofuels	Stubble wheat	Thermal process	Pellets
64	Nutrient recovery from livestock by-products by thermochemical process	Livestock waste and by-products	Thermal process	Biofertilizer
65	Obtaining bioenergy and nutrients from poultry slurry	Poultry slurry	Thermal process	Thermal energy
66	Thermo-chemical treatment for obtaining activated carbon and synthesis gas	Agricultural waste	Thermal process	Activated charcoal
67	Pyrolysis, carbonization	Agricultural waste	Thermal process	Biochar, charcoal
68	Pyrochemy	*Cassava*, rice, soy and groundnut	Thermal process	Biochar, syngas, bio-oil (Kerosene or Diesel)
69	BUSH project (Biomass Utilization by Sustainable Harvest) biochar stove	Agricultural waste, wood cuttings, native bushes	Thermal process	Biochar, heat
70	Household biogas digester	*Human waste, agricultural waste*	Thermal process	Heat
71	Staramaki	Wheat stems	Trimming	Drinking straw
72	Reuse of olive wash water in agriculture as a bio fungicide	Olive washing water	Washing	Bio fungicide

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1 – Novel bio-based products from meadow grass

PROBLEM STATEMENT

Displacement of fossil based products with bio-based alternatives, while offering rural diversification opportunities.

EXECUTIVE SUMMARY

The biorefinery processes meadow grass silage into a variety of alternative bio-based products including bio-composites, bio-based insulation material, fertiliser and biogas.

DESCRIPTION

SOURCE:

STAKEHOLDER: Producers associations or cooperatives
COUNTRY: Switzerland, Germany
YEAR: 2004

Biowert Industrie GmbH operates a green biorefinery in Brensbach in the Odenwald, which consists of a biogas plant with two combined heat and power plants (total 1.4 MWel) and a grass refinement plant. In the grass refinement plant, grass from permanent grassland and arable land is processed into various material products, such as AgriCell (thermal insulation material), AgriPlast (natural fibre-reinforced composite material), AgriFer (fertiliser from fermentation residue), as well as the energy products electricity and heat. Grass silage is slurried and the cellulose fibres are isolated in a mechanical digestion process and then dried. The "grass juice" is fermented together with food waste in the biogas plant. The biogas is converted into electricity and heat. Heat and electricity cover the plant's own needs, the surplus electricity is fed into the public grid. The fermentation residue is used as fertiliser. The process water recovered from the digestate is used again to slurry the silage. For the production of AgriPlast, the dried cellulose fibres are mixed with a plastic matrix, such as recycled PP or bio-based plastics, such as PLA, and combined in a modified pellet press to form granules that can be processed by injection moulding or extrusion.

Technology feedstock: *Grass silage for fiber based products, food waste for biogas production*
Type of process: *Anaerobic digestion*
Technology output: *Bio-composites, Bio-based Insulation Material, Fertiliser, Biogas, electric and thermal energy*
TRL: *TRL 9 – actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)*
Scale: *Village, Community*

Market deployment considerations: *Acceptance for bio-based materials (and possibly higher prices)*
Environmental considerations: *Circular economy, minimal ressource consumption, biobased, CO_2 saving*

CONTACT INFO

Technology owner: Biowert AG - info@biowert.com Link: https://biowert.com/

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

2 – Agricultural anaerobic co-digestion of grass clippings and manure

PROBLEM STATEMENT

This technology improves the digestion of pig manure and uses grass for energy generation.

EXECUTIVE SUMMARY

The technology entails the co-digestion of pig manure with grass clippings, improving the ammonia accumulation in the digester. The co-digestion with pig manure improves the flowing of grass, as monodigestion of grass can be technically challenging due to its fibrous nature.

DESCRIPTION

The anaerobic co-digestion of pig manure and grass is advantageous over the monodigestion of either feedstock. Up to 20% grass can be added to the digester without detrimental effects due to the fibrous nature of grass. The digestion is done in a continuous stirred reactor, with a mixture of grass and pig manure being fed daily and digestate being removed also daily. The best combination is grass plus separated pig manure to be able to adjust the composition of solid manure plus pig slurry. This enables the reduction of the ammonia content in the digester while still guaranteeing a proper dry matter content. Biogas is produced, which can either be purified into biomethane or be burned in a CHP for heat and electricty production. The digestate can be used as fertilizer.

SOURCE:

STAKEHOLDER: Research and Technological Center
COUNTRY: Belgium
YEAR: 2020

Technology feedstock: *Grass, separated pig manure*
Type of process: *Anaerobic digestion*
Technology output: *Biogas and biofertilizer*
TRL: *TRL 6 – technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies)*
Scale: *Farm*

Market deployment considerations: *Consideration of local renewable energy and bio-fertiliser market conditions and supporting policies.*

Environmental considerations: *Manure digestion is preferred over direct spreading in the field; grass digestion is preferred over composting.*

CONTACT INFO

Technology owner: Ghent University and Inagro - privacy@ugent.be

Link: https://www.biorefine.eu/publications/d-1-4-1-co-digestion-of-roadside-grass-with-vedows-manure-and-pig-slurry/

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

3 – Ethanol production from sorghum milling wastes

PROBLEM STATEMENT

Nigeria is the world's second largest sorghum producer, producing 6.5 million metric tonnes per year. The accumulated wastes from sorghum processing are potentially suitable for bioethanol production.

EXECUTIVE SUMMARY

Sorghum bran is an underutilised waste from the sorghum milling process in Nigeria. It contains relatively high amounts of starch and protein, indicating that it is a suitable substrate for fermentative conversion into value-added products.

DESCRIPTION

SOURCE:
STAKEHOLDER: University
COUNTRY: Nigeria
YEAR: 2019

Sorghum is processed by soaking and wet milling to obtain bran, which is a typical processing technique in Nigeria. The sorghum bran is soaked and milled to separate the sorghum bran from the starch. The starch is the main product, while the residual sorghum bran is hydrolysed by enzymes or acids to generate a sugar-rich hydrolysate. The hydrolysate is fermented to produce bioethanol by yeast fermentation. The waste yeast, together with the unfermented solid wastes, can be used as high-protein animal feed. The University of Ilorin achieves a bioethanol production yield of 0.151 g bioethanol per g sorghum bran. It is estimated that if all the sorghum bran produced in Nigeria were used, the bioethanol produced could provide 17% of Nigeria's annual transport fuel needs.

Technology feedstock: *Sorghum milling wastes*
Type of process: *Anaerobic digestion*
Technology output: *Bioethanol*
TRL: *TRL 6 – technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies)*
Scale: *Farm*

Market deployment considerations: Currently unverified industrial scale.

CONTACT INFO

Technology owner: University of Ilorin - expresso-support@bepress.com

Link: https://www.sciencedirect.com/science/article/pii/S1369703X19302244

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

4 – Biogas production from macroalgae wastes

PROBLEM STATEMENT

Laminaria japonica is a marine macroalgae that is widely cultivated for biofuel production, pharmaceuticals and the food industry. Even so, waste is generated from these algae, which can still be used to produce biomethane.

EXECUTIVE SUMMARY

The digestion of Laminaria japonica in batch and continuous bioreactors produced acceptable biomethane production rates at laboratory and pilot plant scale. On the other hand, against all odds, a pre-treatment of the algae does not increase biomethane production, recommending fermenting them in their "native" state.

DESCRIPTION

SOURCE:

STAKEHOLDER: University
COUNTRY: Germany
YEAR: 2015

Macroalgae production is increasing considerably every year worldwide. Most of this production is destined for food, but other industries also use macroalgae as biomass (pharmaceuticals, paper, textiles, etc.). Between harvesting and further processing of Laminaria in industries, between 10% and 30% of residual biomass is generated, which ends up being discharged into the sea or treated as low impact waste. Macroalgae are a type of biomass with potential for biomethane production. Its fractionated carbohydrate structure (soluble and easily hydrolysable sugars) makes it suitable for anaerobic digestion. In short, the absence of large amounts of lignin and cellulose makes them suitable for digestion by microorganisms. The study was carried out on Laminaria waste, at laboratory scale and at pilot plant scale. In both cases, pretreatment of the biomass was not positive for fermentation, contrary to the recommendation in the literature. On the other hand, when these algal wastes were fermented without any pretreatment or mixing with other substances, acceptable amounts of biomethane were produced, despite being waste biomass and thus possessing less fermentable compounds than if a whole plant was fermented.

Technology feedstock: *Processing wastes of Laminaria japonica*
Type of process: *Anaerobic digestion*
Technology output: *Biogas*
TRL: *TRL 6 – technology demonstrated in relevant environment (industrially relevant environment)*
Scale: *Village, Community*

CONTACT INFO

Technology owner: Department of Life Sciences and Chemistry, Jacobs University - support@mdpi.com

Link: https://www.mdpi.com/1660-3397/13/9/5947

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

BIO4AFRICA

5 – Decentralised production of high purity biogas from pig slurry

PROBLEM STATEMENT

Pig farms generate a large amount of waste. It is estimated that each animal produces an average equivalent to one and a half tubs of slurry per year.

EXECUTIVE SUMMARY

The novelty lies in the possibility of decentralised recovery treatment and in the fact that the biogas produced is of high purity (biomethane) and can be injected directly into the natural gas network or used as automotive fuel.

DESCRIPTION

SOURCE:

STAKEHOLDER: University
COUNTRY: Spain
YEAR: 2019

The valorisation strategy combines two sequential processes: biogas gas purification treatment and anaerobic digestion of livestock waste. The photosynthetic micro-organism used for this transformation is a purple phototrophic bacterium, capable of capturing the sun's infrared energy and feeding on the phosphorus, nitrogen and organic matter present in the slurry. Specifically, these bacteria can support high rates of nutrient assimilation and exhibit high tolerance to slurry toxicity. These organisms perform anoxygenic photosynthesis with carbon dioxide (CO_2) and hydrogen sulphide (H_2S) fixation, which allows high purity biomethane to be obtained. The technology can be implemented on small farms, using the biomethane produced on the farm itself. For best performance, it is recommended to dilute/concentrate the slurry to˜600 mg/L total nitrogen. The presence of volatile fatty acids improves CO_2 fixation, thus allowing a purer biomethane. The low phosphorus concentrations inherent in pig slurry are not significant in the performance of the process, but slightly improve the quality of the biomethane. Concentrations of 93.3% CH_4 can be achieved, meeting most international standards for use as vehicle fuel.

Technology feedstock: *Pork slurry*
Type of process: *Anaerobic digestion*
Technology output: *Biogas*
TRL: *TRL 6 – technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies)*
Scale: *Farm*

CONTACT INFO

Technology owner: Sustainable Processes Institute. University of Valladolid - web@residuosprofesional.com

Link: https://www.residuosprofesional.com/proceso-convierte-purines-energia-limpia/

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

6 – Bioenergy with carbon capture and storage (BECCS)

PROBLEM STATEMENT

It is used for a sustainable agriculture to address the simultaneous demands of food, energy, and environmental security. Biomasses are converted to biogas and thence to electricity, heat and/or biomethane; stable carbon and plant nutrients are recycled to the fields by applying effluent digestate avoiding the greenhouse gases (GHG) emissions and other environmental impacts associated with fossil-based fertilisers.

EXECUTIVE SUMMARY

Anaerobic digestion of manure, agri-food by-products, and energy crops to produce biogas and digestate (biofertilizer) that can be carried out in Africa.

DESCRIPTION

Organic farming. In anaerobic digesters, about 70% of the carbon goes to biogas and 30% is transformed into more stable carbon using the digestate residue coupled with practices derived from conservation agriculture. The CO_2 from the atmosphere is used for energy crop growth and introduced into the soil. The overall system therefore functions as a bioenergy with carbon capture and storage (BECCS) process.

SOURCE:

STAKEHOLDER: Research and Technological Center
COUNTRY: Italy
YEAR: 2000

Technology feedstock: *Manure, orange peels, olive pomace, Opuntia spp., Moringa oleifera, Chrysopogon zizanioides (vetiver), Pennisetum purpureum (napier grass), and other graminaceae waste*
Type of process: *Anaerobic digestion*
Technology output: *Bioenergy (biogas and/or biofuel)*
TRL: *TRL 9 – actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)*
Scale: *Farm, Village, Community*

Market deployment considerations: *Anaerobic digestion is a very scalable technology in terms of plants size and feedstock/biomasses exploiting. To implement anaerobic digestion widespread in Africa, capital and operational costs reduction and small-scale technology development are key aspects for the market deployment.*

Environmental considerations: *No, negative relevant environmental impact. On the contrary, a primary cause of illness and reduced life expectancy in sub-Saharan Africa is open-fire cooking and heating with wood. Using anaerobic digestion at the African village level to process animal wastes, crop residues, and energy crops could improve soils providing some electricity and biogas for heating and cooking.*

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

CONTACT INFO

Technology owner: CRPA (Centro Ricerche Produzioni Animali) - info@crpa.it

Link: https://farmingforfuture.it/

Dale, B.E., Sibilla, F., Fabbri, C., Pezzaglia, M., Pecorino, B., Veggia, E., Baronchelli, A., Gattoni, P. and Bozzetto, S. (2016), Biogasdoneright™: An innovative new system is commercialized in Italy. Biofuels, Bioproducts and Biorefining, 10: 341-345. https://doi.org/10.1002/bbb.1671

Dale, B.E., Bozzetto, S., Couturier, C., Fabbri, C., Hilbert, J.A., Ong, R., Richard, T., Rossi, L., Thelen, K.D. and Woods, J. (2020), The potential for expanding sustainable biogas production and some possible impacts in specific countries. Biofuels, Bioprod. Bioref., 14: 1335-1347. https://doi.org/10.1002/bbb.2134

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7 – Biogasdoneright®

PROBLEM STATEMENT

It is used for a sustainable agriculture to address the simultaneous demands of food, energy, and environmental security. Biomasses are converted to biogas and thence to electricity, heat and / or biomethane; stable carbon and plant nutrients are recycled to the fields by applying effluent digestate avoiding the greenhouse gases (GHG) emissions and other environmental impacts associated with fossil-based fertilisers.

EXECUTIVE SUMMARY

Biogas production in rethinking innovative agricultural systems to produce food and bioenergy achieving large environmental benefits.

DESCRIPTION

SOURCE:

STAKEHOLDER: Research and Technological Centre
COUNTRY: Italy
YEAR: 2000

Biogas is produced from the anaerobic decomposition of organic feedstock such as manure, agricultural residues, agro-industrial by products, energy crops, food waste. These residues are placed into anaerobic digesters (biogas plant) in which specific microorganisms at controlled conditions break down the organic materials producing biogas and digestate. Pre-treatment technology (i.e.: mechanical devices, trace elements supplementation, enzymes) can be used to optimize the process. The effluent from anaerobic digestion is called digestate and it is a natural fertiliser. It is returned to the land by irrigation ("fertigation") recycling a large fraction of the mineral nutrients and increasing soil carbon levels with soil fertility benefits (organic farming).

Technology feedstock: *Manure, orange peels, olive pomace, Opuntia spp., Moringa oleifera, Chrysopogon zizanioides (vetiver), Pennisetum purpureum (napier grass), and other graminaceae waste*
Type of process: *Anaerobic digestion*
Technology output: *Biofertiliser*
TRL: *TRL 9 – actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)*
Scale: *Farm, Village, Community*

Market deployment considerations: *Anaerobic digestion is a very scalable technology in terms of plants size and feedstock/biomasses exploiting. To implement anaerobic digestion widespread in Africa, capital and operational costs reduction and small-scale technology development are key aspects for the market deployment.*

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

Environmental considerations: *No relevant environmental impact. On the contrary, a primary cause of illness and reduced life expectancy in sub-Saharan Africa is open-fire cooking and heating with wood. Using anaerobic digestion at the African village level to process animal wastes, crop residues, and energy crops could improve soils providing some electricity and biogas for heating and cooking.*

CONTACT INFO

Technology owner: CRPA (Centro Ricerche Produzioni Animali) - info@crpa.it

Link: https://farmingforfuture.it/

Dale, B.E., Sibilla, F., Fabbri, C., Pezzaglia, M., Pecorino, B., Veggia, E., Baronchelli, A., Gattoni, P. and Bozzetto, S. (2016), Biogasdoneright™: An innovative new system is commercialized in Italy. Biofuels, Bioproducts and Biorefining, 10: 341-345. https://doi.org/10.1002/bbb.1671

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8 – Compression of agri-residues

PROBLEM STATEMENT

High production of agriwastes and lack of cheap energy.

EXECUTIVE SUMMARY

Production of pellets for renewable energy production.

DESCRIPTION

SOURCE:

STAKEHOLDER: Private sector
COUNTRY: Uganda
YEAR: 2012

The proposed solution is a series of physical and biological processes. Firstly, it starts by gathering all the biomass in the facilities and grinding it. Then drying it in a dram, covered without oxygen to produce anaerobic digestion and biogas. Later, the biomass, rich in lignin, is compressed, forming pellets for energy production.

Technology feedstock: *Coffee husks, rice husks, ground nuts shells maize cobs*
Type of process: *Anaerobic digestion*
Technology output: *Biochar, pellets and biogas.*
TRL: *TRL 9 – actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)*
Scale: *Community*

Market deployment considerations: *Financing is a barrier in Uganda and it's all majority at policy level with limited really implementation opportunities.*

Environmental considerations: *No, little negative environmental impact, only short transportation to gather the biomass.*

CONTACT INFO

Technology owner: Bio-Innovations Company - Alex Tumukunde, alex.t@bioinnovations-ug.org

Link: https://bioinnovations-ug.org/

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

9 – Biooxidation of livestock manure and GHG emissions reduction

PROBLEM STATEMENT

GHG emissions or the contamination of aquifers produced by organic waste production.

EXECUTIVE SUMMARY

Composting is a tool within the circular economy through which organic waste is valorised by transforming it into fertiliser with high added value. It provides a solution to the management of organic waste that can be a problem due to its negative effects on the environment, such as GHG emissions or the contamination of aquifers through leaching.

DESCRIPTION

SOURCE:

STAKEHOLDER: Research and Technological Centre
COUNTRY: Spain
YEAR: 2012

It is an aerobic biological process where organic matter is oxidised by different microorganisms, mainly fungi and bacteria, which degrade this matter and transform the organic waste into a stable product, free of pathogens and weed seeds. It must be carried out under controlled conditions to obtain quality compost. The most influential parameters are temperature, pH, humidity, C/N ratio and aeration. The advantages of composting are multiple, as in addition to achieving adequate waste management, a product is obtained which, when applied to the soil, has many social, environmental and economic benefits. On the one hand, the use of inorganic fertilisers is reduced, as compost is an alternative to chemical fertilisers and can be used as a substitute for them, which, in turn, means savings in fertiliser costs due to the substitution of inorganic fertilisers in agriculture. It also reduces the demand for irrigation water because compost increases the water retention capacity of the soil, a fact to be taken into account in areas where water availability is limited and in a global context in which water resources are becoming increasingly scarce.

Compost applied to the soil also provides other benefits to the cultivated land, and therefore to the farmer, as this substrate provides beneficial micro-organisms that increase their activity on the organic matter in the compost. This microbial community produces biostimulant substances or plant growth regulating compounds and are capable of suppressing certain pathogens, which results in better crop development.

Technology feedstock: *Organic waste from livestock, forestry, agriculture*
Type of process: *Aerobic digestion*
Technology output: *Biofertiliser*
TRL: *TRL 9 – actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)*
Scale: *Farm, Village, Community*

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Market deployment considerations: *It is a process that can be carried out with little technology and the investment needed for control is low. Space and time are needed for the process to be adequate and to produce quality compost. Information is widely available and easily accessible.*

Environmental considerations: *It would result in less water being needed for crops, which is a very interesting process particularly in areas where water is a scarce resource.*

CONTACT INFO

Technology owner: Castilla y León Agricultural Technology Institute (ITACYL). - suelos@itacyl.es

Link: https://www.compostaenred.org

https://www.fao.org/3/i3388s/I3388S.pdf

https://www.juntadeandalucia.es/export/drupaljda/COMPOSTAJE_2014_OK_BAJA.pdf

http://www.compost.org/

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

10 – Use of waste from cardamom production in the cultivation of the edible mushroom mushroom

PROBLEM STATEMENT

In Mexico, mushroom cultivation allows the recycling of more than 500,000 tonnes of agricultural, agro-industrial and forestry waste per year, thus reducing the environmental impact of the final disposal of such waste.

EXECUTIVE SUMMARY

In the cultivation of mushrooms (Pleurotus spp.) a wide variety of agricultural or agro-industrial waste or by-products can be used as substrate. Pulp from cardamom, lemon or coffee can be used for this purpose, making it possible to reduce the environmental impact of the disposal of these wastes.

DESCRIPTION

SOURCE:

STAKEHOLDER: Research and Technological Centre
COUNTRY: Mexico
YEAR: 2016

Mushroom cultivation is an efficient biotechnological system, as high yields and good productivity are achieved with few environmental controls. Mushrooms have short growth times, grow in a wide temperature range and their ability to use various lignocellulosic materials as substrate makes it possible to use regionally available agricultural, agro-industrial and forestry residues. In particular, cardamom pulp can achieve a biological efficiency of ~114% in the production of Pleurotus ostreatus. The results of biological efficiency (BE) vary greatly from substrate to substrate, however, the recommended substrates are those with a BE value close to or greater than 100, which can be achieved by testing some combinations of waste materials or by carrying out some type of pre-treatment of the material such as fermentation, composting or simply pasteurisation. In this way, regionally produced waste can be used to produce high-protein foodstuffs and the exhausted substrate can still be used for both the re-cultivation of edible mushrooms and the remediation of contaminated soils. This is achieved by enriching with other agro-industrial wastes, thus reducing the environmental impact of the exhausted substrate.

Technology feedstock: *Cardamom*
Type of process: *Biological treatment*
Technology output: *Edible fungi*
TRL: *TRL 4 – technology validated in lab*
Scale: *Farm*

CONTACT INFO

Technology owner: National Polytechnic Institute of Mexico - editora.rica@atmosfera.unam.mx

Link:
https://www.revistascca.unam.mx/rica/index.php/rica/article/viewFile/RICA.2016.32.05.10/46678

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

11 – Valorisation of Jatropha curcas waste by composting

PROBLEM STATEMENT

This crop requires different pruning seasons for proper production, which generates a large amount of waste in the form of biomass.

EXECUTIVE SUMMARY

A simple controlled composting step produces an organic solid with properties that make it suitable as a fertiliser in agriculture. The process requires mixing the waste with other agricultural waste from the fruit, thus solving several environmental problems.

DESCRIPTION

SOURCE:

STAKEHOLDER: University
COUNTRY: Morocco
YEAR: 2016

Jatropha curcas is generally used for the production of bio-oil which is then transformed into biodiesel by transesterification. For intensive production, several parameters are important, notably pruning, which generates significant quantities of biomass wastes. Pruning not only increases the number of branches and therefore the number of fruits, but also makes it possible to maintain a tree shape that facilitates harvesting. This operation generates green waste rich in mineral elements (NPK). Green waste, a mixture of pruning wastes or branches and fruit peels in a ratio of 5:1, is used for composting. The mixture is homogenised and placed in a bioreactor. During composting, the reactor is fed by a flow of compressed air to ensure complete oxygenation. An automatic system continuously keeps the biomass in motion. The composting period is one month, producing a compost with the following parameters: C/N <21, NH4+/NO3- <1 and a pH between 5 and 7. Phosphorus levels increase after the fifth day of composting to reach 0.03 mg/g.

Technology feedstock: *Jatropha pruning wastes*
Type of process: *Biological treatment*
Technology output: *Biofertilizer*
TRL: *TRL 5 – technology validated in relevant environment (industrially relevant environment in the case of key enabling technologies)*
Scale: *Farm*

CONTACT INFO

Technology owner: Cadi Ayyad University - rep_researchgate@prighter.com

Link:
https://www.researchgate.net/publication/311873033_Valorization_of_Jatropha_curcas_waste_by_composting

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

12 – "Cold Composting" to increase soil fertilization and reduce emissions and waste

PROBLEM STATEMENT

Mowing the lawn generates a large amount of landfill, emissions to the environment from transport to landfill and energy consumption in the process.

EXECUTIVE SUMMARY

The practice of mowing the lawn and leaving the grass clippings on the ground is called "Cold Composting". The trimmings decompose and increase soil fertility rather than being collected and sent to landfills or a traditional composting facility.

DESCRIPTION

SOURCE:

STAKEHOLDER: Public sector
COUNTRY: United States of America
YEAR: 2014

At the Lovell Federal Health Care Center in Illianois, USA, 320 tonnes of waste from lawn mowing was reduced by the simple practice of not picking up waste after finishing. This helps reduce the amount of waste sent to landfills, a practice that is under-exploited. Grass clippings left on the ground increase soil fertility. It also reduces the consumption of resources such as energy and labour involved in sending this waste to landfill, as well as eliminating the greenhouse gas emissions involved in transporting this waste.

Technology feedstock: *Grass mowed grass*
Type of process: *Biological treatment*
Technology output: *Biofertilizer*
TRL: *TRL 7 – system prototype demonstration in operational environment*
Scale: *Village, Community*

CONTACT INFO

Technology owner: Lovell Federal Health Care Center - r5hotline@epa.gov

Link: https://www.epa.gov/sites/production/files/2015-04/documents/cs9-lovell-cold-composting.pdf

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

13 – Extraction of bromelain from pineapple wastes by enzymatic pre-treatment and membrane process

PROBLEM STATEMENT

In Costa Rica alone, ~10 million tonnes of stubble are generated per year. Although there are already processes that allow bromelain to be recovered enzymatically, filtration and purification is still problematic.

EXECUTIVE SUMMARY

The enzymatic pre-treatment and diafiltration operation is used in a two-stage ultrafiltration system to improve the performance of the bromelain purification and concentration process. This pretreatment uses pectinase, reducing the apparent viscosity and making the process more efficient.

DESCRIPTION

SOURCE:

STAKEHOLDER: University
COUNTRY: Australia
YEAR: 2018

The pineapple waste consists of ~15% fruit core, ~30% crown and ~55% skin. It is mixed with an equal mass of water before being filtered and centrifuged. The obtained supernatant is subjected to enzymatic pre-treatment by adding 0.01% pectinase from Aspergillus aculeatus (3800 U/mL), adjusting the pH 7. The filtration process is carried out by cross-flow, with membranes of 75 kDa and 10 kDa pore size in the 1st and 2nd stages respectively. In the 1st pre-filtration stage, bromelain is separated from the high molecular mass compounds and recovered in the permeate. In the 2nd purification stage, the permeate containing bromelain is separated from the low molecular mass compounds, such as amino acids and pigments, and concentrated. To increase the efficiency between the two stages, an intermediate diafiltration step is introduced. The purpose is to first dilute the bromelain in a diluent (water) to maintain a constant feed volume.

Technology feedstock: *Pineapple waste*
Type of process: *Biological treatment*
Technology output: *Bromelain*
TRL: *TRL 4 – technology validated in lab*
Scale: *Village, Community*

CONTACT INFO

Technology owner: College of Health and Biomedicine, University Victoria - info@ncbi.nlm.nih.gov

Link: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6117993/

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

14 – Reuse of vine pruning waste (vine shoots) for the production of biofertiliser

PROBLEM STATEMENT

Annual pruning of vine shoots produces approximately 800-1500 kg/ha of waste that is difficult to manage, which is normally disposed of by burning (emitting ~2.2 tonnes CO_2/ha of burnt prunings into the atmosphere).

EXECUTIVE SUMMARY

The process avoids burning the vine shoots (which involves emissions into the atmosphere and a high risk of fires due to its proximity to forest areas), transforming them into compost to be used as fertiliser and improve the state of the soil, which benefits grape production.

DESCRIPTION

SOURCE:

STAKEHOLDER: Producers associations or cooperatives
COUNTRY: Spain
YEAR: 2019

Preparatory actions require the definition of the logistics plan, obtaining permits and licenses if necessary and conditioning the transformation area. For this, the plots, location of collection points and location of the composting place are selected. It is recommended to build the transformation area with concrete bed to avoid possible contamination of the soil by leachate. After this, the proposed system integrates the following phases: I. Provisioning: collection of shoots in the plots after the annual pruning. II. Crushing: transfer of shoots to collection points where they are crushed. Depending on the distance to the composting site, the crushing is carried out at collection points or directly at the composting site. III. Transport to the composting site: transfer of the crushed material. IV. Composting process: transformation of pruning waste into compost. V. Distribution of compost: transport of the substrate from the production site to its place of application. VI. Fertilization: application of the resulting compost in the field. Specifically, composting in an open pile in the open air is proposed under thermophilic temperatures (60ºC – 70ºC) for 6 months, producing a product free of pathogens and weeds that is used as an organic amendment.

Technology feedstock: *Wine pruning waste*
Type of process: *Biological treatment*
Technology output: *Biofertilizer*
TRL: *TRL 9 – actual system proven in operational environment*
Scale: *Village, Community*

Market deployment considerations: *Minimum amount of 50-100kg of biodegradable material..*

Environmental considerations: *Rainfall and temperature regime in the region.*

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

CONTACT INFO

Technology owner: Microgaia Biotech S.L. - info@lifesarmiento.eu

Link: http://lifesarmiento.eu/wp-content/uploads/2019/06/Gu%C3%ADa-t%C3%A9cnica-para-la-implementaci%C3%B3n.pdf

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

15 – Karnal Process

PROBLEM STATEMENT

High levels of fiber are observed in feed resources, which are not in a good state to enhance animal nutrition. There is therefore need to increase the quality of feed material and ensure that animals derive maximum benefit from feed resources.

EXECUTIVE SUMMARY

Biological treatments (Karnal process) aiming at the deconstruction of lignocelluloses employs selective ligninolytic white-rot basidiomycetes under solid-state fermentation.

DESCRIPTION

SOURCE:

STAKEHOLDER: Research and Technological Centre
COUNTRY: India
YEAR: 2012

Technology developed at NDRI, Karnal (India). Straw is treated with 4% urea at moisture level of 60%. The treated straw is stacked in a silo pit under cover for 30 days. A temporary loose brick structure is constructed and a thin layer of urea treated straw spread evenly in this structure. A solution of the following composition is prepared. 60g superphosphate, 60g calcium oxide dissolved in 8-liter water. Sprinkled over the urea treated straw and inoculated with 3% Coprinus fimeratius culture. This is allowed to remain for 5 days then used for feeding. The main advantage of this process is that free ammonia is converted into microbial protein and ligno cellulose bond is degraded.

Technology feedstock: *Straw, Crop Residues*
Type of process: *Biological treatment*
Technology output: *Animal Feed*
TRL: *TRL 9 – actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)*
Scale: *Farm, Village*

Market deployment considerations: *Longer time required in processing feed; issues of space and storage*

CONTACT INFO

Technology owner: National Dairy Research Institute, Karnal, India - support.it@icar.gov.in

Link: http://ndri.res.in/

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

16 – Biofertilizer with fish wastes

PROBLEM STATEMENT

There high loss of food in consumption than production along the food systems in Africa. Food recovery can create multiple jobs and solve feed/fertilizer challenges for farmers in Africa.

EXECUTIVE SUMMARY

Produce animal proteins and organic fertilizer using BSF larvae.

DESCRIPTION

SOURCE:

STAKEHOLDER: Private sector
COUNTRY: Kenya
YEAR: 2020

Use of Fish Offal's and other organic waste from markets to hatch and feed Black Soldier Fly larvae and produce organic fertilizer and fish and poultry feeds at Hydro Victoria Fish & Poultry Feed Plant, using 10-20 Tons of waste per day and producing 2-3 Tons of animal proteins per day, 6-12 Tons of organic fertilizer per day. Located in Busia County in Kenya, East Africa.

Technology feedstock: *Fish offals, potatoe and mango peelings, maize stalks*
Type of process: *Biological treatment*
Technology output: *Fish Feed , Poultry Feed, Organic fertilizer, Bar Soap, Pharmaceuticals*
TRL: *TRL 7 – system prototype demonstration in operational environment*
Scale: *Village, Community*

Market deployment considerations: *small bioeconomy farms can have significant impact in villages compared to commercial large farms in urbans towns. Consumption and production patterns are similar across Africa. Land use patterns and trends are near similar e.g., more small-scale farmers feeding cities and communities. Multiple demand of products at village level.*

CONTACT INFO

Technology owner: Hydro-Victoria Fish Hatchery Farm LTD - info@hydrovictoriafishhatcheryfarm.co.ke

Link: www.hydrovictoriafishhatcheryfarm.co.ke

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

17 – Briquetting of dry biomass

PROBLEM STATEMENT

Production of voluminous sidestream biomasses not being utilized in an optimal way.

EXECUTIVE SUMMARY

Compacts dry biomass (straw, woodchips, bagasse many more) for transport/burning in small stoves.

DESCRIPTION

Briquetting equipment for numerous types of waste biomasses, such as straw, woodchips, sawdust, bagasse, coffee husk, groundnut shells, etc. The compaction of the biomass makes transport, distribution and storage easier and more cost-effective. At the same time, it makes it possible to burn the biomass. Often if not compacted, the biomass could not be burned.

SOURCE:

STAKEHOLDER: Producers associations or cooperatives
COUNTRY: Denmark
YEAR: 2000

Technology feedstock: *Straw, stalks, wood chips, bagasse, coffee husk and more*
Type of process: *Briquetting*
Technology output: *Biomass briquettes*
TRL: *TRL 9 – actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)*
Scale: *Village, Community*

Market deployment considerations: *Technology in the market, the challenge is maintenance.*

Environmental considerations: *Saves energy, reduce transport costs & emissions.*

CONTACT INFO

Technology owner: CF Nielsen - hbc@cfnielsen.com

Link: https://cfnielsen.com/

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

18 – Valorisation of grass, pasture and plant wastes using the biorefinery concept

PROBLEM STATEMENT

The potential of these wastes is currently not exploited as the usual actions are composting, direct use in animal feed, conversion to pellets for energy production or biogas production by fermentation.

EXECUTIVE SUMMARY

Using the biorefinery concept, protein-rich compounds for pig feed, sugar and protein-rich compounds for cattle feed, fibres for cardboard manufacturing, as well as electricity and heat can be produced.

DESCRIPTION

SOURCE:

STAKEHOLDER: University
COUNTRY: Netherlands
YEAR: 2015

The technology consists of a first mechanical separation step where the input is converted into a pressed fibre cake and a juice rich in protein and minerals. The juice is then heated to produce a protein coagulate, useful as feed in the pig sector. As for the cake, it is low in protein but suitable for livestock feeding needs. The cellulose fibres it contains can be transported for the manufacture of cardboard. Finally, the residual fractions from the process are used to produce biogas. The decentralised approach makes it possible to avoid the transport of wet green leaf and grass waste, thus reducing emissions. Moreover, the substitution of soya feed with local feed allows for a more sustainable production. This technology has been developed by Wageningen University and is marketed by GRASSA BV. On the other hand, other approaches to the biorefinery concept could include the production of acids (lactic acid and amino acids) or lignin, and different scenarios can be developed depending on the complexity of the valorisation process.

Technology feedstock: *Grass, pasture and plant wastes*
Type of process: *Cascade processing*
Technology output: *Feed*
TRL: *TRL 4 – technology validated in lab*
Scale: *Farm*

CONTACT INFO

Technology owner: GRASSA BV - info@hoogeveen.nl

Link: https://www.wur.nl/upload_mm/d/4/8/6c738231-e1c7-4e58-a1c8-8b02bb13fb98_Final%20report%20version%206%20Biomass%20Drenthe.pdf?itemuuid=6c5e1270-7cd0-4344-bfaa-e0a6c76811b0&webId=26098

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

19 – Production of 5-HMF (5-Hydroxymethylfurfural) from inulin-containing wastes

PROBLEM STATEMENT

Chicory roots are an environmental management problem.

EXECUTIVE SUMMARY

Through a hydrothermal synthesis, 5-HMF is produced using waste containing hexoses and monomeric sugars. This technology can establish synergies with biogas production within the biorefinery concept and reduce transport costs for the supply of a decentrally implemented conversion plant.

DESCRIPTION

SOURCE:

STAKEHOLDER: University
COUNTRY: Germany
YEAR: 2017

Sugars are extracted through a counter-current diffusion leaching process using only water (without contaminants such as sulphur, which is usually found in today's HMF). The resulting effluent is purified and then undergoes catalysed acid conversion. The main by-products are leached root chips, CaCO3 sludge (peptides, anions, degraded proteins, colloids) that can be used as fertiliser and process water containing low molecular weight compounds that can be used in biogas production. During the conversion of biogas to electricity, excess heat is produced which can be used for the extraction and conversion of the sacchar solution. The process can also be applied to wastes from other crops with high inulin content such as Jerusalem artichoke, dandelion or scorzonera.

5-HMF is of particular interest for the production of polyethylene furanoate (PEF), a 100% renewable and sustainable alternative to polyethylene terephthalate (PET) for beverage and food packaging. The major benefits are lower material usage (in terms of weight) while maintaining quality and stability criteria and reducing transport costs.

Technology feedstock: *Inulin-rich wastes, e.g. chicory*
Type of process: *Cascade processing*
Technology output: *Furfural*
TRL: *TRL 5 – technology validated in relevant environment (industrially relevant environment in the case of key enabling technologies)*
Scale: *Farm*

Market deployment considerations: *Lower conversion ratio compared to using a two-phase leaching agent.*

CONTACT INFO

Technology owner: University of Hohenheim - post@uni-hohenheim.de - Link: https://www.uni-hohenheim.de/organisation/projekt/5-hydroxymethylfurfural-from-inulin-containing-crops

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

20 – Use of crustacean shells for gourmet dressings and biofertilisers

PROBLEM STATEMENT

The shell, including the head, constitutes ~60 % of the weight of the animal (shrimp, prawn), which can reach several tonnes per day, entailing high transport costs.

EXECUTIVE SUMMARY

A multi-stage process is used to obtain different products. From the initial extraction, the raw material for food is obtained. Subsequently, pigments are obtained and finally chitin, which can be converted into chitosan by deacetylation.

DESCRIPTION

SOURCE:

STAKEHOLDER: Private sector
COUNTRY: Chile
YEAR: 2019

Shrimp shells have the highest chitin content, 30-40 %, followed by crab shells, 15-30 %. In the first extraction, raw material is obtained for dressings, from which pâté, soups and premium sauces or for direct application are produced. This is followed by grinding, deproteinisation, demineralisation, filtering and decolourisation. At this point in the process, pigments are obtained that can be marketed. The decolourisation results in a cake which is washed and dried to obtain chitin. This undergoes a deacetylation process and is converted into chitosan. This is a biopolymer (a polysaccharide) that can be used in a wide range of applications in its different modified forms as well as different degrees of purity. The company Ryomar, which implements this technology, uses chitosan as a biofertiliser in agriculture. Other potential uses are as a food-grade flocculant in water treatment and paper manufacturing; in foams in cosmetics; in edible films or microencapsulation of ingredients in food applications; in pharmaceuticals in nutritional supplements as a fat binder; to reduce infections and improve performance in aquaculture and ruminant feed; or in medicine.

Technology feedstock: *Crustacean shells*
Type of process: *Cascade processing*
Technology output: *Biopolymers*
TRL: *TRL 9 – actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)*
Scale: *Village, Community*

CONTACT INFO

Technology owner: Rymar CL - gguerra@agenciacircular.cl

Link: https://www.paiscircular.cl/industria/rymar-la-pesquera-que-aprovecha-la-cascara-del-camaron-para-hacer-aderezos-gourmet-y-fertilizantes/

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

21 – Production of bactericidal peptides from beef residues

PROBLEM STATEMENT

The meat industry generates large volumes of by-products (blood, bones, meat trimmings, ...) which are costly to treat and dispose of ecologically. These costs can be balanced by generating value-added products.

EXECUTIVE SUMMARY

Bioactive peptides can be obtained from meat by-products through the application of enzymes that cut or hydrolyse meat proteins at certain points, obtaining peptides of all kinds. The most interesting are those that have a bactericidal function, preventing the growth of bacteria.

DESCRIPTION

SOURCE:

STAKEHOLDER: University
COUNTRY: Spain
YEAR: 2016

The production of bioactive peptides from meat by-products is highly researched. Bioactive peptides are sequences generally between 2 and 20 amino acids that exert a biological function in one or more of the human physiological systems. Antimicrobial peptides can modulate the gastrointestinal and immune systems. The use of by-products as a source of bioactive peptides has been extensively studied in recent years. In this regard, blood and collagen, very important by-products from slaughterhouses and the meat industry, have been the most tested. Blood is a rich source of protein where haemoglobin, an iron-containing protein, is the most abundant complex. The use and application of the enzyme pepsin on bovine blood in the presence of 30% alcohol produces peptides with antibacterial activity (Kocuria luteus) that cause pathologies such as endocarditis, septic arthritis, meningitis and lung infections.

Technology feedstock: *Beef by-products*
Type of process: *Cascade processing*
Technology output: *Bactericidal*
TRL: *TRL 3 – experimental proof of concept*
Scale: *Village*

CONTACT INFO

Technology owner: Institute for Agrochemistry and Food Technology (CSIC) - expresso-support@bepress.com

Link: https://www.sciencedirect.com/science/article/pii/S0309174016301140#!

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

BIO4AFRICA

22 – Aflasafe® (Biopesticide)

PROBLEM STATEMENT

Aflatoxin exposure is frequent and widespread in most African countries. Key staples such as maize and groundnuts are particularly vulnerable to aflatoxin contamination. A stealthy and silent killer, aflatoxin is a major concern because of its acute, chronic and irreversible health effects on people and livestock, sometimes leading to fatalities. Besides being lifethreatening and compromising health, aflatoxin contamination hampers domestic, regional and international trade as companies are unable to meet international and regional standards.

EXECUTIVE SUMMARY

Aflasafe® is an environmentally friendly product that was developed by IITA and USDA. Aflasafe consistently reduces aflatoxin contamination in groundnuts, maize and sorghum by between 80% and 100% when the crop is in the field and during storage.

DESCRIPTION

SOURCE:

STAKEHOLDER: Research and Technological Centre
COUNTRY: Uganda, Senegal
YEAR: 2014

Strains of Aspergillus flavus (A. flavus) that do not produce aflatoxins, called atoxigenic strains are identified. Carefully selected atoxigenic strains are the active ingredients of Aflasafe and are coated on roasted, sterile sorghum grains, which are then spread in fields while crops are developing. The active ingredients grow and spread across crops and outcompete aflatoxin producers, preventing the fungi from growing on crops and contaminating them. Each Aflasafe product contains four atoxigenic A. flavus active ingredient strains native to the target nation. In all countries, the use of Aflasafe leads to an 80-100% reduction in aflatoxin contamination in fields.

Technology feedstock: *Sorgum*
Type of process: *Cascade processing*
Technology output: *Aflasafe® (Biopesticide)*
TRL: *TRL 9 – actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)*
Scale: *Community*

Market deployment considerations: *Aflasafe is formulated as spores carried by inert carrier for ease of deployment.*

Environmental considerations: *Efficacy of Aflasafe strains is region-specific and thus requires isolation and characterization of different strains for different regions.*

CONTACT INFO

Technology owner: IITA/USDA - hello@aflasafe.com - Link: https://aflasafe.com/wp-content/uploads/pdf/Status_of_Aflasafe_Commercialisation_in_Africa.pdf

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

23 – Multistage anaerobic digestion process

PROBLEM STATEMENT

High production of agriwastes that can become an environmental problem.

EXECUTIVE SUMMARY

Treatment of any kind of agricultural and residential biowaste/residues.

DESCRIPTION

It is a mechanical-chemical or a mechanical-thermal pre-treatment with separation of non-fermentable solids followed by a multistep anaerobic digestion and final concentration of mineral nutrients.

SOURCE:
STAKEHOLDER: Private sector
COUNTRY: Germany
YEAR: 2010

Technology feedstock: *Manure, plant residues, leftovers, faeces, etc.*
Type of process: *Cascade processing*
Technology output: *Compost, liquid fertilisers, fresh water, gaseous fuels*
TRL: *TRL 6 – technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies)*
Scale: *Farm, Village, Community*

Environmental considerations: *Engineering, maintenance and operational skills on a professional/business base are necessary, but the system's design is made to easily install it everywhere on earth, i.e., the parts are easily available and a cheap, most of them even very cheap.*

CONTACT INFO

Technology owner: Hochschule Flensburg, Schleswig-Holstein, University of Applied Sciences - privacy@researchgate.net

Link: https://www.researchgate.net/profile/Ehiaze-Ehimen/publication/A_combination_anaerobic_digestion_scheme_for_biogas_production_from_dairy_effluent-CSTR_and_ABR_and_biogas_upgrading/links/5b1a7e3a45851587f29d14ca/A-combination-anaerobic-digestion-scheme-for-biogas-production-from-dairy-effluent-CSTR-and-ABR-and-biogas-upgrading.pdf

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

24 – Gas permeable membranes at atmospheric pressure

PROBLEM STATEMENT

High production of livestock effluents.

EXECUTIVE SUMMARY

It reduces the ammonia load in livestock effluents, recovering nitrogen in the form of an ammonium salt, with high fertiliser value.

DESCRIPTION

It is a physico-chemical process that, by increasing the pH of the effluent to be treated, favours the transformation of ammonium to ammonia. This ammonia is recovered by contact with an acid solution, producing an ammonium salt solution. The result is the reduction of the nitrogen load in the livestock effluent and the recovery and concentration of that nitrogen in the form of an inorganic fertiliser product.

SOURCE:

STAKEHOLDER: Research and Technological Centre
COUNTRY: Spain
YEAR: 2020

Technology feedstock: *Livestock effluents*
Type of process: *Cascade processing*
Technology output: *Biofertiliser, biosustrate*
TRL: *TRL 6 – technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies)*
Scale: *Farm*

Environmental considerations: *No negative relevant environmental impact.*

CONTACT INFO

Technology owner: Castilla y León Agricultural Technology Institute (ITACYL). - suelos@itacyl.es

Link: http://ammoniatrapping.com ,http://ammoniatrapping.com/difusion/?lang=en#descargas

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

BIO4AFRICA

25 – Antcare

PROBLEM STATEMENT

High production of agriwastes that can become an environmental problem.

EXECUTIVE SUMMARY

Production of cosmetics from biowaste.

DESCRIPTION

SOURCE:

STAKEHOLDER: Private sector
COUNTRY: Italy
YEAR: 2020

The company gathers wastes from organic apples produced on an old family plot of land in Barge: Azienda Agricola e Agriturismo Magnarosa. Then they produce Apple Paste © up cycled, obtained by processing the seeds and skins of apples left over from the production of organic apple juice. The formulation and production of the final product is 98% or 99% natural, used for biocosmetics produced with renewable energy. The final product has nourishing effect and antioxidant functions from the naturalness of the fruit. Furthermore, recycled and recyclable packaging is used. They package the products with cardboard chipboard recovered and recycled by local actors.

Technology feedstock: *Apple seeds, peels and other wastes*
Type of process: *Cascade processing*
Technology output: *Biocosmetic*
TRL: *TRL 9 – actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)*
Scale: *Farm*

Market deployment considerations: *These technologies are modulable and scalable, as well as used at local or regional level, therefore, very replicable technologies.*

Environmental considerations: *The process is adapted to reduce the carbon footprint in the entire production chain, integrating only local, ethical, and sustainable suppliers into its supply chain.*

CONTACT INFO

Technology owner: Vortex - vortex.olimpia@pec.it

Link: https://www.antcare.net/chi-siamo/ , https://www.linkedin.com/company/vortex-start-up-innovativa-a-vocazione-sociale/?originalSubdomain=it

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

26 – Production of polymeric biocomposites from rice endosperm

PROBLEM STATEMENT

Starch production yields ~80% endosperm, 8% protein and 12% other by-products, including rice endosperm, the latter being used as a low value-added animal feed.

EXECUTIVE SUMMARY

By mixing rice endosperm with a polysuccinate butylene (PBS) matrix, polymeric materials are obtained. The functional characteristics of these are similar and even improved in aspects such as ductility. Mixing can be done with both the original and the enzymatically treated endosperm.

DESCRIPTION

SOURCE:

STAKEHOLDER: University
COUNTRY: Italy
YEAR: 2017

Rice endosperm has a high content in the form of starch (65%), but may also contain oils and proteins. The PBS compound can be prepared from a mixture of the original waste or from the enzymatically treated waste. This treatment splits the original by-product derived from rice endosperm into a solid waste, suitable for the preparation of polymeric biocompounds, and a supernatant, which contains bioactive molecules with high potential value for application in cosmetics and nutraceuticals due to its polyphenol content. Rice endosperm has good compatibility with the PBS matrix, which can be mixed at 125ºC in amounts between 10-30%. At the functional level, it does not modify the thermal properties and significantly improves its characteristics, making the material more ductile. In particular, hydrolysed rice endosperms improve approximately 100% of the tensile and flexural strength. These results are obtained without the use of compatibilising agents within the matrix polymer or without interfacial fibre modifications. Therefore, rice endosperm can potentially be used as a reinforcing material for the manufacture of biocomposites.

Technology feedstock: *Rice endosperms*
Type of process: *Chemical treatment*
Technology output: *Biopolymers*
TRL: *TRL 4 – technology validated in lab*
Scale: *Farm*

CONTACT INFO

Technology owner: University of Bologna - urbanrec@aimplas.es

Link: https://urbanrec-project.eu/detalle_registro.php?re_id=102&tipo=7

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

27 – Waste sanitation to produce alkaline biofertilizer adapted to acidic land

PROBLEM STATEMENT

High production of agriwastes that can become an environmental problem.

EXECUTIVE SUMMARY

Elaboration of a liquid and solid alkaline biofertilizer that adapts the soil for a greater use of nutrients using waste to give them a second life.

DESCRIPTION

SOURCE:
STAKEHOLDER: Private sector
COUNTRY: Spain
YEAR: 1999

It is a chemical reaction that produce heat to sanitize organic wastes. The process consists of adding a mix of calcium oxide (quick lime) and wood chips (or other lignocellulosic waste) that reacts with the moisture of the residue, produces a significant increase in the temperature and in the pH of the mixture, so that all bacteria and pathogens present in the initial residue are eliminated. This process has to be maintained for 2 h around 50-55 degrees Celsius and the pH will remain above 12 for 72 h. The chemical reaction that occurs can be described through this equation: $CaO + H_2O \rightarrow Ca(OH)_2$ *+ heat. The lignocellulosic part of the mixture enhances the Nitrogen concentration of the biofertilizer since it avoids partially its vaporisation. The biofertilizer increases soil organic matter and pH and its peculiarity is that, in addition to this, it also manages to provide, in small doses, Nitrogen, Phosphorous and Potassium as well as a contribution of lime that benefits the soil. This process only requires an uncovered extension of land (adapted to retain landfill leachates) and shovels to move the material and the mixture.*

Technology feedstock: *Organic waste (animal by-products not intended for human consumption)*
Type of process: *Chemical treatment*
Technology output: *Biofertilizer*
TRL: *TRL 9 – actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)*
Scale: *Farm, Village, Community*

Market deployment considerations: *The main factor lies in the simplicity of the process, it allows a low level of automation to start and a simple technical training to a certain extent, which implies a much smaller investment than for other technologies.*

Environmental considerations: *Obtaining huge amounts of calcium oxide (quick lime) causes negative environmental impact. Also, Quicklime, used for the stabilization of organic waste, currently has no more environmentally sustainable substitute. Nor can it currently be partially replaced by the use of biomass ash (waste) by legislative change and in our authorization. Moreover, the carbon*

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emission to the atmosphere is a current impact due to the mobilisation and logistics of the wastes to valorise.

CONTACT INFO

Technology owner: AGROAMB - agroamb@agroamb.com

Link:

https://www.mapa.gob.es/app/consultafertilizante/ListadoFertilizantes.aspx?idFabricante=506&NombreComercial=&Provincia

https://sirga.xunta.gal/xestores

www.agroamb.com

http://agroamb.com/wp/wp-content/uploads/2020/10/Declaracion_ambiental_2020_validada-firmada-digitalmente-1.pdf

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

28 – Production of natural dye from the seed of Bixa orellana (achiote)

PROBLEM STATEMENT

The use of natural colouring has increased due to the health problems caused by chemical dyes. In short, the seeds of the fruits are by-products with beneficial and usable properties.

EXECUTIVE SUMMARY

The extraction of bixin from 'achiote' is based on leaving the seeds of the fruit in potassium soda for 12 hours. Subsequently, 10% sulphuric acid is added and finally filtered under vacuum, obtaining a mass that is dried in an oven at 56º-58ºC. The final material obtained is crushed to obtain colouring powder.

DESCRIPTION

SOURCE:

STAKEHOLDER: University
COUNTRY: Peru
YEAR: 2016

Bixa orellana or 'achiote', is a species native to tropical America with yields of up to 2500 kg/ha. Peru is the main producer of 'achiote', while the United States is the main demander of this plant species in powdered form. Carotenoids expressed as provitamin A have been found in the seeds of this commonly used food and cooking spice. One of them is bixin, a dark red carotenoic acid found in the outer covering of the fruit. Bixin is an excellent colouring agent with advantages for use in the cosmetics industry. Nowadays, both consumers and industrialists prefer the use of these products of natural origin, due to their biodegradability and low toxicity. B. orellana L. has great potential and demand for the global food industry, as the bixin extracted from its seeds provides one of the purest and most natural shades of red colour available, for the production of cheese, soft drinks, condiments and other food products. By adding potassium soda, then adding sulphuric acid and finally filtering, bixin-rich material is obtained.

Technology feedstock: *Seeds of Bixa orellana (achiote)*
Type of process: *Chemical treatment*
Technology output: *Natural dyes*
TRL: *TRL 4 – technology validated in lab*
Scale: *Farm*

CONTACT INFO

Technology owner: Faculty of Pharmacy and Biochemistry. National University of Trujillo - tdsgunt@unitru.edu.pe

Link: http://journal.upao.edu.pe/Arnaldoa/article/view/238

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

BIO4AFRICA

29 – Use of banana leaves for the production of nano/microfibres

PROBLEM STATEMENT

The annual production of banana leaves in the Canary Islands is ~400,000 tonnes, causing 320,000-400,000 tonnes of waste in the form of leaves, resulting in high management costs.

EXECUTIVE SUMMARY

Banana waste leaves are used to create a pulp from which micro/nano lignocellulose fibres (MNFLC) are obtained, which can be used for papermaking by adding them to cellulose pulp from wood, improving the mechanical qualities of the paper.

DESCRIPTION

SOURCE:

STAKEHOLDER: University
COUNTRY: Spain
YEAR: 2017

Canary Island banana (Musa acuminate var. Dwarf Cavenish) wastes are a source of micro/nano lignocellulosic fibres (MNFLC) with high lignin and hemicelluloses content, having the same reinforcing capacity as micro/nano cellulosic fibres (MNFC) in paper production. The first step is the preparation of the pulp according to Specel® conditions (100◦C±1◦C, 150 min, 7% NaOH and liquid/solid ratio of 10:1), presenting a pulp yield of more than 80%. After this, the material is washed to remove the resulting liquor, subjected to mechanical drying and grinding processes and taken to the refining stage where the MNFLC are obtained. These are added to the bleached wood pulp sludge and cationic starch and silica are added to retain the MNFLCs on the surface. The MNFLC obtained show different properties than those obtained by oxidative and enzymatic methods, although they provided almost the same increase in properties to the paper. On the other hand, these fibres allow the production of paper with lower water retention capacity, have lower production costs than fibres from oxidative processes and have a higher yield in terms of raw material utilisation.

Technology feedstock: *Musa acuminate (banana) leaves*
Type of process: *Chemical treatment*
Technology output: *Biofilms, Biodegradable films*
TRL: *TRL 3 – experimental proof of concept*
Scale: *Farm or community*

CONTACT INFO

Technology owner: University of Girona - expresso-support@bepress.com

Link: https://www.sciencedirect.com/science/article/abs/pii/S0926669017300213

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

30 – Conversion of agricultural waste fibers into biodegradable food packaging

PROBLEM STATEMENT

High prodution of banana, Cassava and other agricultural wastes.

EXECUTIVE SUMMARY

Buying of banana wastes, Cassava wastes and other agricultural wastes from farmers to produce bioplastics for food packaging.

DESCRIPTION

SOURCE:

STAKEHOLDER: Private sector
COUNTRY: Uganda
YEAR: 2019

Hya Bioplastics creates bio-based and 100% home compostable food packaging that provides a cost competitive alternative to petroleum-based plastics. They use Cassava starch and pulped fibers from banana pseudo stem as a key raw materials to make a range of food packaging including fruit and vegetable trays, takeaway food boxes and disposable plates. Hya Bioplastics are actively working on patenting this technology within Africa and licensing it as an additional revenue stream.

The business model is that they pay farmers for their undervalued banana pseudo-stem waste, providing them a valuable additional source of income. Moreover, they provide an alternative market for abundant commodities; Cassava is an undervalued, drought-resistant and widely grown crop in Africa. Cassava is a crop that is grown in 40 of the 53 African countries and it sells at half the price of alternative starches like cornstarch. They are offering additional markets for an abundant crop to prevent the losses farmers are currently making.

Technology feedstock: *Banana fibers, starch from maize, cassava or potatoes*
Type of process: *Composting*
Technology output: *Biodegradable food packaging*
TRL: *TRL 8 – system complete and qualified*
Scale: *Community*

Market deployment considerations: *High costs in relation to research & development. Regulation and production certification. Moreover, availability of raw material could also be a handicap sometimes.*

Environmental considerations: *Sourcing of banana stem waste from farms to our processing centers. This would require setting up the processing centers as close to the waste as possible. Large scale sourcing of high quality and consistent Cassava starch is a challenge.*

CONTACT INFO

Technology owner: Hya Bioplastics - hyabioplastics@gmail.com Link: www.hyabioplastics.com , https://www.linkedin.com/company/hya-bioplastics/

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

31 – Paper production from tomato and pepper crop wastes

PROBLEM STATEMENT

This waste is currently landfilled or used for composting. As it is produced in large quantities, they have a high environmental impact due to the transport required for their management.

EXECUTIVE SUMMARY

The technology has been developed by the Dutch company Shutpapier through the "Valorise" process, marketing the paper produced through VELPA B.V. The paper is produced from fibres extracted from waste and can be used for packaging vegetables, seeds, etc., providing a circular economy approach.

DESCRIPTION

SOURCE:

STAKEHOLDER: Private sector
COUNTRY: Netherlands
YEAR: 2019

The first step is a cleaning and grinding of the waste, similar to what wood undergoes when it is used as raw material for paper. The resulting pulp is pressed and then dried. No coating is applied, making it suitable for common printing processes. A regional component is promoted so that waste treatment is carried out in a decentralised manner. The paper obtained can be either 125 or 250 g. and can be used for all types of office supplies as it can be folded and is suitable for laser and offset printing. This paper with tomato plant fibres was chosen in 2015 by CEPI, the Confederation of European Paper Industries, as one of the twenty most innovative products in the pulp and paper industry.

Technology feedstock: *Tomato and/or pepper waste*
Type of process: *Drying*
Technology output: *Paper*
TRL: *TRL 9 – actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)*
Scale: *Village*

CONTACT INFO

Technology owner: VELPA B.V - welck@steinbeis-europa.de

Link:
https://ec.europa.eu/research/participants/documents/downloadPublic?documentIds=080166e5adf221c6&appId=PPGMS

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

32 – Production of an eco-insulating material using tree bark

PROBLEM STATEMENT

Wood bark, produced in large quantities in sawmills, is often used to produce energy in inefficient and CO2-intensive processes, composting or landfilling.

EXECUTIVE SUMMARY

Technology for the development of an eco-insulation through compression processes with insulation capacity similar to that of artificial insulators and a higher specific heat than traditional materials based on foam or fibres. Its main added value is its environmental sustainability with a neutral CO2 footprint.

DESCRIPTION

SOURCE:

STAKEHOLDER: University
COUNTRY: Hungary
YEAR: 2019

The raw material to be used (wood bark) is low cost and, depending on its typology, will require a specific optimum compression level. Specifically, the bark is pre-dried below 20% moisture content, granulated and finally dried to 6-9% moisture content. An adhesive based on a dilution of urea formaldehyde mixed with an aqueous solution of ammonium sulphate as a catalyst is added and then the resulting material is compressed to the desired density, the optimum being 350kg/m3. In case of medium production volumes, low production costs can be achieved. The most energy-demanding processes of this technology would be drying and transport, so it is important: (1) quality inputs, which should be protected from the weather; and (2) design regional/local production nodes to reduce transport costs. Similar products are already available on the European market, and in the case of these eco-insulators, the comfort they provide in residential and municipal buildings is also of interest, as vapour can pass through them, making them highly suitable as interior insulation.

Technology feedstock: *Wood bark*
Type of process: *Drying*
Technology output: *Biofilms, Biodegradable films*
TRL: *TRL 6 – technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies)*
Scale: *Farm or community*

Market deployment considerations: *Separate processing nodes would mean high transport costs.*

Environmental considerations: *Bark must not be stored outdoors.*

CONTACT INFO

Technology owner: University of Sopron - customerservices@ioppublishing.org

Link: https://iopscience.iop.org/article/10.1088/1755-1315/307/1/012007

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

33 – ORIBAGS Ecopulping&Packaging Technology

PROBLEM STATEMENT

There are numerous bioresources in Africa that remain discarded or underutilised. Over 90% of materials are dicarded, dumped, incenerated or burned.

EXECUTIVE SUMMARY

Manufacture of paper, packaging, stationary and other products.

DESCRIPTION

SOURCE:

STAKEHOLDER: Private sector
COUNTRY: Uganda
YEAR: 2009

The company turns agricultural by-products and other paper waste into decorative and professional paper stationery, manufactured in harmony with nature and personalized to the client's needs. After drying the paper, it has to be smoothen. If it dries under normal sun, the paper will be very hard and strong and so we use rollers to smoothen, making the paper smooth. Then comes a step of measurements, according to the standard size of a client needs. And then, they do the printing because they must be personalized according to the clients address, logo, or a specific trendy word that you need on the Eco bag.

Technology feedstock: *Agricultural waste*
Type of process: *Drying*
Technology output: *Paper, Gift bags, Gift boxes, Stationary, Paper board,etc*
TRL: *TRL 9 – actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)*
Scale: *Community*

Market deployment considerations: *Biobased technologies remain underdeveloped in Africa. there is lack of knowledge and awarenesss about use of biobased products in Africa.*

Environmental considerations: *Transportation of materials from farms, lifecycle assesment of products, etc.*

CONTACT INFO

Technology owner: ORIBAGS Innovations (U) Ltd - info@oribags-innovations.com

Link: https://paulndiho.com/2011/12/14/a-ugandan-company-oribags-innovations-is-turning-agricultural-waste-into-eco-bags-2/

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

34 – Obtaining high value-added active compounds from olive grove biomass

PROBLEM STATEMENT

The olive grove industry generates an enormous amount of waste in the olive cultivation process (leaves, pruning wastes) and in the production of the oil.

EXECUTIVE SUMMARY

In addition to the extraction of active compounds for human use, which provides high added value, two additional processes are carried out: (1) the generation of electrical energy that can be consumed by the plant itself; and (2) generation of products for animal feed.

DESCRIPTION

SOURCE:

STAKEHOLDER: Producers associations or cooperatives
COUNTRY: Spain
YEAR: 2014

The company Innovaoleo is a joint-venture between Natac and Oleícola El Tejar (world leader in the production of olive trees). Through this initiative, a catalogue of active compounds extracted from different wastes from the olive grove and the olive oil production process has been developed. Through a process of extraction, purification and drying of the compounds, ~1,000 ton./year of biomass are treated. Ingredients with high concentrations of oleuropein (olive leaf), hydroxytyrosol (olive leaf) and triterpenes (olive and olive leaf) are obtained, as well as a wide variety of innovative formulas (20% Oleuropein, 13% Pentacyclic triterpenes, 3% Hydroxytyrosol, 3% α-Tocopherol) with interesting applications in food (both nutraceuticals and functional food), pharmacy, animal nutrition and cosmetics. As for animal feed, a functional oil is produced for salmon aquaculture (improves the intestinal health of salmon, enhancing its growth and reducing production costs). The waste left from the extraction is taken to a combustion process, generating electrical energy.

Technology feedstock: *Biomass from the olive grove*
Type of process: *Extraction, concentration and purification*
Technology output: *Fortified food ingredients*
TRL: *TRL 7 – system prototype demonstration in operational environment*
Scale: *Farm*

CONTACT INFO

Technology owner: Natac S.L. - attcliente@unidadeditorial.es

Link: https://www.elmundo.es/economia/2014/06/26/53abea74e2704ef64b8b4574.html

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

BIO4AFRICA

35 – Biorefining of sugar beet for food, feed and biochemical applications

PROBLEM STATEMENT

The traditional beet industry faces high energy and operating costs (OPEX), especially at the process stage related to the concentration of beet sugar syrup.

EXECUTIVE SUMMARY

The technology of small-scale biorefining of beet sugar and its by-products provides an innovative and energy-efficient solution through a method based on the solubility of sugar and which, through a decentralised approach, also proposes to reduce transport costs.

DESCRIPTION

SOURCE:

STAKEHOLDER: Research and Technological Centre
COUNTRY: Ireland
YEAR: 2017

By adding an anti-solvent, the solubility of beet sugar in water is reduced, allowing beet crystallization to occur even in high concentrations of water, thus replacing three steps or stages of processing in large-scale refinings. Since the viscosity of the mixture is much lower than a sugar/water mixture, the sugar crystals can be collected without the need for centrifugation (a very energy-intensive process) and the anti-solvent is recovered and recirculated in a closed-loop system. In this way, a reduction of approximately 50% of the energy requirements of the process is achieved. The recovered sugar can be sold in the local food market (thus displacing imports), as well as used for fermentation processes, including "chemical building blocks" through a decentralization strategy. Besides, beet wastes contain a low volume of amino acids of high added value, while the pulp of beet pressing is of high value as animal feed.

Technology feedstock: *Beetroot*
Type of process: *Extraction, concentration and purification*
Technology output: *Purified effluent*
TRL: *TRL 4 – technology validated in lab*
Scale: *Farm*

CONTACT INFO

Technology owner: Institute of Technology Tralee - infoKerry@mtu.ie

Link:
https://ec.europa.eu/research/participants/documents/downloadPublic?documentIds=080166e5bc2a0824&appId=PPGMS

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

36 – Production of biodegradable bicycle lubricant from sheep hair

PROBLEM STATEMENT

Every year, bicycle users apply about 24 million litres of oil to their bicycle chains to lubricate them, polluting the environment.

EXECUTIVE SUMMARY

Bicycle chain lubricants are produced from petroleum. Eco Sheep™ is a biodegradable lubricant, obtained from the sheep's summer coat. The wool is washed and the lanolin is removed by degreasing. This is mixed with vegetable oils and used as a lubricant.

DESCRIPTION

SOURCE:

STAKEHOLDER: Private sector
COUNTRY: United States of America
YEAR: 2016

Sheep naturally produce lanolin, an oil they secrete in their wool to protect their bodies against moisture and weather. Eco Sheep™ is a fully biodegradable lubricating oil made from this lanolin extracted from sheep's wool. Sheep are sheared in summer and their wool is degreased by washing it in hot water and scrubbing it with either a soapy substance or a volatile solvent. In addition, Eco Sheep™ uses a mixture of other vegetable oils together with lanolin to produce this lubricant. The problem raised by the company is that every year around 24 million litres of petroleum are used as lubricant for bicycle chains, contaminating soil and water, causing a means of transport that respects the environment to end up affecting it. This is why it has developed this 100% biodegradable and non-toxic lubricant.

Technology feedstock: *Sheep's wool*
Type of process: *Extraction, concentration and purification*
Technology output: *Lipids*
TRL: *TRL 9 – actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)*
Scale: *Farm*

CONTACT INFO

Technology owner: Harper & Hopkins, LLC -

Link: https://store.ecosheep.com/

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

37 – Farm-based lignocellulosic biorefinery

PROBLEM STATEMENT

The biorefinery approach uses farm residues to produce bio-materials and energy, without competing with food production. The focus is the production of the platform chemical hydroxymethylfurfural for biobased plastics.

EXECUTIVE SUMMARY

This is a pilot research project that involves the creation of a biorefinery plant at the university's "Unterer Lindenhof" research station. The vision is to design a small-scale plant for farm use that uses both biogenic plant residues and agricultural by-products to produce a wide range of raw materials and energy sources, without competing with food production.

DESCRIPTION

SOURCE:

STAKEHOLDER: University
COUNTRY: Germany
YEAR: 2021

In the center of the biorefinery, there is an existing biogas plant. The whole concept is demonstrated in the research station "Lindenhöfe" of the University of Hohenheim. The mass flows of the research-station, which is a farm, are used as input of the biorefinery. For the utilization of agricultural residues via the production of the bio based basic chemical 5-hydroxymethylfurfural (HMF for short) a pilot plant was built up. In this process, the carbohydrates in the (residual) biomass react in aqueous medium under pressure and elevated temperature (hydrothermal conditions) to form HMF. The different chemical-functional groups of this reactive molecule allow a variety of chemical modifications and make HMF a versatile renewable basic building block. For this reason, it is also one of the 12 most important bio based platform chemicals of the future. For example, oxidation of 5-HMF produces the platform chemical FDCA, which can replace petrochemical-based terephthalic acid (TA) in all its polymer applications. Currently, one of the best studied polymer applications is polyethylene furanoate (PEF), a high-performance bio-based polymer with excellent physicochemical properties compared to PET. This leads to lower energy requirement in further processing and thus the environmental impact. In addition, PEF has higher gas barriers by a factor of 10. The structural similarity to PET allows, in addition to single-grade recycling, the mixing with PET.

Technology feedstock: *Lignocellulosic farm residues (wood, grass, straw)*
Type of process: *Fermentation*
Technology output: *Hydroxymethylfurfural (HMF), Furfural, activated carbon*
TRL: *TRL 6 – technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies)*
Scale: *Farm*

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

Environmental considerations: *In the case of PEF, a saving of approx. 4.6 kg of CO_2 per kg of plastic is possible.*

CONTACT INFO

Technology owner: University of Hohenheim - bioraffinerie@uni-hohenheim.de

Link: https://konversionstechnologie.uni-hohenheim.de/en/118578/biorefinery-pilot-plant

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

38 – Use of Ligninolytic Micro organisms

PROBLEM STATEMENT

Feed resources in the tropics are high in fiber and low in digestibility, due mainly to non-polysaccharide components. There is therefore need to increase their feeding values by biological treatments to improve the nutritional quality of these feed resources.

EXECUTIVE SUMMARY

This technology subsumes the use of white-rot; Brown-rot and soft rot fungi. White rot fungi are capable of degrading lignin without affecting much of cellulose and hemicelluloses, while Brown rot fungi preferentially attack cellulose and hemi-cellulose. Soft-rot fungi leaves the attacked lignocellulosic material watery-soft and breaks down cellulose and hemicelluloses.

DESCRIPTION

SOURCE:

STAKEHOLDER: Research and Technological Centre
COUNTRY: Ethiopia, India, China
YEAR: 2020

Fungal strains are collected from the surrounding and maintained on solid media (for example Potato Dextrose Agar, Formedium, Hunstanton- UK) and stored at room temperature. The dose of application of fungus to feeds varies. In one such treatment, Montañez-Valdez et al. added 250 g of the Pleurotus djamor strain to a 10 kg of maize stover packed by polyethylene bag. The wheat grain spawn of two Pleurotus fungi including P. florida (PF) and P.ostreatus (PO), are used to inoculate the straw, at the rate of 3.5 kg spawn per 100 kg straw fresh weight basis. The nutritive value of low-quality feeds, which has been widely reported using rape straw, wheat straw, rice straw, and corn Stover and sugarcane bagasse can be greatly enhanced using this technology.

Technology feedstock: *Straw, Crop Residues*
Type of process: *Fermentation*
Technology output: *Animal Feed*
TRL: *TRL 9 – actual system proven in operational environment*
Scale: *Farm, Village*

Market deployment considerations: *Palatability of feed; acceptability by livestock farmers and scaling up challenges after on-farm trials.*

Environmental considerations: *Identification and culture of safe fungi.*

CONTACT INFO

Technology owner: Bahir Dar University, Ethiopia - bduinfo@bdu.edu.et - Link: Bimrew Asmare (2020). Biological treatment of crop residues as an option for feed improvement in the tropics: A review. Department of Animal Production and Technology, College of Agriculture and Environmental Sciences, Bahir Dar University, Ethiopia Anim Husb Dairy Vet Sci, doi: 10.15761/AHDVS.1000176 Volume 4: 1-6

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

39 – Vegetable Granules for Vibratory Finishing, Polishing, Sandblast

PROBLEM STATEMENT

High production of agriwastes that can become an environmental problem.

EXECUTIVE SUMMARY

Main aim is to valorise agri-food wastes and transforming them in materials used in sand blasting, deburring and polishing as well as additives in many industrial production processes for machining metals, animal feed and restoration work.

DESCRIPTION

SOURCE:

STAKEHOLDER: Private sector
COUNTRY: Italy
YEAR: 2010

Granules from hazelnuts, almonds, corn cobs, etc.) are produced and used for the following applications:

- *Products made from different annually renewable raw materials (hazelnuts, almonds, corn cobs, etc.): these fibrous materials are ground to the grain size wanted by the user and are used for sand blasting, deburring, and polishing as well as additives in many industrial production processes for machining metals, animal feed and restoration work.*
- *Soft sandblasting: hazelnuts, almonds, corn cobs, etc. are used for removal of carbon residues and encrustations on metal parts of engines, reactors, metal dies for foundries, moulds for rubber and plastic materials. They don't corrode the metal, so it does not alter the dimensions, finishes or edges of the parts. They are used for removal of unwanted parts on valuable wood beams, statues, monuments, tombs, works of art. Also as a softener for processing in the tannery, fabric, and leather industries.*
- *Deburring objects: the granules of hazelnuts, almonds, corn cobs, etc. are coated with abrasive pastes and are used widely in vibro-finishes and barrelling in various sectors (metal and alloy, plastic material, spectacles, silverware, and gold smithery industries).*
- *Fillers and additives (mixed with resins): for foundry models and for industries that manufacture resins, sealants, and adhesives.*
- *Zootechny and supplements: fibrous support for chemical-pharmaceutical industries that manufacture supplements for zootechny. The granules can be coated with active substances, allowing the user to obtain powder-free granular medicinal products.*
- *Organic Mix for fertilizers and agrochemicals: the granules, as absorbents, may incorporate nutrients and healing principles for different types of agrarian crops.*

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

Technology feedstock: *Hazelnuts, almonds, corn cobs, etc.*
Type of process: *Grinding*
Technology output: *Biomaterial, bioadditive, biofertiliser*
TRL: *TRL 9 – actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)*
Scale: *Community*

Market deployment considerations: *These technologies are modulable and scalable, as well as used at local or regional level, therefore, very replicable technologies.*

Environmental considerations: *Feasibility studies with different biomasses should be made.*

CONTACT INFO

Technology owner: Agrind - info@agrind.it

Link: https://www.agrind.it/en/portfolio/project-number-12/

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

40 – Removal of synthetic dyes from wastewater using rice biomass

PROBLEM STATEMENT

Rice is grown in more than 75 countries, with annual paddy production amounting to 80 million tonnes, representing 20% of whole rice.

EXECUTIVE SUMMARY

By using rice husks as a bioadsorbent, tartrazine yellow and brilliant blue FCF (both synthetic azo dyes), among others, are removed from wastewater from the agri-food, textile, leather and paper industries.

DESCRIPTION

SOURCE:

STAKEHOLDER: University
COUNTRY: Portugal
YEAR: 2018

In general, wastewater contains dye concentrations ranging from 10 to 200 mg/L. In its use as a bioadsorbent, rice husk is ground and sieved in order to obtain homogeneous particle size (>50µm). The screenings are washed and dried at 60°C in order to remove adhering organic matter. The adsorption process for both dyes is highly pH-dependent, being favoured at pH 2. The adsorption capacity of rice husk increases with increasing dosage of adsorbent material and initial adsorbate concentration. Regarding the contact time, this is independent of the initial concentration, reaching a constant adsorption after 60min and 90min of contact between the Brilliant Blue FCF and Tartrazine on the rice husk, respectively, for an adsorbent dose of 1.4g. The process is carried out at room temperature.

Technology feedstock: *Rice husk*
Type of process: *Grinding*
Technology output: *Purified effluent*
TRL: *TRL 4 – technology validated in lab*
Scale: *Farm or community*

CONTACT INFO

Technology owner: Polytechnic Institute of Leiria - contact@docplayer.es

Link: https://docplayer.es/95515214-Remocion-de-colorantes-sinteticos-de-las-aguas-residuales-de-la-industria-alimentaria-usando-como-material-adsorbente-biomasa-de-arroz.html

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

41 – *Making of packaging materials from zero carbonisation process*

PROBLEM STATEMENT

Waste is a growing problem in Uganda. Every citizen disposes at least half a tonne of trash each year. Only 55% of the solid waste generated in Kampala is collected and managed. And most Ugandan enterprises and institutions still send over 90% of recyclable materials to the landfill or incinerate them. This compromises the environment and creates pollution that lowers the quality of life for all Ugandans.

EXECUTIVE SUMMARY

Circular economy model is promoted in Uganda so that people know that their waste is gold.

DESCRIPTION

The hand bags are made from agricultural products using zero carbon production process. The agricultural wastes are delivered through the waste suppliers, then it is sorted and the appropriate ones are mixed with water in carbon process and a straw board paper is developed. A multi take low zero carbon production process is used.

SOURCE:

STAKEHOLDER: Private sector

COUNTRY: Uganda

YEAR: 2007

Technology feedstock: *Agricultural waste*
Type of process: *Grinding*
Technology output: *Biodegradable bags*
TRL: *TRL 9 – actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)*
Scale: *Community*

CONTACT INFO

Oribag Innovations, info@oribags-innovations.com, Link: http://oribags-innovations.com/

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

42 – Fish protein hydrolysate from fish farming wastes

PROBLEM STATEMENT

Aquaculture production generates waste in the form of discards and effluents, to which must be added the mortality of aquaculture individuals, amounting to ~4% of production.

EXECUTIVE SUMMARY

Fish protein hydrolysates are the result of enzymatic or chemical hydrolysis of the protein fraction of fish or fractions such as muscle, by-products or process waters, presenting interesting properties from a technological and sensory point of view.

DESCRIPTION

SOURCE:

STAKEHOLDER: Private sector
COUNTRY: Spain
YEAR: 2018

Hydrolysates can be obtained from any type of fish (whole or by-products). Mainly from muscle or protein-rich fractions. No pre-processing is necessary, although it is advisable to carry out a concentration to reduce transport costs. The raw material must be stored refrigerated or frozen and histamine production must be carefully controlled. The first step is grinding, followed by hydrolysis. After this, the product is sieved to obtain on the one hand the discarded bones and on the other hand the stream with the fish protein, which is centrifuged. From this stage, on the one hand, oils/emulsion is obtained and on the other hand, after a final drying stage, the fish protein hydrolysate. It is typically a cream-coloured powder with a fishy odour. It has about 80 % protein and less than 5 % moisture and less than 11 % fat. There are two types of presentations: soluble fish protein hydrolysate and partially hydrolysed protein.

Technology feedstock: *Fish farming waste*
Type of process: *Hydrolisis*
Technology output: *Protein*
TRL: *TRL 9 – actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)*
Scale: *Village, Community*

CONTACT INFO

Technology owner: AZTI Tecnalia - info@azti.es

Link: https://www.azti.es/wp-content/uploads/2018/12/AZTI_guia_VALACUI101218online.pdf

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

43 – Livestock feed production from fish by-product silage

PROBLEM STATEMENT

The increase of fish by-products (tissues, viscera, etc.) in the processing industry generates a large environmental impact by promoting the proliferation of harmful bacteria.

EXECUTIVE SUMMARY

A liquefaction process prepares the fish for ensiling. This occurs due to the presence of enzymes naturally present in the fish, and is accelerated by the acid, creating suitable conditions for the enzymes to break down the tissues, while limiting the growth of harmful bacteria.

DESCRIPTION

SOURCE:

STAKEHOLDER: Private sector
COUNTRY: Spain
YEAR: 2018

Fish silage can be made from all fish species and their respective parts separately. The final quality of the silage depends on the degree of freshness of the raw materials. The fish by-product silage process is based on the liquefaction of raw materials such as fish viscera and skin. It starts with grinding, followed by an acidification process, where acids, enzymes and lactic acid producing bacteria are added to break down the tissues. The mixture is then shaken to homogenise the medium. Finally, this mixture is ensiled and the silage product obtained is heated, centrifuged and two products are obtained, protein hydrolysate and silage oil. The former is used in aquaculture for the growth of species other than the species of origin and as an organic agricultural fertiliser. The resulting oil is used for biodiesel production.

Technology feedstock: *Fish viscera*
Type of process: *Liquefaction*
Technology output: *Sillage*
TRL: *TRL 6 – technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies)*
Scale: *Village, Community*

CONTACT INFO

Technology owner: Azti tecnalia - info@azti.es

Link: https://www.azti.es/wp-content/uploads/2018/12/AZTI_guia_VALACUI101218online.pdf

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

44 – Feed formulation/mixing

PROBLEM STATEMENT

The use of low-quality forage, such as cereal stover, as the major feedstuff in ruminant diets can limit both energy density and intake.

EXECUTIVE SUMMARY

Supplementation of low-quality forage with legumes will increase diet utilization to some extent, but for higher levels of production, increased dietary energy density through the use of higher quality forage and some grain may become of interest to livestock producers. Legume fodder such as cowpea can remain an important part of these higher energy diets.

DESCRIPTION

SOURCE:

STAKEHOLDER: Research and Technological Centre
COUNTRY: Nigeria
YEAR: 2005

Cowpea (Vigna unguiculata [L.] Walp.) is an annual legume grown throughout the semi arid tropics, where it is valued as both human and livestock food. It is drought tolerant, can be grown on relatively poor soils, and fixes nitrogen, thereby improving soil fertility. In addition to grain, cowpea can produce good yields of fodder for ruminant feeding systems. In Africa, cowpea is widely intercropped with maize, sorghum and millet. Cowpea is intergrated with sorghum to boost the nutritional component. This is done by having the cowpea cut into small pieces by the chaff cutter and mixed in a feed miller. An animal nutritionist is needed to determine the inclusion rates. A Near infra red machine for nutritional analysis is also needed.

Technology feedstock: *Cowpea, sorghum*
Type of process: *Milling*
Technology output: *Livestock feed (protein supplement)*
TRL: *TRL 9 – actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)*
Scale: *Community*

Market deployment considerations: *The product is safe to be deployed in the market.*

Environmental considerations: *Environmental friendly.*

CONTACT INFO

Technology owner: ILRI and IITA - ILRIdataprivacysupport@cgiar.org

Link: https://cgspace.cgiar.org/rest/rest/bitstreams/886f96f2-65ee-4fa1-81c7-65a6281a28e9/retrieve

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

45 – Tableware made from sugar cane waste

PROBLEM STATEMENT

Agricultural waste from the sugar industry represents an environmental hazard due to its easy combustion and degradation time, as only ~10% is reused.

EXECUTIVE SUMMARY

The demand and interest for sustainable food packaging and disposable tableware is growing exponentially, requiring significant solutions. For these requirements, Pacovis produces biologically degradable materials (Naturesse line), reducing CO2 emissions and waste generation.

DESCRIPTION

SOURCE:

STAKEHOLDER: Private sector
COUNTRY: Switzerland
YEAR: 2019

The first step is the collection and drying of the sugar cane bagasse. It is then compressed and pressed to obtain a syrup with a high fibre content, which is compacted into a final paste by the addition of water and natural binding agents. The final step is processing and pressing in moulds. Alternatively, the company has also developed more complex processes where sugar cane starch is used for the production of PLA - Poly Lactic Acid, which is also used to produce kitchenware. The products of the Naturesse range are EN 13432 certified and are therefore food safe, taste neutral, heat and water resistant. The same company works with waste from other origins within the same line: palm leaf, bamboo and cellulose/wood.

Technology feedstock: *Sugar cane bagasse*
Type of process: *Moulding*
Technology output: *Bioplastics*
TRL: *TRL 8 – system complete and qualified*
Scale: *Village*

Market deployment considerations: *Requires industrial technology e.g., moulding and extrusion equipment.*

CONTACT INFO

Technology owner: Pacovis - admonpeconvi@gmail.com

Link: http://peconvi.es/wp-content/uploads/2019/10/Catalogo_Naturesse.pdf

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

46 – Packaging and disposable tableware solutions from agricultural waste

PROBLEM STATEMENT

Agricultural waste such as tomato and wheat wastes and banana roots, among others, are not used, which has an environmental impact and a management cost for the producer.

EXECUTIVE SUMMARY

BIOSOLUTIONS offers innovative packaging solutions as well as environmentally friendly and intelligent disposable tableware. In terms of packaging there are three options: Basic, with food grade additives or with aluminium laminate. The products are sustainable and innovatively designed, extremely efficient and cost-effective.

DESCRIPTION

SOURCE:

STAKEHOLDER: Private sector
COUNTRY: Alemania
YEAR: 2019

BIOSOLUTIONS works with a local partner, (e.g. the NGO VIKASANA) who collaborates in the collection of waste from small farmers in the region. After this, the materials are cleaned and preserved (through pressing and drying). The processing consists of conversion to micro and nanofibres and subsequent moulding and lamination to shape them into tableware and packaging materials, and the products can also be moulded and coloured according to market needs. The final product is delivered to local customers and after use can be energy efficiently burned, recycled, or landfilled as it is biodegradable. The process avoids the addition of chemical additives and achieves low energy and water consumption. The establishment of BIOSOLUTIONS facilities is possible all over the world (currently they have implemented the system in Thailand), as they are compact and require only basic infrastructure. Depending on local demand and resource availability, it is possible to open multiple facilities in different areas of each country, shortening transport to the point of sale, significantly reducing CO2 emissions. In addition, production staff do not need special technical skills so they can be trained on site, creating local jobs.

Technology feedstock: *Agriculture waste: tomato, banana, wheat, etc.*
Type of process: *Moulding*
Technology output: *Bioplastics*
TRL: *TRL 9 – actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)*
Scale: *Community*

Market deployment considerations: *Infrastructure, electricity and water supply.*

CONTACT INFO

Technology owner: BIO-SOLUTIONS - info@bio-lutions.com - Link: https://www.bio-lutions.com/

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

47 – Development of functional materials from natural fibres

PROBLEM STATEMENT

Agricultural waste entails a management cost that represents an environmental impact. Moreover, society is demanding new materials made from less toxic compounds.

EXECUTIVE SUMMARY

The technology developed produces functional materials through the use of natural fibres and bio-resins, which avoids the use of chemical additives/adhesives. Two types of materials have been developed, STRAWave and TRAshell, and it is possible to use straw or coconut fibres.

DESCRIPTION

SOURCE:
STAKEHOLDER: University
COUNTRY: Germany
YEAR: 2019

The technology has been developed by the BioMat/ITKE - Faculty of Architecture at the University of Stuttgart. The products are made from recycled natural agricultural fibres combined with thermosetting bio-resins. The natural fibres are ground and combined separately with the bio-resins and moulded in a closed vacuum press in custom-designed moulds to achieve the required final shape pattern. In the case of STRAWave, different wave and colour designs were applied. The products can be used in non-structural façade cladding systems and interior cladding. STRAWave panels measure around 400 x 400 mm. In the case of TRAShell, this is a 300x 300 x 300 x2-5 mm carcass with glossy additives applied to suit exterior façade use. The business model is based on licensing, available to industrial partners in the fields of interior architecture, automotive interiors, plastics industry and wood composites. The process can be "do-it-yourself" and does not require specific training or high operating costs.

Technology feedstock: *Natural fibres from agricultural waste (straw, coconut...)*
Type of process: *Moulding*
Technology output: *Biofibres*
TRL: *TRL 9 – actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)*
Scale: *Farm*

CONTACT INFO

Technology owner: BioMat/ITKE - Fac. Arquitectura - Univ. Stuttgart - info@materialdistrict.com

Link: https://materialdistrict.com/material/strawave/

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

BIO4AFRICA

48 – Pelletizing- Use of cassava in livestock and aqualculture feeding programs

PROBLEM STATEMENT

Despite recognized nutritional shortcomings, all parts of cassava can be successfully used in livestock and aquaculture feeding programs. Various studies document the replacement value of processed cassava root/ peels as an energy ingredient when paired with appropriate nitrogen sources, substituting for maize at up to ~40% of total diets in cattle, 20 to 50% in small herbivores (goats, sheep, rabbits), and up to 100% in swine diets, 10 to 40% in various poultry diets, and 15–30 to >60% in aquaculture diets (depending on species/age). Further, in aquaculture, cassava starch acts as a natural pellet binder.

EXECUTIVE SUMMARY

On a global scale, cassava (Manihot esculenta) represents both an important human food resource and, in many regions, an underutilized animal feed ingredient. Cultivated in tropical/subtropical environments, cassava can be grown on marginal lands; it is relatively drought-hardy, and all parts of the plant can be utilized; and its roots comprise an energy staple in many regions. In recent years, the African continent produced ~60% of the global cassava crop (256 million tonne) through targeted efforts to develop improved varieties; yet only a small fraction is utilized for animal feeding programs throughout Africa. Potential for increased utilization is vast, particularly of unused or underused fractions and residues such as peels.

DESCRIPTION

SOURCE:

STAKEHOLDER: Research and Technological Centre
COUNTRY: Nigeria
YEAR: 2014

The first step is usually washing, followed by peeling, drying and pelletizing.The key innovation is to grate the peels, and then squash them in a hydraulic press to rapidly remove the liquid.The process produces a kind of 'cassava peel cake', which is then grated again, forming particles of uniform size, which dry out in a matter of hours. The resulting product - called "High Quality Cassava Peels" or HQCP -- has just 10-12 percent moisture content and keeps for six months.

The high-fibre coarser particles can be separated out for pig and ruminant feed, while the higher-protein finer particles can be given to poultry (Drying, fermentation and enzyme treatments improve utilization of cassava peel fractions for monogastrics and polygastrics). Dryers, hydraulic press machine and pelletizing equipment needed.

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

Technology feedstock: *Cassava peels*
Type of process: *Pelletizing*
Technology output: *Livestock feed for monograstrics and polygastrics*
TRL: *TRL 9 – actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)*
Scale: *Village, Community*

Market deployment considerations: *Cassava use as livestock feeds reguires pre-treatment before being fed to livestcok due to presence of antinutritive factors.*

Environmental considerations: *The byproducts are safe to the environment*

CONTACT INFO

Technology owner: ILRI - ILRI-Kenya@cgiar.org

Link: https://www.ilri.org/publications/use-cassava-livestock-and-aquaculture-feeding-programs

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

49 – Densified Total Mixed Ration Blocks

PROBLEM STATEMENT

Feed is the major input cost for livestock production. Poor nutrition of animals has been identified as the major constraint to animal production across the developing world (FAO, 2000) chiefly due to:

1. *An acute shortage of feed resources.*
2. *Lack of efforts to increase green forage production and to improve the management of degraded and unmanaged pastures.*
3. *Improper management of feed resources, especially that of the bulky and fibrous crop residues, and wastage through burning*

Thus, there is an urgent need to optimize the use of the limited feed resources, especially straws for ruminant feeding.

EXECUTIVE SUMMARY

The first step in the process of making straw-based feed blocks is the grinding of concentrate ingredients, followed by their mixing and addition of the feed additives. This is then followed by mixing of these ingredients and straw in proper proportions along with addition of molasses in a specifically designed TMR mixer, taking care that mixing is uniform and ingredients are not separated due to gravity. Finally, the weighed quantity of the mixed stuff is transferred into a hydraulic press to get the final product – the DTMRB.

DESCRIPTION

SOURCE:

STAKEHOLDER: Research and Technological Centre
COUNTRY: India
YEAR: 2012

A grinder (hammer mill) and a mixer are required for making a normal concentrate mixture. A specially designed TMR Mixer is required for mixing weighed quantities of low density crop residue (straws, stovers, bagasse, dried forest grasses, dried tree leaves etc.) and the high-density concentrate. Molasses and any other liquid feed additive are also added at this stage. The mixing is done through vertical motion, so that there is no separation due to gravity. Weighed quantity of the mixed ingredients is transferred into densification machine (Works on the principle of hydraulic compression) which compresses the forage and concentrate mixture into densified complete feed block.

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

Technology feedstock: *Straws of wheat, soybean, mustard and cotton*
Type of process: *Pelletizing*
Technology output: *Animal Feed*
TRL: *TRL 9 – actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)*
Scale: *community*

Market deployment considerations: *Market is available. Issues of storage and binding material used.*

CONTACT INFO

Technology owner: National Dairy Research Institute, Karnal, India - support.it@icar.gov.in

Link: FAO. 2012. Crop residue based densified total mixed ration – A user-friendly approach to utilise food crop by-products for ruminant production, by T.K. Walli, M.R. Garg & Harinder P.S. Makkar. FAO Animal Production and Health Paper No. 172. Rome, Italy.

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

50 – Uromin lick (UML)/urea-molasses-multi-nutrient blocks (UMMB)

PROBLEM STATEMENT

An assessment of the nutritional status of dairy animals showed these animals were being offered highly imbalanced diets, deficient in protein; energy and minerals. The deficiency in minerals and salt reflected in the reproductive problems of animals in these areas.

EXECUTIVE SUMMARY

UMMB is a convenient and inexpensive method of providing a range of nutrients to animals. It can improve the digestion of low-quality roughages by satisfying the requirement of rumen microorganisms, creating a better environment for fermentation and increasing production of microbial protein and volatile fatty acids. Urea, after hydrolysis to ammonia in the rumen, provides a nitrogen source for the rumen microbes, while molasses acts as a source of readily-fermentable energy.

DESCRIPTION

SOURCE:

STAKEHOLDER: Research and Technological Centre
COUNTRY: India
YEAR: 2011

The conventional UMMB weighing 3 kg contains (g): molasses 900, urea 300, mustard cake 300, de-oiled rice bran 300, wheat flour 450, mineral mixture 450, calcium oxide 120, salt 120 and guar gum 60. The required quantity of molasses and urea are weighed and mixed in a 25 kg capacity iron pan. The guar gum is added to the urea-molasses mixture as a binder. A premix of other ingredients is prepared; calcium oxide is the last ingredient to be added to this premix in the iron pan with rapid stirring. Two to eight UMMBs may be prepared at a time, either in a manually operated (for small/marginal/landless dairy farmers) or electrically powered (for commercial production) block-making machine.

Technology feedstock: *Agricultural waste*
Type of process: *Pelletizing*
Technology output: *Nutrient Supplement/Animal Feed*
TRL: *TRL 9 – actual system proven in operational environment*
Scale: *Community*

Environmental considerations: *The hardness of the blocks affect intake.*

CONTACT INFO

Technology owner: National Dairy Research Institute, Karnal, India - support.it@icar.gov.in

Link: FAO. 2011. Successes and failures with animal nutrition practices and technologies in developing countries. Proceedings of the FAO Electronic Conference, 1-30 September 2010, Rome, Italy. Edited by Harinder P.S. Makkar. FAO Animal Production and Health Proceedings. No. 11. Rome, Italy.

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

51 – *Refining water void of heavy metals*

PROBLEM STATEMENT

Some water sources in Uganda especially River Nyamwamaba, in Kasese, is affected with heavy metals. This technology sets out to forestall such a challenge by ensuring that water is purified through this bio adsorbent technology.

EXECUTIVE SUMMARY

This technology uses locally available biological materials especially agricultural waste to remove heavy metals from water and wastewater. This effort alone contributes towards the achievement of sustainable development goals 6, 11 and 13. Besides the technology provides an economical alternative for removing toxic heavy metals from industrial wastewater thus aiding in environmental remediation. The project is being implemented in Kasese, district in Nyamwamba valley and, to make the project as low cost as possible, coffee husks and cotton seed cakes are used as bio adsorbents.

DESCRIPTION

The removal of heavy metals is done through a physicochemical process that occurs naturally in the biomass which allows it to passively concentrate and bind its contaminants onto its cellular structure. The entire process is called bisorption and the biomass used in this application is called a biosorbent.

SOURCE:
STAKEHOLDER: Research and Technological Centre
COUNTRY: Uganda
YEAR: 2017

Technology feedstock: *Coffee husks and cotton feed stocks.*
Type of process: *Physicochemical*
Technology output: *Purified clean water*
TRL: *TRL 4 – technology validated in lab*
Scale: *Farm*

CONTACT INFO

Gulu University, pro@gu.ac.ug, Link: https://gu.ac.ug/

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

52 – Valorisation of non-food-grade milk by casein extraction and conversion

PROBLEM STATEMENT

One hundred million tonnes of milk are discarded annually because it is considered unfit for food consumption (due to thermal degradation, cellular problems or germs).

EXECUTIVE SUMMARY

In a simple process, casein is extracted from milk and processed without the addition of chemicals to obtain various products such as biopolymers (automotive, clothing, home textiles, cosmetics or medical applications).

DESCRIPTION

SOURCE:

STAKEHOLDER: Private sector
COUNTRY: Germany
YEAR: 2014

Casein (milk protein) is produced through a precipitation process and then plasticised with water at moderate temperature in a continuous kneading process. The resulting biopolymer is pressed through a spinner in a melt spinning process. Since the process takes place at less than 100°C, the special properties of the milk can be maintained (the resulting products being suitable for people with allergies and topical problems). The production of 1 kg of biopolymer takes place in 5 minutes and requires 2 litres of water. The products are marketed by the company QMILK. Used in cosmetics, it is produced in the form of micro beads, being antibacterial and hypoallergenic for skin cleansing. Used in the textile field, it is antibacterial, self-regulates temperature and absorbs moisture. As a functional material, it can be produced in granules or in sheets/films. In general, the product resulting from the process is free of isocyanate, halogens, solvents, hazardous plasticisers, silver, triclosan and zinc oxide.

Technology feedstock: *Milk not fit for consumption*
Type of process: *Polymerisation*
Technology output: *Biopolymers*
TRL: *TRL 9 – actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)*
Scale: *Farm*

CONTACT INFO

Technology owner: QMILK - financial@theguardian.com

Link: https://www.theguardian.com/sustainable-business/sour-milk-fibres-textiles-qmilk

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

53

– Melt compounding of agri-food wastes biomass

PROBLEM STATEMENT

Global needs of researching and developing bioplastics from agri-wastes.

EXECUTIVE SUMMARY

This technology produces bioplastics and biodegradable plastics to valorise agricultural wastes.

DESCRIPTION

SOURCE:

STAKEHOLDER: Private sector
COUNTRY: Italy
YEAR: 2000

The proposed solution is a series of physical process, starting with drying and grinding the agricultural wastes. Then adding them to an extruder with thermoplastic polymers (it can be a biodegradable thermoplastic polymers). Then, inside the compounding line, where the input is mixed, temperature increases, and the heated mixture comes out of the machine as a combined biopolymer or bioplastic.

Technology feedstock: *Rice husks, corn combs and hemp scraps from hemp fibres.*
Type of process: *Polymerisation*
Technology output: *Biopolymer or bioplastics*
TRL: *TRL 9 – actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)*
Scale: *Village, Community*

Market deployment considerations: *This technology is modulable, the main machine is an extruder, that melts and binds different compounds. It favours to use local agri-wastes and use them for bioplastics making. To reach the amount of biomass needed to be feed to the machine (extruder).*

Environmental considerations: *Biopolymers can be composted if they are bio-compostable, although their market price is higher than the non-compostable ones.*

CONTACT INFO

Technology owner: Proplast - info@proplast.it

Link: https://www.mdpi.com/2073-4360/13/9/1471

https://www.proplast.it/technical-services/materials-engineering/

https://journals.scholarsportal.info/details/02540584/v180icomplete/284_rbmaeppcpapt.xml

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

54 – Decentralized refinery for local

PROBLEM STATEMENT

The refinery enables local processing of cassava into products and intermediates overcoming traditional logistical challenges.

EXECUTIVE SUMMARY

The refinery of Vieux Manioc BV enables local processing of cassava through mobile processing and refinery units which overcome traditional logisical and preservation issues when processing cassava.

DESCRIPTION

SOURCE:

STAKEHOLDER: Producers associations or cooperatives
COUNTRY: Netherlands, Nigeria, Mozambique, Ghana
YEAR: 2002

The refinery process has 3 components: an autonomous mobile processing unit (AMPU), a mobile refinery (MRU) and dryer. The AMPU processes fresh cassava roots into cassava cake using a high speed rasper which can release 98% of the starch granules in the roots. The MRU enables the extraction of cassava fibres from the cassava cake. The cake is then dewatered using a decanter centrifuge to increase dry matter, before being further dried using a flash dryer or mobile drying unit. The solution can be deployed at small-scale using a mobile system, or using a decentralized approach, whereby the initial refining steps take place locally and intermediate products can be upgraded centrally. This local processing approach helps to overcome the challenge of the perishability of cassava, which typically must be processed within 24 hours of harvesting. This short processing timeframe makes it challenging to transfer the cassava to a centralized plant for further processing. Using the Vieux Manioc BV technology, processing can take place close to the harvesting site within a short time frame, producing storable intermediates and products such as cassava cake, cassava fibre and cassava flour, along with intermediate ingredients to further process into products such as sorbitol, ethanol and beer.

Technology feedstock: *Cassava*
Type of process: *Refining*
Technology output: *Cassava Starch Cake (product/intermediate), Cassava Flour*
TRL: *TRL 9 – actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)*
Scale: *Farm or community*

Market deployment considerations: *Widely replicable in Africa given the scale of cassava production.*

Environmental considerations: *Reduces transport emissions associated with transfer of high moisture content cassava over long distances.*

CONTACT INFO

Technology owner: Vieux Manioc BV - philafricafoods@philafricafoods.com - Link: https://www.philafricafoods.com/dadtco/?s=

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

55 – Bioliq

PROBLEM STATEMENT

The biorefinery approach uses farm residues to produce bio-materials and energy, without competing with food production.

EXECUTIVE SUMMARY

The lignocellulosic biomass residues used do not compete with food and feed production, but have to be collected from wide-spread areas for industrial large-scale use. The two-stage gasification concept bioliq offers a solution to this problem. It aims at the conversion of low-grade residual biomass from agriculture and forestry into synthetic fuels and chemicals. Central element of the bioliq process development is the 2–5 MW pilot plant along the complete process chain: fast pyrolysis for pretreatment of biomass to obtain an energy dense, liquid intermediate fuel, high-pressure entrained flow gasification providing low methane synthesis gas free of tar, hot synthesis gas cleaning to separate acid gases, and contaminants as well as methanol/dimethyl ether and subsequent following gasoline synthesis.

DESCRIPTION

SOURCE:
STAKEHOLDER: Research and Technological Centre
COUNTRY: Germany
YEAR: 2005

bioliq® is one answer searching for high quality BTL fuels or fuel components produced from sustainable biomass residuals. The problem to be solved is the widely distributed rising of biomass connected to the need of large scale fuel production plants required by economies of scale. The solution is the de-centralized pre-treatment of biomass to obtain an intermediate energy carrier of high energy density (bioliqSyncrude), which can be transported economically over long distances to supply an industrial plant of reasonable size for synthetic fuel production. By chemical synthesis fuels will be produced which can be used as drop-in fuels or as stand-alone products completely compatible to exiting diesel or gasoline type fuels. Nearly any type of dry biomass can be utilized for this process; a focus is set on by-products and residues of agriculture, forestry or landscaping.

Technology feedstock: *Straw and other "dry" biomass residues*
Type of process: *Refining*
Technology output: *Syngas, converted to syngfuel*
TRL: *TRL 6 – technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies)*
Scale: *Farm, Village, Community*

Market deployment considerations: *KIT works on the bioliq process development for synthetic fuels production with partners from industry. The bioliq pilot plant aims at process demonstration and research platform.*

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

Environmental considerations: *The bioliq process is estimated to perform around 85 % GHG reduction, LCA available from verious projects.*

CONTACT INFO

Technology owner: KIT and industrial partners of bioliq process development - info@kit.edu

Link: www.bioliq.de

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

56

– Conversion of cotton waste into biodiesel and animal feed

PROBLEM STATEMENT

Energy shortage in Kenya.

EXECUTIVE SUMMARY

Conversion of cotton waste into biodiesel to power vehicles, the factory and farm machinery.

DESCRIPTION

SOURCE:

STAKEHOLDER: Private sector
COUNTRY: Kenya
YEAR: 2013

It is a chemical process through which the waste oil is converted into biodiesel and the solid in animal feed. The industry operates on a commercial level with a production capacity of 10.000 Litres per month of biodiesel and 70 tons of animal feed with a market of 1.200 farmers and 3 institutions including the United Nations in Nairobi. It produces high quality fuel and animal feed, through a simple process, in areas with adequate feedstock. It can be developed further for glycerine extraction and detergent production.

Technology feedstock: *Cotton seeds*
Type of process: *Refining*
Technology output: *Biodiesel and animal feed*
TRL: *TRL 9 – actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)*
Scale: *Community*

Market deployment considerations: *It produces high quality fuel and animal feed, through a simple process, in areas with adequate feedstock.*

Environmental considerations: *No, it is already working and is having a positive impact on the community. With more feedstock it can be scaled rapidly.*

CONTACT INFO

Technology owner: Zayn Agro Industries Limited - zaynagro@cotton-africa.com

Link: www.cotton-africa.com, https://www.reuters.com/article/kenya-farming-environment-idUKL4N233366

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

57

– Production of Biodiesel from

PROBLEM STATEMENT

Used vegetable oil can become a relevant contaminant if delivered to rivers and auriferous areas.

EXECUTIVE SUMMARY

The biodiesel is green fuel produced from various sources. At NARO biodiesel is produced by converting vegetable oil into fuel. Re-use and overuse of vegetable oils results into production of compounds that can lead to cancer in human beings. Poor exposure of such oils is also a municipal catastrophe as the highly vicious oil can clog water ways and limit the flow water causing clogs and affecting municipal waste management. As such conversion of waste oil into bio diesel alleviates its overuse, provides for better waste management practices, while generating fuel that is environmentally sound. Bio diesel can be used to make animal feed making machines, small house generators, walking tractors for clearing the land.

DESCRIPTION

This technology involves the production of calcium based catalyst from egg shells and use of Cassava waste, derived from ethanol and methanol, producing biodiesel. The breakdown of this used oil, in the presence of such catalyst, produces biodiesel while the residues include glycerol-based compounds that can be further processed into glycerine or used in production of other high energy compounds such as briquettes.

SOURCE:
STAKEHOLDER: Research and Technological Centre
COUNTRY: Uganda
YEAR: 2017

Technology feedstock: *Eggshells*
Type of process: *Refining*
Technology output: *Biodiesel*
TRL: *TRL 9 – actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)*
Scale: *Community*

Market deployment considerations: *High cost for used vegetable oil and competition of the waste oil with re-users (especially roadside vendors).*

CONTACT INFO

NARO, info@narouniversitario.com.mx, Link: https://newvision.co.ug

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

BIO4AFRICA

58 – BIO2CHP

PROBLEM STATEMENT

Agro-food waste could be valorised on site to produce bioenergy.

EXECUTIVE SUMMARY

The BIO2CHP solution is a compact, mobile and modular 25kWel and 67 KWTH CHP unit that fits in the size of a container and combines the technologies of gasification and internal combustion engines. The unit is fully automated and operational with a variety of solid waste streams from agro-industry.

DESCRIPTION

SOURCE:

STAKEHOLDER: Private sector
COUNTRY: Greece
YEAR: 2017

The BIO2CHP unit is a power generator, at the size of a container, which converts solid organic residues into energy, on-site. What is now treated as waste is thus transformed into a valuable commodity, decreasing both energy & waste disposal costs. The 25kWel unit produces 187,500 kWh electric & 502,500 kWh thermal, in a yearly basis, consuming approx. a total of 187.5 tons of solid organic residues. A fully stand-alone unit, ideal for agro-food SMEs with access to solid organic residues & year-round heat & power needs. Fuels tested so far: Olive kernels, grape pomace, coffee chafs, solid digestate and mixes.

Technology feedstock: *Organic residues with moisture <50% (agricultural, food industry, woodchips, sewage slude etc.)*
Type of process: *Thermal process*
Technology output: *Electricity, heat, biochar*
TRL: *TRL 7 – system prototype demonstration in operational environment*
Scale: *Farm*

Market deployment considerations: *A small-scale solution (<150kW electric) that can use untreated organic waste for modern agro-food industries that have high energy bills and produce large quantities of residues.*

Environmental considerations: *For every 20kWel unit , 62 tnCO2eq per year are saved, equivalent to the electrification of 9 households.*

CONTACT INFO

Technology owner: Bio-based Energy Technologies P.C. - contact@bio2chp.com

Link: www.bio2chp.com

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

59 – BIO2SYN

PROBLEM STATEMENT

Value adding technology for biogas plant solid digestate.

EXECUTIVE SUMMARY

The BIO2SYN solution is a mobile gasification unit that utilises up to 800 t/y raw solid digestate for synthetic fuel prodiction. A fully stand-alone unit, ideal for biogas plants with existing CHP, & year-round heating needs.

DESCRIPTION

SOURCE:

STAKEHOLDER: Private sector
COUNTRY: Greece
YEAR: 2021

The BIO2SynG unit combines a small-scale gasifier & filtering system, that converts solid organic residues into a clean gaseous fuel. What is now treated as waste, is thus transformed into a valuable commodity, that can be directly used for energy production, on-site. The 100kWth unit produces 565,000 Nm3 of syngas and around 110 t biochar per year.

Technology feedstock: *Organic residues with moisture <50% (agricultural, food industry, woodchips, sewage slude etc.)*
Type of process: *Thermal process*
Technology output: *Syngas, Biochar*
TRL: *TRL 5 – technology validated in relevant environment (industrially relevant environment in the case of key enabling technologies)*
Scale: *Farm*

Market deployment considerations: *Clients have access to conventional gas burners or gas engines.*

CONTACT INFO

Technology owner: Bio-based Energy Technologies P.C. - contact@bio2chp.com

Link: www.bio2chp.com

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

60 – SMARt-CHP

PROBLEM STATEMENT

Demonstrate an innovative, small-scale, mobile power production unit, which uses the agricultural residues generated in rural areas.

EXECUTIVE SUMMARY

The SMARt-CHP prototype is a mobile and modular 5kWel and 12 KWth CHP unit that fits in the size of a container and combines the technologies of gasification and internal combustion engines.

DESCRIPTION

SOURCE:

STAKEHOLDER: University
COUNTRY: Greece
YEAR: 2012

The SMARt-CHP unit consists of a gasification reactor combined with an internal combustion engine and adjusted to work on producer gas for electrical power and heat. The unit was built in Thessaloniki and transported to the premises of the two associated beneficiaries. The feedstock was made up of grape, peach and olive kernels that had been collected from the region of Western Macedonia. The unit has operated for more than 3000 hours with a variety of solid waste streams from agro-industry such as grape pomace, olive and peach kernels, almond shells etc. Also, the unit would operate close to the place of feedstock origin, thus minimising transportation and logistic costs.

Technology feedstock: *Organic residues with moisture <20% (agricultural, food industry, woodchips, sewage slude etc.)*
Type of process: *Thermal process*
Technology output: *Electricity, heat, biochar*
TRL: *TRL 6 – technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies)*
Scale: *Farm*

Market deployment considerations: *Residual biomass can constitute an extra income for farmers based on the current market prices of electricity and heat, while simultaneously contributing to CO2 emissions reduction and ecological impacts on the environment.*

CONTACT INFO

Technology owner: Aristotle University of Thessaloniki - contact@bio2chp.com

Link: www.bio2chp.com

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

61 – BIO2Pyr

PROBLEM STATEMENT

Continuous and fully automated biomass and waste flash pyrolysis unit.

EXECUTIVE SUMMARY

The BIO2Pyr unit is a compact and fully portable flash pyrolysis unit for the production of bio-oil from organic and plastic waste. It is capable of processing up to 3 g/min of fuel.

DESCRIPTION

Fluidized bed riser equiped with tube furnace (3-zone independent control, 20°C/min heat rate)

- *Fuel capacity: modulated 0.1 – 1.5 g/min*
- *Fully controlled conditions*
- *Stainless steel SS316 construction*
- *Fully transportable*
- *Remotely controlled SCADA*

SOURCE:

STAKEHOLDER: Private sector
COUNTRY: Greece
YEAR: 2019

Technology feedstock: *Biomass, plastics, tyres (dry, granular form)*
Type of process: *Thermal process*
Technology output: *Bio-oil, biochar, syngas, heat*
TRL: *TRL 4 – technology validated in lab*
Scale: *Farm*

CONTACT INFO

Technology owner: Bio-based Energy Technologies P.C. - contact@bio2chp.com

Link: www.bio2chp.com

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

62 – Valorisation of mango waste for healthy bakery products

PROBLEM STATEMENT

The world's high mango production produces by-products (peel and seeds) during processing, which have no commercial value and are also a problem of contamination.

EXECUTIVE SUMMARY

Basic physical techniques such as drying and sieving can produce a powder from mango wastes, rich in antioxidants and dietary fibre, suitable for human consumption. This technique focuses on producing additives for healthy bakery products that reduce the glycaemic index after consumption.

DESCRIPTION

SOURCE:

STAKEHOLDER: University
COUNTRY: Mexico
YEAR: 2014

After the mango is squeezed to extract the pulp, the peel, the bagasse and its seed remain, which are equivalent to 35-65% of the initial weight of the fruit. Mango peel is rich in dietary fibre (pectin, cellulose and hemicellulose), proteins, reducing sugars, bioactive compounds such as carotenoids, vitamin C and phenolic compounds. These by-products are dried at 60ºC for approximately 24h, using a convection oven with air circulation. After drying, they are ground to a fine powder which is then sieved through a 150 micron sieve. This powder is added as a supplementary flour together with the baker's flour and yeast in the 'dry' dough mix. The baking of the bakery product (muffin, cake, sponge cake...) follows the conventional steps. The consumer, after ingesting the muffin enriched with phenolic substances (difficult to digest and insoluble substances) decreases the rate of starch hydrolysis and may modulate the postprandial glucose response in vivo.

Technology feedstock: *Mango by-products after pulp extraction*
Type of process: *Thermal process*
Technology output: *Fortified food ingredients*
TRL: *TRL 6 – technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies)*
Scale: *Farm*

Market deployment considerations: *Applicability at pilot scale is not demonstrated.*

CONTACT INFO

Technology owner: Technological Institute of Tepic, Integral Laboratory of Food Research - expresso-support@bepress.com

Link: https://www.sciencedirect.com/science/article/pii/S0963996915000861?via%3Dihub

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

63 – Torrefaction of wheat stubble into pellets for solid biofuels

PROBLEM STATEMENT

The high domestic consumption of firewood produces a high level of pollution, producing wheat stubble. The habitual practice of burning wheat stubble also contributes to this pollution.

EXECUTIVE SUMMARY

Wheat stubble biomass has an irregular size, low density and low calorific value, among others. By means of a torrefaction process (thermal process carried out at moderate temperatures in an inert environment), a significant increase in retained energy and calorific value was obtained at moderate operating conditions below 150ºC.

DESCRIPTION

SOURCE:

STAKEHOLDER: University
COUNTRY: Chile
YEAR: 2017

Wood biomass is a fuel widely used for domestic heating. This high consumption of wood directly affects air pollution and usually people are exposed to concentrations of Particulate Matter below 2.5 µm (PM2.5) above 20 mg/m3. Some countries are currently investing in the generation of pellets as an alternative to forest biomass, as wheat stubble can be abundant. Moreover, the usual practice for eliminating this stubble is burning, which generates a great environmental impact. Despite the unpromising characteristics of this biomass (irregular size, low density, low calorific value, among others), the Universidad de la Frontera has optimised a torrefaction process (a thermal process carried out at moderate temperatures in an inert environment) to generate pellets from wheat stubble. The pellet (black pellet) produced at pilot scale with this torrefied biomass was characterised according to the European standard ISO 17225-1 (2014). An increase in bulk density from 469 kg/m3 to 568 kg/m3 was achieved due to the torrefaction pre-treatment.

Technology feedstock: *Stubble wheat*
Type of process: *Thermal process*
Technology output: *Pellets*
TRL: *TRL 9 – actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)*
Scale: *Farm*

CONTACT INFO

Technology owner: Universidad de la Frontera, Temuco-Chile - comunicaciones@ufrontera.cl

Link: https://www.avebiom.org/sites/default/files/BIE/BIE_37-Septiembre_2017.pdf

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

64

– Nutrient recovery from livestock by-products by thermochemical process

PROBLEM STATEMENT

The direct agricultural use of by-products of the livestock industry with protein content provides a high environmental risk due to possible trans- and recontamination by human and animal pathogens.

EXECUTIVE SUMMARY

The aim of the 3R Zero emission technology is the recovery of nutrients through the valorisation of animal by-products into high-value organic phosphorus fertilisers and bio-oils by integrated thermal and biotechnological recycling means. The products are "Animal BioChar" - organic biophosphate fertiliser and NPK bioformulations.

DESCRIPTION

SOURCE:

STAKEHOLDER: Private sector
COUNTRY: Hungary
YEAR: 2019

ABC (Animal Bone Char) - Biophosphate fertiliser is made from different types of food-grade animal bone grindings, which are heated up to 850 ºC. During this advanced pyrolysis (reductive thermal processing) all volatile and protein-based substances are removed, resulting in a highly macro-porous apatite-type mineral composed of hydroxyapatite (70-76%), $CaCO_3$ (7-13%) and carbon (8-11%). The output products are of high quality and sterile and can be used for agricultural and environmental applications (adsorbents). The process is flexible in terms of the inputs to be used as it can handle a wide range of organic materials. The operational prototype has been successfully demonstrated between 2005 and 2019 and will be scaled up to an average scale of 2,500 t/year in 2020, with the next level being 20,800 t/year. In economic terms, it requires low investment and low operation and maintenance costs. Finally, there is the possibility to combine the system with biogas and composting processes. This technology has been developed with the support of the European Union through the different Framework Programmes (FP6, FP7 and H2020).

Technology feedstock: *Livestock waste and by-products*
Type of process: *Thermal process*
Technology output: *Biofertilizer*
TRL: *TRL 6 – technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies)*
Scale: *Village, Community*

Market deployment considerations: *Implementation plans in EU27, USA, Japan and Australia.*

CONTACT INFO

Technology owner: Terra Humana Ltd. - biochar@3ragrocarbon.com

Link: https://biophosphate.net/sites/default/files/2021-02/abc_biophosphate_fact_sheet.pdf

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

65
– Obtaining bioenergy and nutrients from poultry slurry

PROBLEM STATEMENT

Poultry slurry is a problem on farms as it accumulates, affecting the quality of life of poultry and involving significant costs in management and disposal.

EXECUTIVE SUMMARY

Fluidised bed combustion produces heat energy, ash (which can be used as PK fertiliser) and electricity (when combined cycle technology is incorporated). The boiler is capable of generating a thermal output of 500 kWh, sufficient to provide hot water at 850°C required for distribution to the hatcheries.

DESCRIPTION

SOURCE:
STAKEHOLDER: Private sector
COUNTRY: Ireland
YEAR: 2019

After the birds have been removed, the slurry is collected and taken to a bio-secure fuel storage area, kept at low negative pressure. An innovative bulk handling system called the BHSL Toploader is then used to transfer the slurry from the storage area to the combustion plant at a rate of 5 tonnes/day. This low energy system is automated, minimising interaction with the slurry and farm personnel. Fluidised bed combustion uses a heated sand bed suspended (fluidised) within a rising air column to burn slurry (and potentially many different types of biomass) at 850°C for 2 seconds, even with varying moisture content. The surplus heat is available to produce renewable energy for on-farm use or export to the grid. The biggest savings come from the consumption of propane for heating the hatchery. By removing the slurry and providing the optimum temperature, the next batch of birds thrive in the warm, dry, optimally ventilated, low ammonia conditions, gaining weight for every kg of grain fed to them. Thus, the slurry produced is drier and less smelly.

Technology feedstock: *Poultry slurry*
Type of process: *Thermal process*
Technology output: *Thermal energy*
TRL: *TRL 9 – actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)*
Scale: *Farm*

CONTACT INFO

Technology owner: BHSL Hydro - sales@bhsl.com

Link: http://www.bhslhydro.com/how-it-works-new/

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

66

– Thermo-chemical treatment for obtaining activated carbon and

PROBLEM STATEMENT

Municipal solid waste, having a diverse composition, makes the management process difficult, especially when the final step is incineration, which can result in the emission of chemical compounds.

EXECUTIVE SUMMARY

An advanced modular thermal process produces synthesis gas and activated carbon. The gas is conditioned for use in power generation. The activated carbon can be reintroduced into the process as a fuel or sold as a commodity and used as a filter medium or for soil remediation.

DESCRIPTION

SOURCE:
STAKEHOLDER: Private sector
COUNTRY: Ireland
YEAR: 2017

The process has been developed by Premier Green Energy, resulting in its Prima conversion technology, which is an integrated multi-stage process based on pyrolysis. In the initial phase, the pre-treated feedstock (drying and grinding) is fed into a kiln rotary furnace. This is preheated to 750°C±50°C and has a reduced oxygen atmosphere to prevent combustion of the feedstock. In a continuous and highly automated process, the feedstock is converted into syngas and char. In a secondary stage, the syngas is recovered and transferred to a dry gas cracking tower. In a subsequent integrated stage, the syngas is channelled into a multi-stage wet gas cleaning process (spray tower, full bed tower with dehumidifier and activated carbon filter pass). Finally, the dry, clean and conditioned syngas is fed to a gas engine and burned to generate clean, renewable electricity. The carbon stream is recovered and can be burned as fuel to instigate and maintain the pyrolysis process or can be used for alternative commercial applications.

Technology feedstock: *Agricultural waste*
Type of process: *Thermal process*
Technology output: *Activated charcoal*
TRL: *TRL 9 – actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)*
Scale: *Farm, Village, Community*

CONTACT INFO

Technology owner: Premier Green Energy - info@pge.ie

Link: https://www.pge.ie/technology/description/

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

BIO4AFRICA

67 – Pyrolysis, carbonization

PROBLEM STATEMENT

High production of agriwastes that can become an environmental problem.

EXECUTIVE SUMMARY

Biochar production and waste recycling.

DESCRIPTION

The feedstock is subjected to low-temperature pyrolysis (combustion without oxygen, 450-600 degrees C), as a result of which charcoal/biocharis formed

SOURCE:

STAKEHOLDER: Private sector
COUNTRY: South Africa
YEAR: 2017

Technology feedstock: *Agricultural waste*
Type of process: *Thermal process*
Technology output: *Biochar, charcoal*
TRL: *TRL 9 – actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)*
Scale: *Farm, Village, Community*

Market deployment considerations: *Fully automatization of the process.*

Environmental considerations: *The technology is eco-friendly, so it will help to save African environment*

CONTACT INFO

Technology owner: GreenPower Ltd

- greenpower@greenpower.es

Link: https://greenpower.equipment/produkciya/continuous-charcoal-kiln-bio-kiln/

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

68 – Pyrochemy

PROBLEM STATEMENT

High production of agriwastes that can become an environmental problem.

EXECUTIVE SUMMARY

Pyrochemy is a renewable energy technology developed by PyroGenesys, it was developed as a carbon removal system for converting agricultural waste to renewable electricity, process heat & biofuels.

DESCRIPTION

SOURCE:
STAKEHOLDER: Private sector
COUNTRY: UK
YEAR: 2017

Pyrochemy utilises the Pyrolysis process combined with state of the art compact containerised technology. The Pyrochemy unit has the advantage of being transportable to remote locations worldwide with ease. The Pyrochemy unit can then use waste biomass from these locations to generate electricity, heat and biofuels. The Pyrochemy process utilises Pyrolysis, the rapid heating of biomass in the absence of oxygen. Without oxygen, instead of combusting at high heats the biomass goes through pyrolysis to create energy and nutrient rich products. The pyrolysis process produces a number of products: the carbon content of the biomass is turned into biochar which can be spread on fields to increase crop yields and directly contributes to carbon sequestration. Hot syngas is also produced which can be used to drive a steam generator and steam turbine to create electricity, or it can be condensed into bio oil which can be upgraded to Kerosene or Diesel. The Pyrochemy unit is designed to use waste biomass as its feedstock. Initial configurations are for harvest waste of common staple foods such as cassava, rice, soy and groundnut. But it can be configured to any harvest waste. The Pyrochemy technology can be upscaled to fit most needs. Current scaling is focussing on rural mini grids, small-medium sized rural communities of up to 300. There is also a focus on farming communities to provide energy for farming and post farm processing equipment. These are particularly attractive as they often have large amounts of waste biomass.

Technology feedstock: *Cassava, rice, soy and groundnut*
Type of process: *Thermal process*
Technology output: *Biochar, syngas, bio-oil (Kerosene or Diesel)*
TRL: *TRL 5 – technology validated in relevant environment (industrially relevant environment in the case of key enabling technologies)*
Scale: *Farm, Village, Community*

Market deployment considerations: *Demand: there will always be a demand for more efficient and effective power generation technologies that are capable of delivering quality power, electricity, heat and fuel, to communities that need it most. Pyrochemy can achieve this across a number of scales, its modular design means it is easy to scale up and down relevant to the communities need. Supply:*

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

Pyrochemy requires a supply of biomass, Africa produces massive amounts of harvest waste to feed its ever growing population, to the point where some communities are being affected by the toll the waste takes on the land. Harvest waste management is ineffective and can damage what was once fertile land. The Pyrochemy solves this issue by creating a use for the waste, removing it from the community and creating incredible products which can even increase land fertility.

Environmental considerations: *The biggest impact would be shipping the unit to Africa. However, the Pyrochemy technology has the ability to offset its carbon footprint very quickly, and once on site its is incredibly efficient. As production increases, manufacturing would be moved to Africa, mitigating the environmental impacts of transport and creating local jobs in the process.*

CONTACT INFO

Technology owner: PyroGenesys LTD - admin@pyrogenesys.com

Link: https://pyrogenesys.com/ , https://pyrogenesys.com/portfolio/emees/ , https://pyrogenesys.com/portfolio/eaa/ , https://pyrogenesys.com/portfolio/rivet/

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

69

– BUSH project (Biomass Utilization by

PROBLEM STATEMENT

While bush encroachment constitutes an immense challenge for Namibia, it also opens significant commercial, as well as unprecedented socio-economic and ecological opportunities, with the sustainable utilization of related biomass for biochar production.

EXECUTIVE SUMMARY

The project titled Biomass Utilisation by Sustainable Harvest (BUSH) ran from November 2018 to July 2021. The sub-project on 'Biochar Production, Processing and Testing', looked at how biochar can create income for farmers and entrepreneurs as well as benefits for crop and rangelands. The project developed prototypes for stoves that heat water or allow cooking while producing biochar.

DESCRIPTION

Portable stoves have been developed as prototypes that use agricultural waste, wood cuttings and native bushes as feedstock for the production of biochar. The stoves also heat water and allow cooking during their operation.

SOURCE:

STAKEHOLDER: Producers associations or cooperatives
COUNTRY: Namimbia
YEAR: 2021

Technology feedstock: *Agricultural waste, wood cuttings, native bushes.*
Type of process: *Thermal process*
Technology output: *Biochar, heat*
TRL: *TRL 3 – experimental proof of concept*
Scale: *Farm*

Market deployment considerations: *Biochar is made accessible to many Namibians. It can also be instrumental in rangeland restoration and horticulture production: adding biochar to soils can create housing for beneficial microbes, return minerals and increase water holding capacity. The optimization of the technology will continue in DIVAGRI H2020 project.*

CONTACT INFO

Technology owner: Namimbia University of Science and Technology (NUST)- ictsupport@nust.na

Link: https://www.nust.na/?q=news/biomass-project-impacts-namibia%E2%80%99s-bioeconomy-development , https://allafrica.com/stories/202110250631.html

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101000762

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PROBLEM STATEMENT

In Sub-Saharan Africa and especially Ghana, the use of renewable energy such as biogas is highly under-developed thus accounting for the country's over-reliance on natural gas and other fossil-based fuels for electrical power generation . It is, therefore, very crucial for Ghana to expand the production of renewable energy such as biogas from food wastes, black water (waste water comprising human faeces, urine and flush water) for both industrial and household consumption. Consequently, coming up with an innovative and good technological design for household biogas production is very imperative.

EXECUTIVE SUMMARY

A household biogas digester piloted in a slum called Terterkessim in the K.E.E.A. Municipality of the Central Region of Ghana. A 2-seater toilet compartment was constructed on a pilot manually-stirred, fixed pyramidal-dome-shaped single-stage household biogas digester for a compound house of 32 persons in the Terterkessim slum. The pyramidal dome-shape biogas digester was constructed on an abandoned septic tank meant to contain faeces from the toilets. Blocks and concrete were used for the construction. The digester has a rectangular sub-surface base and a pyramidal gas holder above the surface of the soil. It also has a two-blade manual stirrer, a ball bearing affixed at the bottom and a handle to manually mix the content of the digester. A solar-photovoltaic was installed on the roof of the toilet connected to the digester to heat the content to a hyper-thermophilic condition for hygienising the digestate.

DESCRIPTION

SOURCE:

STAKEHOLDER: University
COUNTRY: Ghana
YEAR: 2021

The single-stage innovative household biogas digester constructed in Terterkessim slum composed of 3 chambers which were originally designed for a septic tank system. The septic tanks were connected to a two-unit toilet meant for that household. The first chamber was the biggest and was converted into the main single-stage household biogas digester in which the AD process occurred. It had a total volume of 8.64 m3. Adjoining the main reactor was a compensation tank which had a tunnel from the main digestion chamber. The compensation tank was about 3.17 m^3. Within the compensation tank were steps designed to help with settling of particles as well as directing clear effluent to be discharged into the next chamber, the effluent collection and storage tank. The effluent collection and storage tank had a total volume of 4.52 m^3. It had an effluent discharge pipe for overflow into a collection container for agricultural usage. The digester could produce about 2.52 $Nm^3CH_4/(kgCOD.d)$ which could be burnt for at least 8 hours for purposes such as cooking and heating in the households in the slum.

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Technology feedstock: *Human waste, agricultural waste.*
Type of process: *Thermal process*
Technology output: *Heat*
TRL: *TRL 3 – experimental proof of concept*
Scale: *Farm*

Environmental considerations: *An average COD removal of 97.6% was recorded for the digester.*

CONTACT INFO

Technology owner: University of Cape Coast- registrar@ucc.edu.gh Link: https://www.intechopen.com/chapters/76104

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71 – Staramaki

PROBLEM STATEMENT

In Greece, 1.000.000.000 plastic straws are consumed every year, while the EC's announcement in 2020 on the banning of several single-use plastic products comes into force. At the same time, unemployment in Kilkis reaches 50% wthile the isssue of rural depopulation is serious and the percentage of extreme poverty in Greece reaches 15%. Staramaki uses the by-product of wheat cultivation in various rural regions of Greece to create natural wheat stems as alternative to single use plastic straws and contributing to the income of struggling local economies.

EXECUTIVE SUMMARY

Staramaki is a straw made of wheat. It is produced by a social cooperative KoinSep in Kilkis, situated in rural Northern Greece. The most widely produced local product – wheat – is used to create a viable eco-friendly alternative to single use plastic straws.

DESCRIPTION

SOURCE:

STAKEHOLDER: Private sector
COUNTRY: Greece
YEAR: 2019

The Staramaki products are made from the stalk that is left over when wheat grains are harvested. The wheat stems are reaped mechanicaly after harvest and collected by hand. Harvested stems are stored according to origin and date of harvest, preselected and trimmed manually, using specially shaped stainless steel scissors. Trimmed stems are prewashed, boiled, rinsed, washed again in industrial units and dried to their final form. At the same time they create employment opportunities and promote social cohesion, as well as local and regional development.

Technology feedstock: *Wheat stems*
Type of process: *Trimming*
Technology output: *Drinking straw*
TRL: *TRL 9 – actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)*
Scale: *Village, Community*

Market deployment considerations: *Competition with products from China or USA.*

CONTACT INFO

Technology owner: Staramaki Social Cooperative Enterprise - info@staramaki.gr

Link: https://www.staramaki.gr/en/intro

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72

– Reuse of olive wash water in agriculture as a biofungicide

PROBLEM STATEMENT

Olive mill wastewater is a major environmental problem due to its high organic load, phytotoxicity and antimicrobial properties. There is an opportunity to use it as a fungicide and bactericide.

EXECUTIVE SUMMARY

Waste water from olive mills generated during the extraction of olive oil by traditional milling and pressing processes is considered to be an agro-industrial by-product rich in phenolic compounds. The quantities and physico-chemical characteristics depend on the used oil extraction system, the olives and the operating conditions.

DESCRIPTION

SOURCE:

STAKEHOLDER: University
COUNTRY: Morocco
YEAR: 2017

95% of the world's olive oil production produces olive mill wastes that have become a serious environmental problem, due to their high chemical oxygen demand and organic load, and because they resist biodegradation due to their high content of phenolic compounds. The phytotoxic and antimicrobial properties of olive mill wastes have been addressed as a negative attribute limiting the beneficial reuse of olive mill effluents. The valorisation of olive mill wastes is certainly more desirable than their treatment, which is usually applied with destructive methods with respect to their phenolic compounds.

The solution proposed is to used this as an addition to irrigation water. The accumulation of phenolic compounds, quinones and other compounds in plants affected by pathogens positively helps to reinforce the defence and resistance mechanisms against fungi, bacteria and other micro-organisms. Plant disease verticillosis, caused by Verticillium dahliae, is one of the most destructive plant pathogenic diseases known worldwide. Irrigation of agricultural fields with this water has proven to be an eco-friendly alternative for the protection of crops against V. dahliae.

Technology feedstock: *Olive washing water*
Type of process: *Washing*
Technology output: *Biofungicide*
TRL: *TRL 4 – technology validated in lab*
Scale: *Farm or community*

CONTACT INFO

Technology owner: Cadi Ayyad University - expresso-support@bepress.com

Link: https://www.sciencedirect.com/science/article/pii/S0048969716321982

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4.2 Online version

Online version can be found at https://www.bio4africa.eu/technologies/

The catalogue is embedded at project website, and it includes as filter the following fields Feedstock, Technology output, Process type and TRL. Hence, the user can select from a dropdown list an item and filter the technologies according to these fields. Moreover, a free-text search field is included.

Below, a screenshot of the main landing page for the catalogue can be found.

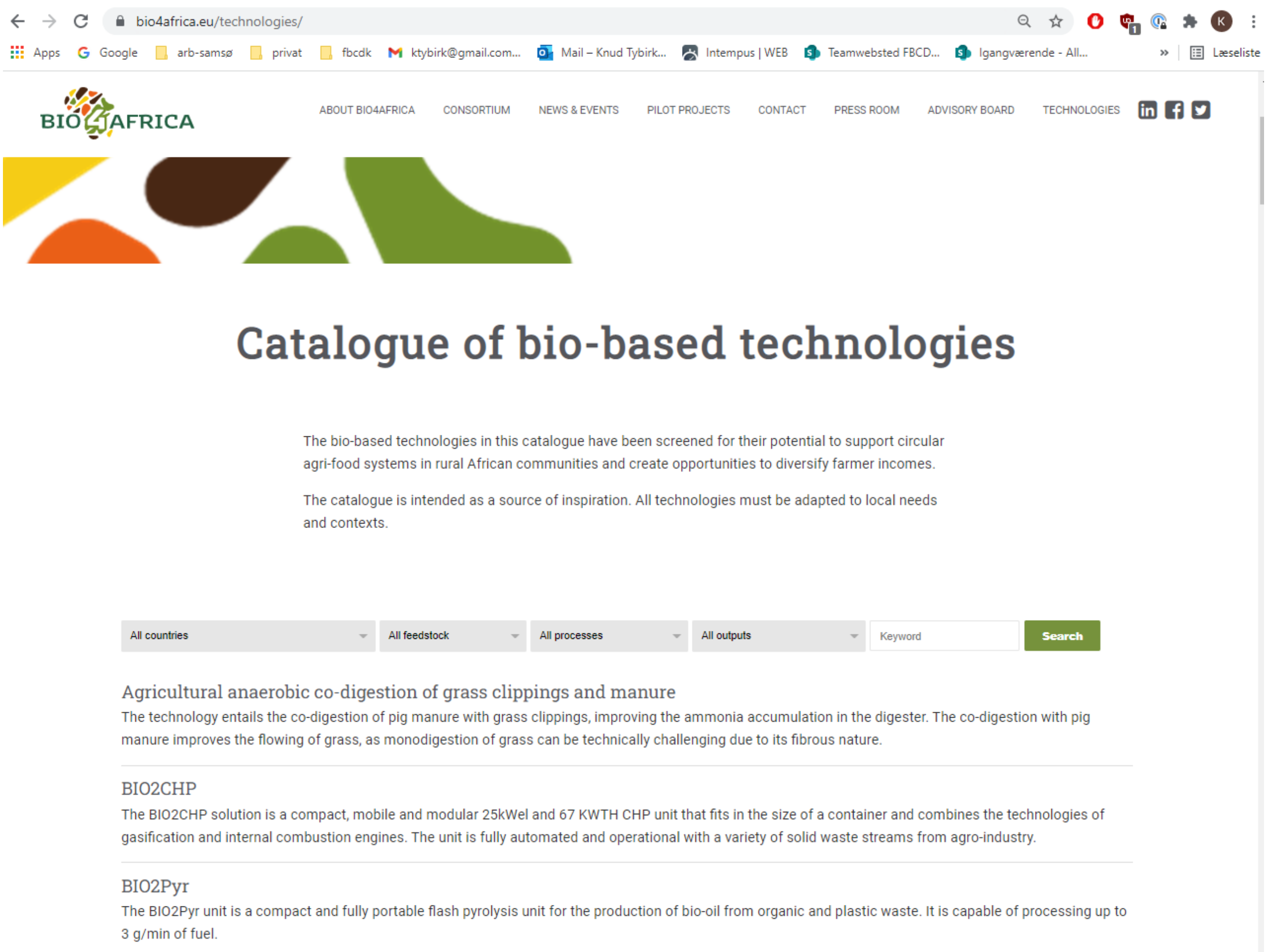

Figure 3. Main landing page of BIO4AFRICA Catalogue

When selecting a technology, the information from the factsheets previously presented is shown on screen. The possibility for downloading all the information in a PDF file is also provided. An example of this PDF is provided in Annex III.

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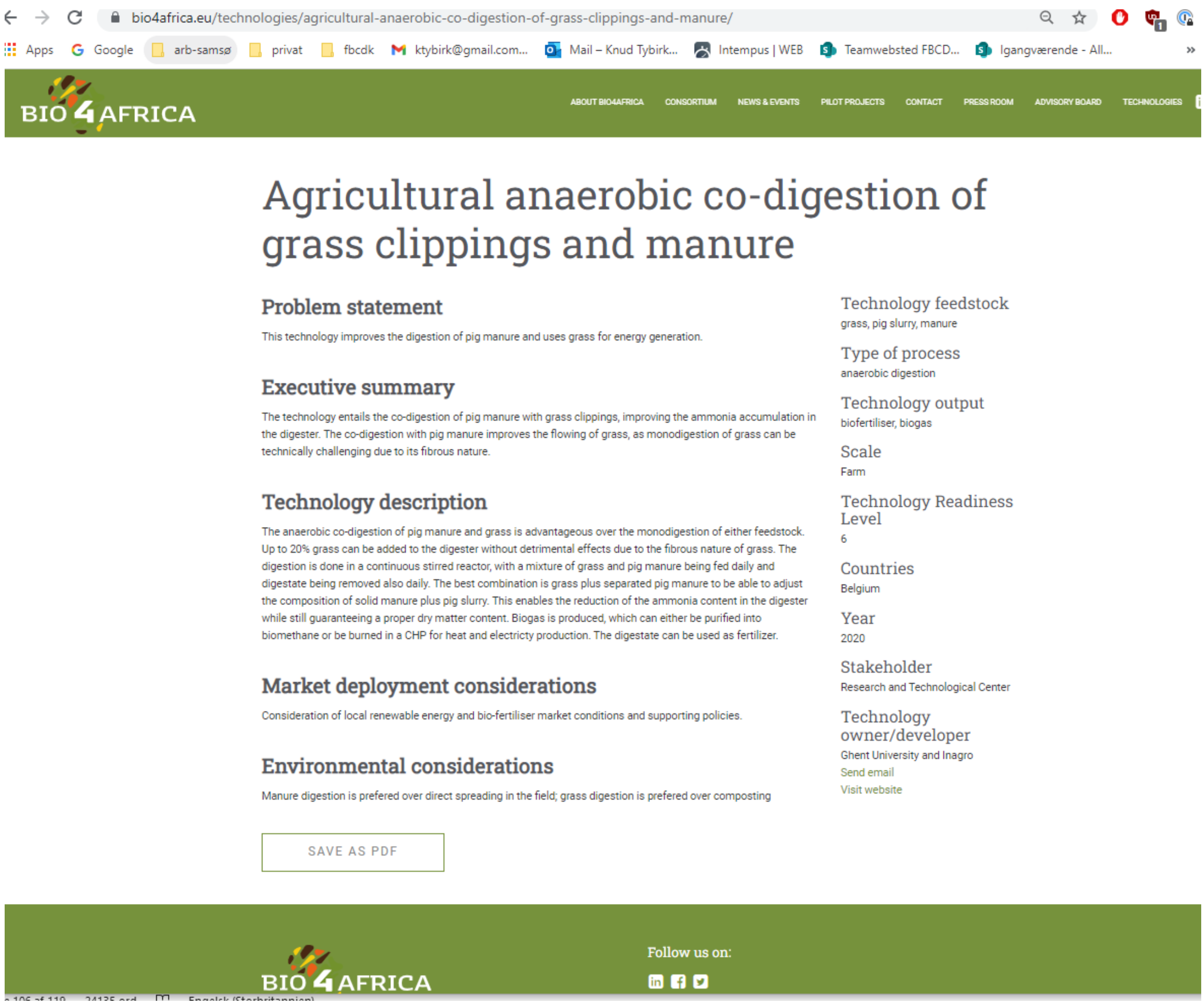

Figure 5. Screenshot of technology factsheet

5. Conclusions

A catalogue for small-scale biobased technologies amenable to be implemented in rural Africa context has been produced as result of T1.3 conducted activities, having both printable and online versions. The methodology that has been design is based in a combination of literature review, interviews and survey distribution. This has made possible to gather valuable information and data which have been assessed and organised through an information systematisation process.

Specifically, 27 interviews have been made and 14 answers to the survey for technologies identification have been received. This information has been validated by partners with strong knowledge on bioeconomy and rural Africa areas. So far 72 technologies have been identified. From these technologies, some of them will be further developed and piloted in the technical WPs from the project (namely WP2, WP3 and WP4). Those

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technologies are as follows: proteins extraction, pyrolysis (biochar), hydrothermal carbonization, pelletization, briquetting, biocomposites, bioplastics.

It has been agreed among partners that the catalogue will be updated bi-annually to include further technologies that could be identified during the BIO4AFRICA Project implementation.

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Annex I: Interview guidelines

CONTEXT

External stakeholders' interviews might be needed within the BIO4AFRICA's project to know small-scale bio-based technologies for rural Africa. BIO4AFRICA project sets off to support the deployment of the bioeconomy in rural Africa via the development of bio-based solutions and value chains with a circular approach to drive the cascading use of local resources and diversify the income of farmers. The aim of this interviews is to identify and classify existing small-scale bio-based technologies to produce a catalogue of technologies with potential for being successfully adapted and transferred to different contexts across rural Africa. Key external stakeholders are being consulted for data collection for this purpose.

Interviews will be done preferably via online through video call via Microsoft Teams or another similar platform. 40 minutes is the estimated time for the interview. Each of the interview sections down below has an assigned response time. It is recommended that the interviewee should not spend more than 15 minutes reading and preparing for the interview to maintain a high degree of spontaneity in the answers.

To facilitate the correct integration of the information into the technologies database, the interviewer will carefully adhere to the set times, giving the interviewee 5 minutes' notice before the allotted time for each section, so that the conversation and ideas could be collected and finalised properly.

Thank you in advance for your kind availability and participation in this study!

STAKEHOLDER DATA	
Expert name:	
Expert position:	
Organisation:	
Brief expert background:	
Interview date:	
BIO4AFRICA interviewer:	

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GLOSARY

Bio-based technologies: those technologies that use either non-food feedstock or circularity principles –or both– for delivering diverse products[1].

Bioeconomy: The European Commission defines the bioeconomy as "the production of renewable biological resources and the conversion of these resources and waste streams into value added products, such as food, feed, bio-based products and bioenergy. Its sectors and industries have strong innovation potential due to their use of a wide range of sciences, enabling and industrial technologies, along with local and tacit knowledge."[2].

Biomass: Biomass refers to the mass of living organisms, including plants, animals, and microorganisms, or, from a biochemical perspective, cellulose, lignin, sugars, fats, and proteins. Biomass includes both the above- and belowground tissues of plants, for example, leaves, twigs, branches, boles, as well as roots of trees and rhizomes of grasses[3].

INTERVIEW SCRIPT

Explanation of the interview methodology (1')

Brief introduction of the interviewee (3')

TECHNOLOGY DESCRIPTION (15')

1. Do you know any small-scale bio-based technology and/or process that uses agricultural or far wastes as feedstock? Do you know its name/how it is called?
2. What is this bio-based technology and/or process used for?
3. What type of biomass or feedstock uses the bio-based technology and/or process?
4. How does the bio-based technology and/or process work? Is it a physical (e.g., grinding), chemical (e.g., solvent extraction), biological process (e.g., fermentation)? Could you describe it?
5. What is the technology output / what is produced by the bio-based technology and/or process?

---

[1] Escobar, N., Laibach, N. (2021). Sustainability check for bio-based technologies: A review of process-based and life cycle approaches. *Renewable and Sustainable Energy Reviews, 135.* https://doi.org/10.1016/j.rser.2020.110213

[2] European Commission. (2012). Innovating for Sustainable Growth, a Bioeconomy for Europe. *Directorate-General for Research and Innovation*. Brussels. https://ec.europa.eu/research/bioeconomy/pdf/bioeconomycommunicationstrategy_b5_brochure_web.pdf

[3] R.A. Houghton, R. A. (2008). Biomass. *Encyclopedia of Ecology*, pp. 448-453. https://doi.org/10.1016/B978-008045405-4.00462-6

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SPECIFIC TECHNOLOGY INFORMATION (15’)

6. What is the scale at which the technology operates? Some examples: (1) Farm or small piece of land owned by one family; (2) Village, a group of families or small farms from the same, very close location; (3) Community: many farms that are scattered through a region.
7. What is the technology readiness level? Is it technology concept formulated, a technology demonstrated in relevant environment, or an actual system proven in operational environment? Please, read EU TRL description here.
8. Is there any public information about this technology? Could you tell us where to find it? (Links would be highly appreciated).
9. When was the technology developed? Who is the owner/developer (academia, private, public organisation, etc.)?

TECHNOLOGY IMPLEMENTATION IN AFRICA (10’)

10. From your point of view, is there any handicap or environmental impact to be considered if the technology were to be implemented in Africa?
11. Have you participated in any bioeconomy implementation experience in Africa? Which are the lessons learned or which market deployment considerations can you identify?
12. What are the key factors in favour of the replicability of this bio-based technology?
13. Are you familiar/aware of any other small-scale bio-based technology that could be relevant for the project?

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Annex II: Survey for technologies information retrieval

The bioeconomy is a central element to the growth of the economy overall so continued improvements in biomass productivity and an optimization of biomass use, combined with a viable bio-business sector that can add value to farming activities and primary production, has the potential to drive a broader African bio-based economic growth.

At BIO4AFRICA we want to support the deployment of the bioeconomy in rural Africa via the development of bio-based solutions and value chains with a circular approach to drive the cascading use of local resources and diversify the income of farmers.

To do so, we are creating a catalogue of technologies with potential for being successfully adapted and transferred to different contexts across rural Africa.

Do you have a small-scale bio-based technology*? Please let us know by filling this quick survey.

*Small scale definition: small-scale biorefineries are characterized by a small investment cost (less than 2 M€), a low processing capacity (less than 100 t/day) and a low process complexity. Ref: Ait Sair, A.; Kansou, K.; Michaud, F.; Cathala, B. Multicriteria Definition of Small-Scale Biorefineries Based on a Statistical Classification. Sustainability 2021, 13, 7310. https://doi.org/10.3390/su13137310

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SURVEY ON SMALL SCALE BIO-BASED TECHNOLOGIES

This survey will take approximately 10 minutes to complete. Thank you in advance for your kind availability and participation in this study.

Data will be only collected for the purposes of the project. By selecting the acceptance box ("I accept the BIO4AFRICA terms and data handling policy") you understand and accept the following terms and conditions:

- BIO4AFRICA privacy policy (https://www.bio4africa.eu/privacy-policy/)
- BIO4AFRICA legal terms (https://www.bio4africa.eu/legal-terms/)
- BIO4AFRICA personal data management (https://www.bio4africa.eu/personal-data-management/)
- MS privacy statement (https://support.microsoft.com/en-us/office/security-and-privacy-in-microsoft-forms-7e57f9ba-4aeb-4b1b-9e21-b75318532cd9)

...

* Required

BIO4AFRICA terms and data handling policy

1. I accept the BIO4AFRICA terms and data handling policy *

(•) Yes

Next

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SURVEY ON SMALL SCALE BIO-BASED TECHNOLOGIES ...

Glosary

Here you could find some terminology used in the survey:

Bio-based technologies: those technologies that use either non-food feedstock or circularity principles –or both– for delivering diverse products.

Bioeconomy: The European Commission defines the bioeconomy as "the production of renewable biological resources and the conversion of these resources and waste streams into value added products, such as food, feed, bio-based products and bioenergy. Its sectors and industries have strong innovation potential due to their use of a wide range of sciences, enabling and industrial technologies, along with local and tacit knowledge.".

Biomass: Biomass refers to the mass of living organisms, including plants, animals, and microorganisms, or, from a biochemical perspective, cellulose, lignin, sugars, fats, and proteins. Biomass includes both the above- and belowground tissues of plants, for example, leaves, twigs, branches, boles, as well as roots of trees and rhizomes of grasses .

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SURVEY ON SMALL SCALE BIO-BASED TECHNOLOGIES

* Required

TECHNOLOGY DESCRIPTION

2. Could you please name any small-scale bio-based technology and/or process that uses agricultural or farm wastes as feedstock? *

Small scale definition: small-scale biorefineries are characterized by a small investment cost (less than 2 M€), a low processing capacity (less than 100 t/day) and a low process complexity.

Ref: Ait Sair, A.; Kansou, K.; Michaud, F.; Cathala, B. Multicriteria Definition of Small-Scale Biorefineries Based on a Statistical Classification. Sustainability 2021, 13, 7310. https://doi.org/10.3390/su13137310

Enter your answer

3. What is this bio-based technology and/or process used for? *

Enter your answer

4. What type of biomass or feedstock is used by this bio-based technology and/or process? *

Enter your answer

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5. How does the bio-based technology and/or process work? Is it a physical, chemical, biological process? Could you describe it? *

Enter your answer

6. What is the technology output / what is produced by the bio-based technology and/or process? *

Enter your answer

Back Next

SPECIFIC TECHNOLOGY INFORMATION

7. What is the scale at which the technology operates? (Farm, village, community...). *

Enter your answer

8. What is the technology readiness level? Is it technology concept formulated, a technology demonstrated in relevant environment, or an actual system proven in operational environment? *

Please, read EU TRL description here:
https://ec.europa.eu/research/participants/data/ref/h2020/wp/2014_2015/annexes/h2020-wp1415-annex-g-trl_en.pdf

Enter your answer

9. Is there any public information about this technology? Could you tell us where to find it? (Links to company product portfolio or website, publications, etc. would be highly appreciated). *

Enter your answer

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10. When was the technology developed? *

Enter your answer

11. Who is the owner/developer? Is it academia, private, public organisation, etc.? *

Enter your answer

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TECHNOLOGY IMPLEMENTATION IN AFRICA

12. From your point of view, is there any handicap or environmental impact to be considered if the technology were to be implemented in Africa? *

Enter your answer

13. Have you participated in any bioeconomy implementation experience in Africa? Which are the lessons learned? *

Enter your answer

14. What are the key factors supporting the replicability of this bio-based technology? *

Enter your answer

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15. Are you familiar/aware of any other small-scale bio-based technology that could be relevant for the project? If yes, can you give us some examples and information? *

Enter your answer

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SURVEY ON SMALL SCALE BIO-BASED TECHNOLOGIES ...

* Required

Identification data

16. Name *

Enter your answer

17. Position *

Enter your answer

18. Organisation *

Enter your answer

19. E-mail *

Enter your answer

Back Submit

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Annex III: Example of technology factsheet PDF file from the catalogue online version

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Agricultural anaerobic co-digestion of grass clippings and manure

Technology name
karnalprocess

Problem statement
This technology improves the digestion of pig manure and uses grass for energy generation.

Executive summary
The technology entails the co-digestion of pig manure with grass clippings, improving the ammonia accumulation in the digester. The co-digestion with pig manure improves the flowing of grass, as monodigestion of grass can be technically challenging due to its fibrous nature.

Technology description
The anaerobic co-digestion of pig manure and grass is advantageous over the monodigestion of either feedstock. Up to 20% grass can be added to the digester without detrimental effects due to the fibrous nature of grass. The digestion is done in a continuous stirred reactor, with a mixture of grass and pig manure being fed daily and digestate being removed also daily. The best combination is grass plus separated pig manure to be able to adjust the composition of solid manure plus pig slurry. This enables the reduction of the ammonia content in the digester while still guaranteeing a proper dry matter content. Biogas is produced, which can either be purified into biomethane or be burned in a CHP for heat and electricty production. The digestate can be used as fertilizer.

Market deployment considerations
Consideration of local renewable energy and bio-fertiliser market conditions and supporting policies.

Environmental considerations
Manure digestion is prefered over direct spreading in the field; grass digestion is prefered over composting

Technology feedstock
grass, pig slurry, manure

Type of process
anaerobic digestion

Technology output
biofertiliser, biogas

Scale
Farm

TRL
6

Countries
Belgium

Year
2020

Stakeholder
Research and Technological Center

Technology owner/developer
Ghent University and Inagro
Email:
privacy@ugent.be

Website:
https://www.biorefine.eu/publications/d-1-4-1-co-digestion-of-roadside-grass-with-vedows-manure-and-pig-slurry/

Horizon 2020
European Union Funding
for Research & Innovation

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BIO2CHP

Technology name
bio2chp

Problem statement
Agro-food waste could be valorised on site to produce bioenergy.

Executive summary
The BIO2CHP solution is a compact, mobile and modular 25kWel and 67 KWTH CHP unit that fits in the size of a container and combines the technologies of gasification and internal combustion engines. The unit is fully automated and operational with a variety of solid waste streams from agro-industry.

Technology description
The BIO2CHP unit is a power generator, at the size of a container, which converts solid organic residues into energy, on-site. What is now treated as waste is thus transformed into a valuable commodity, decreasing both energy & waste disposal costs. The 25kWel unit produces 187,500 kWh electric & 502,500 kWh thermal, in a yearly basis, consuming approx. a total of 187.5 tons of solid organic residues. A fully stand-alone unit, ideal for agro-food SMEs with access to solid organic residues & year-round heat & power needs. Fuels tested so far: Olive kernels, grape pomace, coffee chafs, solid digestate and mixes.

Market deployment considerations
A small-scale solution (<150kW electric) that can use untreated organic waste for modern agro-food industries that have high energy bills and produce large quantities of residues.

Environmental considerations
For every 20kWel unit , 62 tnCO2eq per year are saved, equivalent to the electrification of 9 households.

Technology feedstock
organic waste

Type of process
thermal process

Technology output
biochar, electrical energy, heat

Scale
Farm

TRL
7

Countries
Greece

Year
2017

Stakeholder
Private sector

Technology owner/developer
Bio-based Energy Technologies P.C.

Email:
contact@bio2chp.com

Website:
www.bio2chp.com

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BIO2Pyr

Technology name

karnalprocess

Problem statement

Continuous and fully automated biomass and waste flash pyrolysis unit.

Executive summary

The BIO2Pyr unit is a compact and fully portable flash pyrolysis unit for the production of bio-oil from organic and plastic waste. It is capable of processing up to 3 g/min of fuel.

Technology description

Fluidized bed riser equiped with tube furnace (3-zone independent control, 20°C/min heat rate)

- Fuel capacity: modulated 0.1 – 1.5 g/min
- Fully controlled conditions
- Stainless steel SS316 construction
- Fully transportable
- Remotely controlled SCADA

Market deployment considerations

Environmental considerations

Technology feedstock

dry biomass, plastics, tyres (dry, granular form)

Type of process

thermal process

Technology output

biochar, bio-oil, heat, syngas

Scale

Farm

TRL

4

Countries

Greece

Year

2019

Stakeholder

Private sector

Technology owner/developer

Bio-based Energy Technologies P.C.
Email:
contact@bio2chp.com

Website:
www.bio2chp.com

Horizon 2020
European Union Funding
for Research & Innovation

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BIO2SYN

Technology name
bio2syn

Problem statement
Value adding technology for biogas plant solid digestate.

Executive summary
The BIO2SYN solution is a mobile gasification unit that utilises up to 800 t/y raw solid digestate for synthetic fuel prodiction. A fully stand-alone unit, ideal for biogas plants with existing CHP, & year-round heating needs.

Technology description
The BIO2SynG unit combines a small-scale gasifier & filtering system, that converts solid organic residues into a clean gaseous fuel. What is now treated as waste, is thus transformed into a valuable commodity, that can be directly used for energy production, on-site. The 100kWth unit produces 565,000 Nm3 of syngas and around 110 t biochar per year.

Market deployment considerations
Clients have access to conventional gas burners or gas engines.

Environmental considerations

Technology feedstock
organic waste, wood chips, agri-residues, food waste

Type of process
thermal process, pyrolysis

Technology output
syngas, biochar

Scale
Farm

TRL
5

Countries
Greece

Year
2021

Stakeholder
Private sector

Technology owner/developer
Bio-based Energy Technologies P.C.
Email:
contact@bio2chp.com

Website:
www.bio2chp.com

Horizon 2020
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for Research & Innovation

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Bioliq

Technology name
bioliq

Problem statement
The biorefinery approach uses farm residues to produce bio-materials and energy, without competing with food production.

Executive summary
The lignocellulosic biomass residues used do not compete with food and feed production, but have to be collected from wide-spread areas for industrial large-scale use. The two-stage gasification concept bioliq offers a solution to this problem. It aims at the conversion of low-grade residual biomass from agriculture and forestry into synthetic fuels and chemicals. Central element of the bioliq process development is the 2–5 MW pilot plant along the complete process chain: fast pyrolysis for pretreatment of biomass to obtain an energy dense, liquid intermediate fuel, high-pressure entrained flow gasification providing low methane synthesis gas free of tar, hot synthesis gas cleaning to separate acid gases, and contaminants as well as methanol/dimethyl ether and subsequent following gasoline synthesis.

Technology description
bioliq® is one answer searching for high quality BTL fuels or fuel components produced from sustainable biomass residuals. The problem to be solved is the widely distributed rising of biomass connected to the need of large scale fuel production plants required by economies of scale. The solution is the de-centralized pre-treatment of biomass to obtain an intermediate energy carrier of high energy density (bioliqSyncrude), which can be transported economically over long distances to supply an industrial plant of reasonable size for synthetic fuel production. By chemical synthesis fuels will be produced which can be used as drop-in fuels or as stand-alone products completely compatible to exiting diesel or gasoline type fuels. Nearly any type of dry biomass can be utilized for this process; a focus is set on by-products and residues of agriculture, forestry or landscaping.

Market deployment considerations
KIT works on the bioliq process development for synthetic fuels production with partners from industry. The bioliq pilot plant aims at process demonstration and research platform.

Environmental considerations
The bioliq process is estimated to perform around 85 % GHG reduction, LCA available from verious projects

Technology feedstock
dry biomass, straw

Type of process
refining

Technology output
syngas

Scale
Farm, Village, Community

TRL
6

Countries
Germany

Year
2005

Stakeholder
Research and Technological Center

Technology owner/developer
KIT and industrial partners of bioliq process development
Email:
info@kit.edu

Website:
www.bioliq.de

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Biorefining of sugar beet for food, feed and biochemical applications

Technology name
karnalprocess

Problem statement
The traditional beet industry faces high energy and operating costs (OPEX), especially at the process stage related to the concentration of beet sugar syrup.

Executive summary
The technology of small-scale biorefining of beet sugar and its by-products provides an innovative and energy-efficient solution through a method based on the solubility of sugar and which, through a decentralised approach, also proposes to reduce transport costs.

Technology description
By adding an anti-solvent, the solubility of beet sugar in water is reduced, allowing beet crystallization to occur even in high concentrations of water, thus replacing three steps or stages of processing in large-scale refinings. Since the viscosity of the mixture is much lower than a sugar/water mixture, the sugar crystals can be collected without the need for centrifugation (a very energy-intensive process) and the anti-solvent is recovered and recirculated in a closed-loop system. In this way, a reduction of approximately 50% of the energy requirements of the process is achieved. The recovered sugar can be sold in the local food market (thus displacing imports), as well as used for fermentation processes, including "chemical building blocks" through a decentralization strategy. Besides, beet wastes contain a low volume of amino acids of high added value, while the pulp of beet pressing is of high value as animal feed.

Market deployment considerations

Environmental considerations

Technology feedstock
sugar beet

Type of process
extraction, concentration, purification

Technology output
purified effluent

Scale
Farm

TRL
4

Countries
Ireland

Year
2017

Stakeholder
Research and Technological Center

Technology owner/developer
Institute of Technology Tralee
Email:
infoKerry@mtu.ie

Website:
https://ec.europa.eu/research/participants/documents/downloadPublic?documentIds=080166e5bc2a0824&appId=PPGMS

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Briquetting of dry biomass

Technology name
karnalprocess

Problem statement
Production of voluminous sidestream biomasses not being utilized in an optimal way.

Executive summary
Compacts dry biomass (straw, woodchips, bagasse many more) for transport/burning in small stoves.

Technology description
Briquetting equipment for numerous types of waste biomasses, such as straw, woodchips, sawdust, bagasse, coffee husk, groundnut shells, etc. The compaction of the biomass makes transport, distribution and storage easier and more cost-effective. At the same time, it makes it possible to burn the biomass. Often if not compacted, the biomass could not be burned.

Market deployment considerations
Technology in the market, the challenge is maintenance

Environmental considerations
Saves energy, reduce transport costs & emissions

Technology feedstock
bagasse, coffee husk, straw, wood chips

Type of process
briquetting

Technology output
biomass briquettes

Scale
Village, Community

TRL
9

Countries
Denmark, Ghana

Year
2000

Stakeholder
Producers associations or cooperatives

Technology owner/developer
CF Nielsen

Email:
hbc@cfnielsen.com

Website:
https://cfnielsen.com/

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000762.

Decentralized refinery for local processing of cassava

Technology name

karnalprocess

Problem statement

The refinery enables local processing of cassava into products and intermediates overcoming traditional logistical challenges.

Executive summary

The refinery of Vieux Manioc BV enables local processing of cassava through mobile processing and refinery units which overcome traditional logisical and preservation issues when processing cassava.

Technology description

The refinery process has 3 components: an autonomous mobile processing unit (AMPU), a mobile refinery (MRU) and dryer.The AMPU processes fresh cassava roots into cassava cake using a high speed rasper which can release 98% of the starch granules in the roots. The MRU enables the extraction of cassava fibres from the cassava cake. The cake is then dewatered using a decanter centrifuge to increase dry matter, before being further dried using a flash dryer or mobile drying unit. The solution can be deployed at small-scale using a mobile system, or using a decentralized approach, whereby the initial refining steps take place locally and intermediate products can be upgraded centrally. This local processing approach helps to overcome the challenge of the perishability of cassava, which typically must be processed within 24 hours of harvesting. This short processing timeframe makes it challenging to transfer the cassava to a centralized plant for further processing. Using the Vieux Manioc BV technology, processing can take place close to the harvesting site within a short time frame, producing storable intemdiates and products such as cassava cake, cassava fibre and cassava flour, along with intermediate ingredients to further process into products such as sorbitol, ethanol and beer.

Market deployment considerations

Widely replicable in Africa given the scale of cassava production

Environmental considerations

Reduces transport emissions associated with transfer of high moisture content cassava over long distances

Technology feedstock

cassava starch

Type of process

refining

Technology output

cassava flour, cassava starch cake

Scale

Farm or community

TRL

9

Countries

Netherlands, Nigeria, Mozambique, Ghana

Year

2002

Stakeholder

Producers associations or cooperatives

Technology owner/developer

Vieux Manioc BV

Email: philafricafoods@philafricafoods.com

Website: https://www.philafricafoods.com/dadtco/?s=

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Farm-based lignocellulosic biorefinery

Technology name

karnalprocess

Problem statement

The biorefinery approach uses farm residues to produce bio-materials and energy, without competing with food production. The focus is the production of the platform chemical hydroxymethylfurfural for biobased plastics.

Executive summary

This is a pilot research project that involves the creation of a biorefinery plant at the university's "Unterer Lindenhof" research station.
The vision is to design a small-scale plant for farm use that uses both biogenic plant residues and agricultural by-products to produce a wide range of raw materials and energy sources, without competing with food production.

Technology description

In the center of the biorefinery, there is an existing biogas plant. The whole concept is demonstrated in the research station "Lindenhöfe" of the University of Hohenheim. The mass flows of the research-station, which is a farm, are used as input of the biorefinery.
For the utilization of agricultural residues via the production of the bio based basic chemical 5-hydroxymethylfurfural (HMF for short) a pilot plant was built up. In this process, the carbohydrates in the (residual) biomass react in aqueous medium under pressure and elevated temperature (hydrothermal conditions) to form HMF. The different chemical-functional groups of this reactive molecule allow a variety of chemical modifications and make HMF a versatile renewable basic building block. For this reason, it is also one of the 12 most important bio based platform chemicals of the future. For example, oxidation of 5-HMF produces the platform chemical FDCA, which can replace petrochemical-based terephthalic acid (TA) in all its polymer applications. Currently, one of the best studied polymer applications is polyethylene furanoate (PEF), a high-performance bio-based polymer with excellent physicochemical properties compared to PET. This leads to lower energy requirement in further processing and thus the environmental impact.
In addition, PEF has higher gas barriers by a factor of 10. The structural similarity to PET allows, in addition to single-grade recycling, the mixing with PET.

Market deployment considerations

Please add some information

Environmental considerations

In the case of PEF, a saving of approx. 4.6 kg of CO_2 per kg of plastic is possible.

Technology feedstock

grass, straw, wood chips

Type of process

anaerobic digestion

Technology output

hydroxymethylfurfural (HMF), activated carbon, furfural

Scale

Farm

TRL

6

Countries

Germany

Year

2021

Stakeholder

University

Technology owner/developer

University of Hohenheim
Email: bioraffinerie@uni-hohenheim.de

Website: https://konversionstechnologie.uni-hohenheim.de/en/118578/biorefinery-pilot-plant

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Novel bio-based products from meadow grass

Technology name
karnalprocess

Problem statement
Displacement of fossil based products with bio-based alternatives, while offering rural diversification opportunities.

Executive summary
The biorefinery processes meadow grass silage into a variety of alternative bio-based products including bio-composites, bio-based insulation material, fertiliser and biogas.

Technology description
Biowert Industrie GmbH operates a green biorefinery in Brensbach in the Odenwald, which consists of a biogas plant with two combined heat and power plants (total 1.4 MWel) and a grass refinement plant. In the grass refinement plant, grass from permanent grassland and arable land is processed into various material products, such as AgriCell (thermal insulation material), AgriPlast (natural fibre-reinforced composite material), AgriFer (fertiliser from fermentation residue), as well as the energy products electricity and heat.
Grass silage is slurried and the cellulose fibres are isolated in a mechanical digestion process and then dried. The "grass juice" is fermented together with food waste in the biogas plant. The biogas is converted into electricity and heat. Heat and electricity cover the plant's own needs, the surplus electricity is fed into the public grid. The fermentation residue is used as fertiliser. The process water recovered from the digestate is used again to slurry the silage.
For the production of AgriPlast, the dried cellulose fibres are mixed with a plastic matrix, such as recycled PP or bio-based plastics, such as PLA, and combined in a modified pellet press to form granules that can be processed by injection moulding or extrusion.

Market deployment considerations
Acceptance for bio-based materials (and possibly higher prices)

Environmental considerations
Circular economy, minimal ressource consumption, biobased, CO2 saving

Technology feedstock
food waste, grass

Type of process
anaerobic digestion

Technology output
bio-based insulation material, bio-composites, biogas, electrical energy, fertiliser, thermal energy

Scale
Village, Community

TRL
9

Countries
Switzerland, Germany

Year
2004

Stakeholder
Producers associations or cooperatives

Technology owner/developer
Biowert AG
Email:
info@biowert.com

Website:
https://biowert.com/

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Obtaining high value-added active compounds from olive grove biomass

Technology name
karnalprocess

Problem statement
The olive grove industry generates an enormous amount of waste in the olive cultivation process (leaves, pruning wastes) and in the production of the oil.

Executive summary
In addition to the extraction of active compounds for human use, which provides high added value, two additional processes are carried out: (1) the generation of electrical energy that can be consumed by the plant itself; and (2) generation of products for animal feed.

Technology description
The company Innovaoleo is a joint-venture between Natac and Oleícola El Tejar (world leader in the production of olive trees). Through this initiative, a catalogue of active compounds extracted from different wastes from the olive grove and the olive oil production process has been developed. Through a process of extraction, purification and drying of the compounds, ~1,000 ton./year of biomass are treated. Ingredients with high concentrations of oleuropein (olive leaf), hydroxytyrosol (olive leaf) and triterpenes (olive and olive leaf) are obtained, as well as a wide variety of innovative formulas (20% Oleuropein, 13% Pentacyclic triterpenes, 3% Hydroxytyrosol, 3% α-Tocopherol) with interesting applications in food (both nutraceuticals and functional food), pharmacy, animal nutrition and cosmetics. As for animal feed, a functional oil is produced for salmon aquaculture (improves the intestinal health of salmon, enhancing its growth and reducing production costs). The waste left from the extraction is taken to a combustion process, generating electrical energy.

Market deployment considerations

Environmental considerations

Technology feedstock
olive grove biomass

Type of process
extraction, concentration, purification

Technology output
fortified food ingredients

Scale
Farm

TRL
7

Countries
Spain

Year
2014

Stakeholder
Producers associations or cooperatives

Technology owner/developer
Natac S.L.
Email:
attcliente@unidadeditorial.es

Website:
https://www.elmundo.es/economia/2014/06/26/53abea74e2704ef64b8b4574.html

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Packaging and disposable tableware solutions from agricultural waste

Technology name
karnalprocess

Problem statement
Agricultural waste such as tomato and wheat wastes and banana roots, among others, are not used, which has an environmental impact and a management cost for the producer.

Executive summary
BIOSOLUTIONS offers innovative packaging solutions as well as environmentally friendly and intelligent disposable tableware. In terms of packaging there are three options: Basic, with food grade additives or with aluminium laminate. The products are sustainable and innovatively designed, extremely efficient and cost-effective.

Technology description
BIOSOLUTIONS works with a local partner, (e.g. the NGO VIKASANA) who collaborates in the collection of waste from small farmers in the region. After this, the materials are cleaned and preserved (through pressing and drying). The processing consists of conversion to micro and nanofibres and subsequent moulding and lamination to shape them into tableware and packaging materials, and the products can also be moulded and coloured according to market needs. The final product is delivered to local customers and after use can be energy efficiently burned, recycled, or landfilled as it is biodegradable. The process avoids the addition of chemical additives and achieves low energy and water consumption. The establishment of BIOSOLUTIONS facilities is possible all over the world (currently they have implemented the system in Thailand), as they are compact and require only basic infrastructure. Depending on local demand and resource availability, it is possible to open multiple facilities in different areas of each country, shortening transport to the point of sale, significantly reducing CO2 emissions. In addition, production staff do not need special technical skills so they can be trained on site, creating local jobs.

Market deployment considerations
Infrastructure, electricity and water supply

Environmental considerations

Technology feedstock
plant waste, tomato waste

Type of process
moulding

Technology output
bioplastics

Scale
Community

TRL

Countries
Germany

Year
2019

Stakeholder
Private sector

Technology owner/developer
BIO-SOLUTIONS
Email:
info@bio-lutions.com

Website:
https://www.bio-lutions.com/

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SMARt-CHP

Technology name
smartchp

Problem statement
Demonstrate an innovative, small-scale, mobile power production unit, which uses the agricultural residues generated in rural areas.

Executive summary
The SMARt-CHP prototype is a mobile and modular 5kWel and 12 KWth CHP unit that fits in the size of a container and combines the technologies of gasification and internal combustion engines.

Technology description
The SMARt-CHP unit consists of a gasification reactor combined with an internal combustion engine and adjusted to work on producer gas for electrical power and heat. The unit was built in Thessaloniki and transported to the premises of the two associated beneficiaries. The feedstock was made up of grape, peach and olive kernels that had been collected from the region of Western Macedonia. The unit has operated for more than 3000 hours with a variety of solid waste streams from agro-industry such as grape pomace, olive and peach kernels, almond shells etc. Also, the unit would operate close to the place of feedstock origin, thus minimising transportation and logistic costs.

Market deployment considerations
Residual biomass can constitute an extra income for farmers based on the current market prices of electricity and heat, while simultaneously contributing to CO_2 emissions reduction and ecological impacts on the environment.

Environmental considerations

Technology feedstock
agri-residues, food waste, wood chips

Type of process
thermal process

Technology output
biochar, electrical energy, heat

Scale
Farm

TRL
6

Countries
Greece

Year
2012

Stakeholder
University

Technology owner/developer
Aristotle University of Thessaloniki
Email: contact@bio2chp.com

Website: www.bio2chp.com

BIO4AFRICA

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Staramaki

Technology name
staramaki

Problem statement
In Greece, 1.000.000.000 plastic straws are consumed every year, while the EC's announcement in 2020 on the banning of several single-use plastic products comes into force. At the same time, unemployment in Kilkis reaches 50% wthile the isssue of rural depopulation is serious and the percentage of extreme poverty in Greece reaches 15%. Staramaki uses the by-product of wheat cultivation in various rural regions of Greece to create natural wheat stems as alternative to single use plastic straws and contributing to the income of struggling local economies.

Executive summary
Staramaki is a straw made of wheat. It is produced by a social cooperative KoinSep in Kilkis, situated in rural Northern Greece. The most widely produced local product – wheat – is used to create a viable eco-friendly alternative to single use plastic straws.

Technology description
The Staramaki products are made from the stalk that is left over when wheat grains are harvested. The wheat stems are reaped mechanicaly after harvest and collected by hand. Harvested stems are stored according to origin and date of harvest, preselected and trimmed manually, using specially shaped stainless steel scissors. Trimmed stems are prewashed, boiled, rinsed, washed again in industrial units and dried to their final form. At the same time they create employment opportunities and promote social cohesion, as well as local and regional development.

Market deployment considerations
Competition with products from China or USA.

Environmental considerations

Technology feedstock
stubble wheat

Type of process
trimming

Technology output
drinking straw

Scale
Village, Community

TRL
9

Countries
Greece

Year
2019

Stakeholder
Private sector

Technology owner/developer
Staramaki Social Cooperative Enterprise
Email:
info@staramaki.gr

Website:
https://www.staramaki.gr/en/intro

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Tableware made from sugar cane waste

Technology name
karnalprocess

Problem statement
Agricultural waste from the sugar industry represents an environmental hazard due to its easy combustion and degradation time, as only ~10% is reused.

Executive summary
The demand and interest for sustainable food packaging and disposable tableware is growing exponentially, requiring significant solutions. For these requirements, Pacovis produces biologically degradable materials (Naturesse line), reducing CO2 emissions and waste generation.

Technology description
The first step is the collection and drying of the sugar cane bagasse. It is then compressed and pressed to obtain a syrup with a high fibre content, which is compacted into a final paste by the addition of water and natural binding agents. The final step is processing and pressing in moulds. Alternatively, the company has also developed more complex processes where sugar cane starch is used for the production of PLA - Poly Lactic Acid, which is also used to produce kitchenware. The products of the Naturesse range are EN 13432 certified and are therefore food safe, taste neutral, heat and water resistant. The same company works with waste from other origins within the same line: palm leaf, bamboo and cellulose/wood.

Market deployment considerations
Requires industrial technology e.g. moulding and extrusion equipment

Environmental considerations

Technology feedstock
sugar cane

Type of process
moulding

Technology output
bioplastics

Scale
Village

TRL
8

Countries
Switzerland

Year
2019

Stakeholder
Private sector

Technology owner/developer
Pacovis

Email: admonpeconvi@gmail.com

Website: http://peconvi.es/wp-content/uploads/2019/10/Catalogo_Naturesse.pdf

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Ethanol production from sorghum milling wastes

Technology name

karnalprocess

Problem statement

Nigeria is the world's second largest sorghum producer, producing 6.5 million metric tonnes per year. The accumulated wastes from sorghum processing are potentially suitable for bioethanol production.

Executive summary

Sorghum bran is an underutilised waste from the sorghum milling process in Nigeria. It contains relatively high amounts of starch and protein, indicating that it is a suitable substrate for fermentative conversion into value-added products.

Technology description

Sorghum is processed by soaking and wet milling to obtain bran, which is a typical processing technique in Nigeria. The sorghum bran is soaked and milled to separate the sorghum bran from the starch. The starch is the main product, while the residual sorghum bran is hydrolysed by enzymes or acids to generate a sugar-rich hydrolysate. The hydrolysate is fermented to produce bioethanol by yeast fermentation. The waste yeast, together with the unfermented solid wastes, can be used as high-protein animal feed. The University of Ilorin achieves a bioethanol production yield of 0.151 g bioethanol per g sorghum bran. It is estimated that if all the sorghum bran produced in Nigeria were used, the bioethanol produced could provide 17% of Nigeria's annual transport fuel needs.

Market deployment considerations

Unverified industrial scale

Environmental considerations

Technology feedstock

sorghum, waste fibres

Type of process

anaerobic digestion, fermentation

Technology output

bioethanol

Scale

Farm

TRL

Countries

Nigeria

Year

2019

Stakeholder

University

Technology owner/developer

University of Ilorin

Email: expresso-support@bepress.com

Website: https://www.sciencedirect.com/science/article/pii/S1369703X19302244

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Biogas production from macroalgae wastes

Technology name
karnalprocess

Problem statement
Laminaria japonica is a marine macroalgae that is widely cultivated for biofuel production, pharmaceuticals and the food industry. Even so, waste is generated from these algae, which can still be used to produce biomethane.

Executive summary
The digestion of Laminaria japonica in batch and continuous bioreactors produced acceptable biomethane production rates at laboratory and pilot plant scale. On the other hand, against all odds, a pre-treatment of the algae does not increase biomethane production, recommending fermenting them in their "native"" state.

Technology description
Macroalgae production is increasing considerably every year worldwide. Most of this production is destined for food, but other industries also use macroalgae as biomass (pharmaceuticals, paper, textiles, etc.). Between harvesting and further processing of Laminaria in industries, between 10% and 30% of residual biomass is generated, which ends up being discharged into the sea or treated as low impact waste. Macroalgae are a type of biomass with potential for biomethane production. Its fractionated carbohydrate structure (soluble and easily hydrolysable sugars) makes it suitable for anaerobic digestion. In short, the absence of large amounts of lignin and cellulose makes them suitable for digestion by microorganisms. The study was carried out on Laminaria waste, at laboratory scale and at pilot plant scale. In both cases, pretreatment of the biomass was not positive for fermentation, contrary to the recommendation in the literature. On the other hand, when these algal wastes were fermented without any pretreatment or mixing with other substances, acceptable amounts of biomethane were produced, despite being waste biomass and thus possessing less fermentable compounds than if a whole plant was fermented.

Market deployment considerations

Environmental considerations

Technology feedstock
Laminaria japonica

Type of process
anaerobic co-digestion, anaerobic digestion

Technology output
biogas

Scale
Village, Community

TRL
6

Countries
Germany

Year
2015

Stakeholder
University

Technology owner/developer
Department of Life Sciences and Chemistry, Jacobs University
Email: support@mdpi.com

Website: https://www.mdpi.com/1660-3397/13/9/5947

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Decentralised production of high purity biogas from pig slurry

Technology name

karnalprocess

Problem statement

Pig farms generate a large amount of waste. It is estimated that each animal produces an average equivalent to one and a half tubs of slurry per year.

Executive summary

The novelty lies in the possibility of decentralised recovery treatment and in the fact that the biogas produced is of high purity (biomethane) and can be injected directly into the natural gas network or used as automotive fuel.

Technology description

The valorisation strategy combines two sequential processes: biogas gas purification treatment and anaerobic digestion of livestock waste. The photosynthetic micro-organism used for this transformation is a purple phototrophic bacterium, capable of capturing the sun's infrared energy and feeding on the phosphorus, nitrogen and organic matter present in the slurry. Specifically, these bacteria can support high rates of nutrient assimilation and exhibit high tolerance to slurry toxicity. These organisms perform anoxygenic photosynthesis with carbon dioxide (CO2) and hydrogen sulphide (H2S) fixation, which allows high purity biomethane to be obtained.
The technology can be implemented on small farms, using the biomethane produced on the farm itself. For best performance, it is recommended to dilute/concentrate the slurry to ̃600 mg/L total nitrogen. The presence of volatile fatty acids improves CO2 fixation, thus allowing a purer biomethane.
The low phosphorus concentrations inherent in pig slurry are not significant in the performance of the process, but slightly improve the quality of the biomethane. Concentrations of 93.3% CH4 can be achieved, meeting most international standards for use as vehicle fuel.

Market deployment considerations

Environmental considerations

Technology feedstock

pig slurry

Type of process

anaerobic digestion

Technology output

biofertiliser, biogas

Scale

Farm

TRL

6

Countries

Spain

Year

2019

Stakeholder

University

Technology owner/developer

Sustainable Processes Institute. University of Valladolid
Email: web@residuosprofesional.com

Website: https://www.residuosprofesional.com/proceso-convierte-purines-energia-limpia/

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Bioenergy with carbon capture and storage (BECCS)

Technology name

karnalprocess

Problem statement

BECCS is used for a sustainable agriculture to address the simultaneous demands of food, energy, and environmental security.

Executive summary

Biomasses are converted to biogas and thence to electricity, heat and/or biomethane; stable carbon and plant nutrients are recycled to the fields by applying effluent digestate avoiding the greenhouse gases (GHG) emissions and other environmental impacts associated with fossil-based fertilisers.

Technology description

Anaerobic digestion of manure, agri-food by-products, and energy crops to produce biogas and digestate (biofertilizer) that can be carried out in Africa.

Market deployment considerations

Farm, Village, Community

Environmental considerations

Research and Technological Center

Technology feedstock

manure, orange peel, olive pomace, Opuntia, Moringa oleifera

Type of process

anaerobic digestion

Technology output

bioenergy, biofuel, biogas

Scale

Organic farming. In anaerobic digesters, about 70% of the carbon goes to biogas and 30% is transformed into more stable carbon using the digestate residue coupled with practices derived from conservation agriculture. The CO_2 from the atmosphere is used for energy crop growth and introduced into the soil. The overall system therefore functions as a bioenergy with carbon capture and storage (BECCS) process.

TRL

9

Countries

Italy

Year

2000

Stakeholder

Anaerobic digestion is a very scalable technology in terms of plants size and feedstock/biomasses exploiting. To implement

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anaerobic digestion widespread in Africa, capital and operational costs reduction and small-scale technology development are key aspects for the market deployment.

Technology owner/developer

CRPA (Centro Ricerche Produzioni Animali)

Email:

info@crpa.it

Website:

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Compression of agri-residues

Technology name
karnalprocess

Problem statement
High production of agriwastes and lack of cheap energy.

Executive summary
Production of pellets for renewable energy production.

Technology description
The proposed solution is a series of physical and biological processes. Firstly, it starts by gathering all the biomass in the facilities and grinding it. Then drying it in a dram, covered without oxygen to produce anaerobic digestion and biogas. Later, the biomass, rich in lignin, is compressed, forming pellets for energy production.

Market deployment considerations
Financing is a barrier in Uganda and it's all majority at policy level with limited really implementation opportunities

Environmental considerations
No, little negative environmental impact, only short transportation to gather the biomass.

Technology feedstock
agri-residues, coffee husk, rice husk, groundnut shells, corn cobs

Type of process
anaerobic digestion

Technology output
biochar, pellets, biogas

Scale
Community

TRL
9

Countries
Uganda

Year
2012

Stakeholder
Private sector

Technology owner/developer
Bio-Innovations Company

Email:

Alex Tumukunde,

alex.t@bioinnovations-ug.org

Website:

https://bioinnovations-ug.org/

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Use of waste from cardamom production in the cultivation of the edible mushroom

Technology name

karnalprocess

Problem statement

In Mexico, mushroom cultivation allows the recycling of more than 500,000 tonnes of agricultural, agro-industrial and forestry waste per year, thus reducing the environmental impact of the final disposal of such waste.

Executive summary

In the cultivation of mushrooms (Pleurotus spp.) a wide variety of agricultural or agro-industrial waste or by-products can be used as substrate. Pulp from cardamom, lemon or coffee can be used for this purpose, making it possible to reduce the environmental impact of the disposal of these wastes.

Technology description

Mushroom cultivation is an efficient biotechnological system, as high yields and good productivity are achieved with few environmental controls. Mushrooms have short growth times, grow in a wide temperature range and their ability to use various lignocellulosic materials as substrate makes it possible to use regionally available agricultural, agro-industrial and forestry residues. In particular, cardamom pulp can achieve a biological efficiency of ~114% in the production of Pleurotus ostreatus. The results of biological efficiency (BE) vary greatly from substrate to substrate, however, the recommended substrates are those with a BE value close to or greater than 100, which can be achieved by testing some combinations of waste materials or by carrying out some type of pre-treatment of the material such as fermentation, composting or simply pasteurisation. In this way, regionally produced waste can be used to produce high-protein foodstuffs and the exhausted substrate can still be used for both the re-cultivation of edible mushrooms and the remediation of contaminated soils. This is achieved by enriching with other agro-industrial wastes, thus reducing the environmental impact of the exhausted substrate.

Market deployment considerations

Environmental considerations

Technology feedstock

cardamom, agri-residues

Type of process

biological treatment

Technology output

biomaterial, Edible fungi/mushrooms

Scale

Farm

TRL

4

Countries

Mexico

Year

2016

Stakeholder

Research and Technological Center

Technology owner/developer

National Polytechnic Institute of Mexico
Email: editora.rica@atmosfera.unam.mx

Website: https://www.revistascca.unam.mx/rica/index.php/rica/article/viewFile/RICA.2016.32.05.10/46678

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Valorisation of Jatropha curcas waste by composting

Technology name

karnalprocess

Problem statement

This crop requires different pruning seasons for proper production, which generates a large amount of waste in the form of biomass.

Executive summary

A simple controlled composting step produces an organic solid with properties that make it suitable as a fertiliser in agriculture. The process requires mixing the waste with other agricultural waste from the fruit, thus solving several environmental problems.

Technology description

Jatropha curcas is generally used for the production of bio-oil which is then transformed into biodiesel by transesterification. For intensive production, several parameters are important, notably pruning, which generates significant quantities of biomass wastes. Pruning not only increases the number of branches and therefore the number of fruits, but also makes it possible to maintain a tree shape that facilitates harvesting. This operation generates green waste rich in mineral elements (NPK). Green waste, a mixture of pruning wastes or branches and fruit peels in a ratio of 5:1, is used for composting. The mixture is homogenised and placed in a bioreactor. During composting, the reactor is fed by a flow of compressed air to ensure complete oxygenation. An automatic system continuously keeps the biomass in motion. The composting period is one month, producing a compost with the following parameters: C/N <21, NH_4^+/NO_3^- <1 and a pH between 5 and 7. Phosphorus levels increase after the fifth day of composting to reach 0.03 mg/g.

Market deployment considerations

Environmental considerations

Technology feedstock

Jatropha pruning waste

Type of process

biological treatment

Technology output

biofertiliser

Scale

Farm

TRL

5

Countries

Morocco

Year

2016

Stakeholder

University

Technology owner/developer

Cadi Ayyad University

Email:

rep_researchgate@prighter.com

Website:

https://www.researchgate.net/publication/311873033_Valorization_of_Jatropha_curcas_waste_by_composting

Horizon 2020
European Union Funding
for Research & Innovation

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"Cold Composting" to increase soil fertilization and reduce emissions and waste

Technology name
karnalprocess

Problem statement
Mowing the lawn generates a large amount of landfill, emissions to the environment from transport to landfill and energy consumption in the process.

Executive summary
"The practice of mowing the lawn and leaving the grass clippings on the ground is called ""Cold Composting"". The trimmings decompose and increase soil fertility rather than being collected and sent to landfills or a traditional composting facility."

Technology description
At the Lovell Federal Health Care Center in Illianois, USA, 320 tonnes of waste from lawn mowing was reduced by the simple practice of not picking up waste after finishing. This helps reduce the amount of waste sent to landfills, a practice that is under-exploited. Grass clippings left on the ground increase soil fertility. It also reduces the consumption of resources such as energy and labour involved in sending this waste to landfill, as well as eliminating the greenhouse gas emissions involved in transporting this waste.

Market deployment considerations

Environmental considerations

Technology feedstock
grass

Type of process
biological treatment

Technology output
biofertiliser

Scale
Village, Community

TRL
7

Countries
United States

Year
2014

Stakeholder
Public sector

Technology owner/developer
Lovell Federal Health Care Center
Email:
r5hotline@epa.gov

Website:
https://www.epa.gov/sites/production/files/2015-04/documents/cs9-lovell-cold-composting.pdf

Horizon 2020
European Union Funding
for Research & Innovation

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Extraction of bromelain from pineapple wastes by enzymatic pre-treatment and membrane process

Technology name

karnalprocess

Problem statement

In Costa Rica alone, ~10 million tonnes of stubble are generated per year. Although there are already processes that allow bromelain to be recovered enzymatically, filtration and purification is still problematic.

Executive summary

The enzymatic pre-treatment and diafiltration operation is used in a two-stage ultrafiltration system to improve the performance of the bromelain purification and concentration process. This pretreatment uses pectinase, reducing the apparent viscosity and making the process more efficient.

Technology description

The pineapple waste consists of ~15% fruit core, ~30% crown and ~55% skin. It is mixed with an equal mass of water before being filtered and centrifuged. The obtained supernatant is subjected to enzymatic pre-treatment by adding 0.01% pectinase from Aspergillus aculeatus (3800 U/mL), adjusting the pH 7. The filtration process is carried out by cross-flow, with membranes of 75 kDa and 10 kDa pore size in the 1st and 2nd stages respectively. In the 1st pre-filtration stage, bromelain is separated from the high molecular mass compounds and recovered in the permeate. In the 2nd purification stage, the permeate containing bromelain is separated from the low molecular mass compounds, such as amino acids and pigments, and concentrated. To increase the efficiency between the two stages, an intermediate diafiltration step is introduced. The purpose is to first dilute the bromelain in a diluent (water) to maintain a constant feed volume.

Market deployment considerations

Environmental considerations

Technology feedstock

pineapple waste

Type of process

biological treatment

Technology output

bromelain

Scale

Village, Community

TRL

4

Countries

Costa Rica, Australia

Year

2018

Stakeholder

University

Technology owner/developer

College of Health and Biomedicine, University Victoria
Email: info@ncbi.nlm.nih.gov

Website: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6117993/

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000762.

Reuse of vine pruning waste (vine shoots) for the production of biofertiliser

Technology name
karnalprocess

Problem statement
Annual pruning of vine shoots produces approximately 800-1500 kg/ha of waste that is difficult to manage, which is normally disposed of by burning (emitting ~2.2 tonnes CO_2/ha of burnt prunings into the atmosphere).

Executive summary
The process avoids burning the vine shoots (which involves emissions into the atmosphere and a high risk of fires due to its proximity to forest areas), transforming them into compost to be used as fertiliser and improve the state of the soil, which benefits grape production.

Technology description
Preparatory actions require the definition of the logistics plan, obtaining permits and licenses if necessary and conditioning the transformation area. For this, the plots, location of collection points and location of the composting place are selected. It is recommended to build the transformation area with concrete bed to avoid possible contamination of the soil by leachate. After this, the proposed system integrates the following phases: I. Provisioning: collection of shoots in the plots after the annual pruning. II. Crushing: transfer of shoots to collection points where they are crushed. Depending on the distance to the composting site, the crushing is carried out at collection points or directly at the composting site. III. Transport to the composting site: transfer of the crushed material. IV. Composting process: transformation of pruning waste into compost. V. Distribution of compost: transport of the substrate from the production site to its place of application. VI. Fertilization: application of the resulting compost in the field. Specifically, composting in an open pile in the open air is proposed under thermophilic temperatures (60ºC – 70ºC) for 6 months, producing a product free of pathogens and weeds that is used as an organic amendment.

Market deployment considerations
Minimum amount of 50-100kg of biodegradable material.

Environmental considerations
Rainfall and temperature regime in the region.

Technology feedstock
vine pruning waste

Type of process
biological treatment

Technology output
biofertiliser

Scale
Village, Community

TRL
9

Countries
Spain

Year
2019

Stakeholder
Producers associations or cooperatives

Technology owner/developer
Micrograia Biotech S.L.
Email:
info@lifesarmiento.eu

Website:
http://lifesarmiento.eu/wp-content/uploads/2019/06/Gu%C3%ADa-t%C3%A9cnica-para-la-implementaci%C3%B3n.pdf

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000762.

Karnal Process

Technology name
karnalprocess

Problem statement
High levels of fiber are observed in feed resources, which are not in a good state to enhance animal nutrition. There is therefore need to increase the quality of feed material and ensure that animals derive maximum benefit from feed resources.

Executive summary
Biological treatments (Karnal process) aiming at the deconstruction of lignocelluloses employs selective ligninolytic white-rot basidiomycetes under solid-state fermentation.

Technology description
Technology developed at NDRI, Karnal (India). Straw is treated with 4% urea at moisture level of 60%. The treated straw is stacked in a silo pit under cover for 30 days. A temporary loose brick structure is constructed and a thin layer of urea treated straw spread evenly in this structure. A solution of the following composition is prepared. 60g superphosphate, 60g calcium oxide dissolved in 8-liter water. Sprinkled over the urea treated straw and inoculated with 3% Coprinus fimeratius culture. This is allowed to remain for 5 days then used for feeding. The main advantage of this process is that free ammonia is converted into microbial protein and ligno cellulose bond is degraded.

Market deployment considerations
"Longer time required in processing feed

Environmental considerations
Research and Technological Center

Technology feedstock
crop residues, straw

Type of process
biological treatment

Technology output
animal feed

Scale
Farm, Village

TRL
9

Countries
India

Year
2012

Stakeholder
issues of space and storage"

Technology owner/developer
National Dairy Research Institute, Karnal, India
Email: support.it@icar.gov.in

Website: http://ndri.res.in/

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Biofertilizer with fish wastes

Technology name
karnalprocess

Problem statement
There is higher loss of food in consumption than production along the food systems in Africa. Food recovery can create multiple jobs and solve feed/fertilizer challenges for farmers in Africa.

Executive summary
Produce animal proteins and organic fertilizer using Black Soldier Fly larvae.

Technology description
Use of fish offals and other organic waste from markets to hatch and feed Black Soldier Fly larvae and produce organic fertilizer and fish and poultry feeds at Hydro Victoria Fish & Poultry Feed Plant, using 10-20 Tons of waste per day and producing 2-3 Tons of animal proteins per day, 6-12 Tons of organic fertilizer per day.
Located in Busia County in Kenya, East Africa.

Market deployment considerations
Small bioeconomy farms can have significant impact in villages compared to commercial large farms in urbans towns. Consumption and production patterns are similar across Africa. Land use patterns and trends are near similar eg More small-scale farmers feeding cities and communities. Multiple demand of products at village level.

Environmental considerations
No

Technology feedstock
fish by-products, fish waste, potato peelings, mango by-products, straw

Type of process
biological treatment

Technology output
fish feed, poultry feed, organic fertiliser, bar soap

Scale
Village, Community

TRL
7

Countries
Kenya

Year
2020

Stakeholder
Private sector

Technology owner/developer
Hydro-Victoria Fish Hatchery Farm LTD
Email: info@hydrovictoriafishhatcheryfarm.co.ke

Website: https://www.hydrovictoriafishhatcheryfarm.co.ke

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Valorisation of grass, pasture and plant wastes using the biorefinery concept

Technology name

karnalprocess

Problem statement

The potential of these wastes is currently not exploited as the usual actions are composting, direct use in animal feed, conversion to pellets for energy production or biogas production by fermentation.

Executive summary

Using the biorefinery concept, protein-rich compounds for pig feed, sugar and protein-rich compounds for cattle feed, fibres for cardboard manufacturing, as well as electricity and heat can be produced.

Technology description

The technology consists of a first mechanical separation step where the input is converted into a pressed fibre cake and a juice rich in protein and minerals. The juice is then heated to produce a protein coagulate, useful as feed in the pig sector. As for the cake, it is low in protein but suitable for livestock feeding needs. The cellulose fibres it contains can be transported for the manufacture of cardboard. Finally, the residual fractions from the process are used to produce biogas. The decentralised approach makes it possible to avoid the transport of wet green leaf and grass waste, thus reducing emissions. Moreover, the substitution of soya feed with local feed allows for a more sustainable production. This technology has been developed by Wageningen University and is marketed by GRASSA BV. On the other hand, other approaches to the biorefinery concept could include the production of acids (lactic acid and amino acids) or lignin, and different scenarios can be developed depending on the complexity of the valorisation process.

Market deployment considerations

Environmental considerations

Technology feedstock

grass, plant waste

Type of process

cascade processing

Technology output

animal feed

Scale

Farm

TRL

4

Countries

Netherlands

Year

2015

Stakeholder

University

Technology owner/developer

GRASSA BV

Email:
info@hoogeveen.nl

Website:
https://www.wur.nl/upload_mm/d/4/8/6c738231-e1c7-4e58-a1c8-8b02bb13fb98_Final%20report%20version%206%20Biomass%20Drenthe.pdf?itemuuid=6c5e1270-7cd0-4344-bfaa-e0a6c76811b0&webId=26098

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Use of crustacean shells for gourmet dressings and biofertilisers

Technology name
karnalprocess

Problem statement
The shell, including the head, constitutes ̃60 % of the weight of the animal (shrimp, prawn), which can reach several tonnes per day, entailing high transport costs.

Executive summary
A multi-stage process is used to obtain different products. From the initial extraction, the raw material for food is obtained. Subsequently, pigments are obtained and finally chitin, which can be converted into chitosan by deacetylation.

Technology description
Shrimp shells have the highest chitin content, 30-40 %, followed by crab shells, 15-30 %. In the first extraction, raw material is obtained for dressings, from which pâté, soups and premium sauces or for direct application are produced. This is followed by grinding, deproteinisation, demineralisation, filtering and decolourisation. At this point in the process, pigments are obtained that can be marketed. The decolourisation results in a cake which is washed and dried to obtain chitin. This undergoes a deacetylation process and is converted into chitosan. This is a biopolymer (a polysaccharide) that can be used in a wide range of applications in its different modified forms as well as different degrees of purity. The company Ryomar, which implements this technology, uses chitosan as a biofertiliser in agriculture.
Other potential uses are as a food-grade flocculant in water treatment and paper manufacturing

Market deployment considerations
in edible films or microencapsulation of ingredients in food applications

Environmental considerations
to reduce infections and improve performance in aquaculture and ruminant feed

Technology feedstock
crustacean shells

Type of process
cascade processing

Technology output
biopolymer

Scale
in foams in cosmetics

TRL
9

Countries
Chile

Year
Village, Community

Stakeholder
in pharmaceuticals in nutritional supplements as a fat binder

Technology owner/developer
Rymar CL
Email: gguerra@agenciacircular.cl

Website: https://www.paiscircular.cl/industria/rymar-la-pesquera-que-aprovecha-la-cascara-del-camaron-para-hacer-aderezos-gourmet-y-fertilizantes/

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000762.

Production of bactericidal peptides from beef residues

Technology name

karnalprocess

Problem statement

The meat industry generates large volumes of by-products (blood, bones, meat trimmings, ...) which are costly to treat and dispose of ecologically. These costs can be balanced by generating value-added products.

Executive summary

Bioactive peptides can be obtained from meat by-products through the application of enzymes that cut or hydrolyse meat proteins at certain points, obtaining peptides of all kinds. The most interesting are those that have a bactericidal function, preventing the growth of bacteria.

Technology description

The production of bioactive peptides from meat by-products is highly researched. Bioactive peptides are sequences generally between 2 and 20 amino acids that exert a biological function in one or more of the human physiological systems. Antimicrobial peptides can modulate the gastrointestinal and immune systems. The use of by-products as a source of bioactive peptides has been extensively studied in recent years. In this regard, blood and collagen, very important by-products from slaughterhouses and the meat industry, have been the most tested. Blood is a rich source of protein where haemoglobin, an iron-containing protein, is the most abundant complex. The use and application of the enzyme pepsin on bovine blood in the presence of 30% alcohol produces peptides with antibacterial activity (Kocuria luteus) that cause pathologies such as endocarditis, septic arthritis, meningitis and lung infections.

Market deployment considerations

Environmental considerations

Technology feedstock

beef residues

Type of process

cascade processing

Technology output

bactericidal peptides

Scale

Village

TRL

3

Countries

Spain

Year

2016

Stakeholder

University

Technology owner/developer

Institute for Agrochemistry and Food Technology (CSIC)
Email:
expresso-support@bepress.com

Website:
https://www.sciencedirect.com/science/article/pii/S0309174016301140#!

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Aflasafe® (Biopesticide)

Technology name
aflasafe

Problem statement
Aflatoxin exposure is frequent and widespread in most African countries. Key staples such as maize and groundnuts are particularly vulnerable to aflatoxin contamination. A stealthy and silent killer, aflatoxin is a major concern because of its acute, chronic and irreversible health effects on people and livestock, sometimes leading to fatalities. Besides being lifethreatening and compromising health, aflatoxin contamination hampers domestic, regional and international trade as companies are unable to meet international and regional standards.

Executive summary
Aflasafe® is an environmentally friendly product that was developed by IITA and USDA. Aflasafe consistently reduces aflatoxin contamination in groundnuts, maize and sorghum by between 80% and 100% when the crop is in the field and during storage.

Technology description
Strains of Aspergillus flavus (A. flavus) that do not produce aflatoxins, called atoxigenic strains are identified. Carefully selected atoxigenic strains are the active ingredients of Aflasafe and are coated on roasted, sterile sorghum grains, which are then spread in fields while crops are developing. The active ingredients grow and spread across crops and outcompete aflatoxin producers, preventing the fungi from growing on crops and contaminating them. Each Aflasafe product contains four atoxigenic A. flavus active ingredient strains native to the target nation. In all countries, the use of Aflasafe leads to an 80-100% reduction in aflatoxin contamination in fields.

Market deployment considerations
Aflasafe is formulated as spores carried by inert carrier for ease of deployment.

Environmental considerations
Efficacy of Aflasafe strains is region-specific and thus requires isoaltion and characterization of different starins for different regions.

Technology feedstock
sorghum

Type of process
cascade processing

Technology output
biopesticide

Scale
Community

TRL
9

Countries
Uganda, Senegal

Year
2014

Stakeholder
Research and Technological Center

Technology owner/developer
IITA/USDA

Email:
hello@aflasafe.com

Website:
https://aflasafe.com/wp-content/uploads/pdf/Status_of_Aflasafe_Commercialisation_in_Africa.pdf

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000762.

Gas permeable membranes at atmospheric pressure

Technology name

karnalprocess

Problem statement

High production of livestock effluents.

Executive summary

It reduces the ammonia load in livestock effluents, recovering nitrogen in the form of an ammonium salt, with high fertiliser value.

Technology description

It is a physico-chemical process that, by increasing the pH of the effluent to be treated, favours the transformation of ammonium to ammonia. This ammonia is recovered by contact with an acid solution, producing an ammonium salt solution. The result is the reduction of the nitrogen load in the livestock effluent and the recovery and concentration of that nitrogen in the form of an inorganic fertiliser product.

Market deployment considerations

Environmental considerations

No, negative relevant environmental impact.

Technology feedstock

effluents, livestock waste, manure, pig slurry

Type of process

cascade processing

Technology output

biofertiliser, biosubstrate

Scale

Farm

TRL

6

Countries

Spain

Year

2020

Stakeholder

Research and Technological Center, Castilla y León Agricultural Technology Institute (ITACYL

Technology owner/developer

Castilla y León Agricultural Technology Institute (ITACYL). Email: suelos@itacyl.es

Website: "http://ammoniatrapping.com

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Antcare

Technology name
karnalprocess

Problem statement
High production of agriwastes that can become an environmental problem.

Executive summary
Production of cosmetics from biowaste.

Technology description
The company gathers wastes from organic apples produced on an old family plot of land in Barge: Azienda Agricola e Agriturismo Magnarosa. Then they produce Apple Paste © up cycled, obtained by processing the seeds and skins of apples left over from the production of organic apple juice. The formulation and production of the final product is 98% or 99% natural, used for biocosmetics produced with renewable energy. The final product has nourishing effect and antioxidant functions from the naturalness of the fruit. Furthermore, recycled and recyclable packaging is used. They package the products with cardboard chipboard recovered and recycled by local actors.

Market deployment considerations
These technologies are modulable and scalable, as well as used at local or regional level, therefore, very replicable technologies.

Environmental considerations
The process is adapted to reduce the carbon footprint in the entire production chain, integrating only local, ethical, and sustainable suppliers into its supply chain.

Technology feedstock
orange peel, potato peelings, food waste, pineapple waste, waste

Type of process
cascade processing

Technology output
biocosmetic

Scale
Farm

TRL

Countries
Italy

Year
2020

Stakeholder
Private sector

Technology owner/developer
Vortex
Email: vortex.olimpia@pec.it

Website: https://www.antcare.net/chi-siamo/ , https://www.linkedin.com/company/vortex-start-up-innovativa-a-vocazione-sociale/?originalSubdomain=it

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for Research & Innovation

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Production of polymeric biocomposites from rice endosperm

Technology name
karnalprocess

Problem statement
Starch production yields ~80% endosperm, 8% protein and 12% other by-products, including rice endosperm, the latter being used as a low value-added animal feed.

Executive summary
By mixing rice endosperm with a polysuccinate butylene (PBS) matrix, polymeric materials are obtained. The functional characteristics of these are similar and even improved in aspects such as ductility. Mixing can be done with both the original and the enzymatically treated endosperm.

Technology description
Rice endosperm has a high content in the form of starch (65%), but may also contain oils and proteins. The PBS compound can be prepared from a mixture of the original waste or from the enzymatically treated waste. This treatment splits the original by-product derived from rice endosperm into a solid waste, suitable for the preparation of polymeric biocompounds, and a supernatant, which contains bioactive molecules with high potential value for application in cosmetics and nutraceuticals due to its polyphenol content. Rice endosperm has good compatibility with the PBS matrix, which can be mixed at 125ºC in amounts between 10-30%. At the functional level, it does not modify the thermal properties and significantly improves its characteristics, making the material more ductile. In particular, hydrolysed rice endosperms improve approximately 100% of the tensile and flexural strength. These results are obtained without the use of compatibilising agents within the matrix polymer or without interfacial fibre modifications. Therefore, rice endosperm can potentially be used as a reinforcing material for the manufacture of biocomposites.

Market deployment considerations

Environmental considerations

Technology feedstock
rice endosperm

Type of process
chemical treatment

Technology output
biopolymer

Scale
Farm

TRL
4

Countries
Italy

Year
2017

Stakeholder
University

Technology owner/developer
University of Bologna
Email:
urbanrec@aimplas.es

Website:
https://urbanrec-project.eu/detalle_registro.php?re_id=102&tipo=7

Horizon 2020
European Union Funding
for Research & Innovation

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000762.

Waste sanitation to produce alkaline biofertilizer adapted to acidic land

Technology name
karnalprocess

Problem statement
High production of agriwastes that can become an environmental problem.

Executive summary
Elaboration of a liquid and solid alkaline biofertilizer that adapts the soil for a greater use of nutrients using waste to give them a second life.

Technology description
It is a chemical reaction that produce heat to sanitize organic wastes. The process consists of adding a mix of calcium oxide (quick lime) and wood chips (or other lignocellulosic waste) that reacts with the moisture of the residue, produces a significant increase in the temperature and in the pH of the mixture, so that all bacteria and pathogens present in the initial residue are eliminated. This process has to be maintained for 2 h around 50-55 degrees Celsius and the pH will remain above 12 for 72 h. The chemical reaction that occurs can be described through this equation: CaO + H2O à Ca (OH)2 + heat. The lignocellulosic part of the mixture enhances the Nitrogen concentration of the biofertilizer since it avoids partially its vaporisation. The biofertilizer increases soil organic matter and pH and its peculiarity is that, in addition to this, it also manages to provide, in small doses, Nitrogen, Phosphorous and Potassium as well as a contribution of lime that benefits the soil. This process only requires an uncovered extension of land (adapted to retain landfill leachates) and shovels to move the material and the mixture.

Market deployment considerations
The main factor lies in the simplicity of the process, it allows a low level of automation to start and a simple technical training to a certain extent, which implies a much smaller investment than for other technologies.

Environmental considerations
Obtaining huge amounts of calcium oxide (quick lime) causes negative environmental impact. Also, Quicklime, used for the stabilization of organic waste, currently has no more environmentally sustainable substitute. Nor can it currently be partially replaced by the use of biomass ash (waste) by legislative change and in our authorization. Moreover, the carbon emission to the atmosphere is a current impact due to the mobilisation and logistics of the wastes to valorise.

Technology feedstock
food waste, organic waste, Animal by products

Type of process
chemical treatment

Technology output
biofertiliser

Scale
Farm, Village, Community

TRL
9

Countries
Spain

Year
1999

Stakeholder
Private sector

Technology owner/developer
AGROAMB
Email:
agroamb@agroamb.com

Website:
"https://www.mapa.gob.es/app/consultafertilizante/ListadoFertilizantes.aspx?idFabricante=506&NombreComercial=&Provincia

Horizon 2020
European Union Funding
for Research & Innovation

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000762.

Production of natural dye from the seed of Bixa orellana (achiote)

Technology name

karnalprocess

Problem statement

The use of natural colouring has increased due to the health problems caused by chemical dyes. In short, the seeds of the fruits are by-products with beneficial and usable properties.

Executive summary

The extraction of bixin from 'achiote' is based on leaving the seeds of the fruit in potassium soda for 12 hours. Subsequently, 10% sulphuric acid is added and finally filtered under vacuum, obtaining a mass that is dried in an oven at 56º-58ºC. The final material obtained is crushed to obtain colouring powder.

Technology description

Bixa orellana or 'achiote', is a species native to tropical America with yields of up to 2500 kg/ha. Peru is the main producer of 'achiote', while the United States is the main demander of this plant species in powdered form. Carotenoids expressed as provitamin A have been found in the seeds of this commonly used food and cooking spice. One of them is bixin, a dark red carotenoic acid found in the outer covering of the fruit. Bixin is an excellent colouring agent with advantages for use in the cosmetics industry. Nowadays, both consumers and industrialists prefer the use of these products of natural origin, due to their biodegradability and low toxicity. B. orellana L. has great potential and demand for the global food industry, as the bixin extracted from its seeds provides one of the purest and most natural shades of red colour available, for the production of cheese, soft drinks, condiments and other food products. By adding potassium soda, then adding sulphuric acid and finally filtering, bixin-rich material is obtained.

Market deployment considerations

Environmental considerations

Technology feedstock

Bixa orellana

Type of process

chemical treatment

Technology output

natural dyes

Scale

Farm

TRL

4

Countries

Peru

Year

2016

Stakeholder

University

Technology owner/developer

Faculty of Pharmacy and Biochemistry. National University of Trujillo
Email:
tdsgunt@unitru.edu.pe

Website:
http://journal.upao.edu.pe/Arnaldoa/article/view/238

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Use of banana leaves for the production of nano/microfibres

Technology name

karnalprocess

Problem statement

The annual production of banana leaves in the Canary Islands is ~400,000 tonnes, causing 320,000-400,000 tonnes of waste in the form of leaves, resulting in high management costs.

Executive summary

Banana waste leaves are used to create a pulp from which micro/nano lignocellulose fibres (MNFLC) are obtained, which can be used for papermaking by adding them to cellulose pulp from wood, improving the mechanical qualities of the paper.

Technology description

Canary Island banana (Musa acuminate var. Dwarf Cavenish) wastes are a source of micro/nano lignocellulosic fibres (MNFLC) with high lignin and hemicelluloses content, having the same reinforcing capacity as micro/nano cellulosic fibres (MNFC) in paper production. The first step is the preparation of the pulp according to Specel® conditions (100◦C±1◦C, 150 min, 7% NaOH and liquid/solid ratio of 10:1), presenting a pulp yield of more than 80%. After this, the material is washed to remove the resulting liquor, subjected to mechanical drying and grinding processes and taken to the refining stage where the MNFLC are obtained. These are added to the bleached wood pulp sludge and cationic starch and silica are added to retain the MNFLCs on the surface. The MNFLC obtained show different properties than those obtained by oxidative and enzymatic methods, although they provided almost the same increase in properties to the paper. On the other hand, these fibres allow the production of paper with lower water retention capacity, have lower production costs than fibres from oxidative processes and have a higher yield in terms of raw material utilisation.

Market deployment considerations

Environmental considerations

Technology feedstock

banana leaves, banana pseudo stems

Type of process

chemical treatment

Technology output

biodegradable films, biofilms

Scale

Farm or community

TRL

3

Countries

Spain

Year

2017

Stakeholder

University

Technology owner/developer

University of Girona
Email:
expresso-support@bepress.com

Website:
https://www.sciencedirect.com/science/article/abs/pii/S0926669017300213

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000762.

Conversion of agricultural waste fibers into biodegradable food packaging

Technology name
karnalprocess

Problem statement
High prodution of banana, Cassava and other agricultural wastes.

Executive summary
Buying of banana wastes, Cassava wastes and other agricultural wastes from farmers to produce bioplastics for food packaging.

Technology description
Hya Bioplastics creates bio-based and 100% home compostable food packaging that provides a cost competitive alternative to petroleum-based plastics. They use Cassava starch and pulped fibers from banana pseudo stem as a key raw materials to make a range of food packaging including fruit and vegetable trays, takeaway food boxes and disposable plates. Hya Bioplastics are actively working on patenting this technology within Africa and licensing it as an additional revenue stream.
The business model is that they pay farmers for their undervalued banana pseudo-stem waste, providing them a valuable additional source of income. Moreover, they provide an alternative market for abundant commodities; Cassava is an undervalued, drought-resistant and widely grown crop in Africa. Cassava is a crop that is grown in 40 of the 53 African countries and it sells at half the price of alternative starches like cornstarch. They are offering additional markets for an abundant crop to prevent the losses farmers are currently making.

Market deployment considerations
High costs in relation to research & development.
Regulation and production certification. Moreover, availability of raw material could also be a handicap sometimes.

Environmental considerations
Sourcing of banana stem waste from farms to our processing centers. This would require setting up the processing centers as close to the waste as possible.
Large scale sourcing of high quality and consistent Cassava starch is a challenge.

Technology feedstock
banana leaves, banana pseudo stems, cassava starch, corn stover, potato peelings

Type of process
composting

Technology output
biodegradable bags, biodegradable food packaging

Scale
Community, manually powered scale. Community

TRL
8

Countries
Uganda

Year
2019

Stakeholder
Private sector

Technology owner/developer
Hya Bioplastics
Email:
hyabioplastics@gmail.com

Website:
http://www.hyabioplastics.com

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000762.

Paper production from tomato and pepper crop wastes

Technology name
karnalprocess

Problem statement
This waste is currently landfilled or used for composting. As it is produced in large quantities, they have a high environmental impact due to the transport required for their management.

Executive summary
The technology has been developed by the Dutch company Shutpapier through the "Valorise" process, marketing the paper produced through VELPA B.V. The paper is produced from fibres extracted from waste and can be used for packaging vegetables, seeds, etc., providing a circular economy approach.

Technology description
The first step is a cleaning and grinding of the waste, similar to what wood undergoes when it is used as raw material for paper. The resulting pulp is pressed and then dried. No coating is applied, making it suitable for common printing processes. A regional component is promoted so that waste treatment is carried out in a decentralised manner. The paper obtained can be either 125 or 250 g. and can be used for all types of office supplies as it can be folded and is suitable for laser and offset printing. This paper with tomato plant fibres was chosen in 2015 by CEPI, the Confederation of European Paper Industries, as one of the twenty most innovative products in the pulp and paper industry.

Market deployment considerations

Environmental considerations

Technology feedstock
tomato waste, pepper crop waste

Type of process
drying

Technology output
paper

Scale
Village

TRL
9

Countries
Netherlands

Year
2019

Stakeholder
Private sector

Technology owner/developer
VELPA B.V

Email:
welck@steinbeis-europa.de

Website:
https://ec.europa.eu/research/participants/documents/downloadPublic?documentIds=080166e5adf221c6&appId=PPGMS

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000762.

Production of an eco-insulating material using tree bark

Technology name

karnalprocess

Problem statement

Wood bark, produced in large quantities in sawmills, is often used to produce energy in inefficient and CO2-intensive processes, composting or landfilling.

Executive summary

Technology for the development of an eco-insulation through compression processes with insulation capacity similar to that of artificial insulators and a higher specific heat than traditional materials based on foam or fibres. Its main added value is its environmental sustainability with a neutral CO2 footprint.

Technology description

The raw material to be used (wood bark) is low cost and, depending on its typology, will require a specific optimum compression level. Specifically, the bark is pre-dried below 20% moisture content, granulated and finally dried to 6-9% moisture content. An adhesive based on a dilution of urea formaldehyde mixed with an aqueous solution of ammonium sulphate as a catalyst is added and then the resulting material is compressed to the desired density, the optimum being 350kg/m3. In case of medium production volumes, low production costs can be achieved. The most energy-demanding processes of this technology would be drying and transport, so it is important: (1) quality inputs, which should be protected from the weather; and (2) design regional/local production nodes to reduce transport costs. Similar products are already available on the European market, and in the case of these eco-insulators, the comfort they provide in residential and municipal buildings is also of interest, as vapour can pass through them, making them highly suitable as interior insulation.

Market deployment considerations

Separate processing nodes would mean high transport costs

Environmental considerations

Bark must not be stored outdoors.

Technology feedstock

woody waste

Type of process

drying

Technology output

biodegradable films, biofilms

Scale

Farm or community

TRL

6

Countries

Hungary

Year

2019

Stakeholder

University

Technology owner/developer

University of Sopron

Email: customerservices@ioppublishing.org

Website: https://iopscience.iop.org/article/10.1088/1755-1315/307/1/012007

Horizon 2020
European Union Funding
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ORIBAGS Ecopulping and Packaging Technology

Technology name

karnalprocess

Problem statement

There are numerous bioresources in Africa that remain discarded or underutilised. Over 90% of materials are dicarded, dumped, incenerated or burned.

Executive summary

Manufacture of paper, packaging, stationary and other products.

Technology description

The company turns agricultural by-products and other paper waste into decorative and professional paper stationery, manufactured in harmony with nature and personalized to the client's needs. After drying the paper, it has to be smoothen. If it dries under normal sun, the paper will be very hard and strong and so we use rollers to smoothen, making the paper smooth. Then comes a step of measurements, according to the standard size of a client needs. And then, they do the printing because they must be personalized according to the clients address, logo, or a specific trendy word that you need on the Eco bag.

Market deployment considerations

Biobased technologies remain underdeveloped in Africa. there is lack of knowledge and awarenesss about use of biobased products in Africa

Environmental considerations

Transportation of materials from farms, lifecycle assesment of products, etc.

Technology feedstock

agri-residues

Type of process

drying

Technology output

gift bags, paper, paper board

Scale

Community

TRL

9

Countries

Uganda

Year

2009

Stakeholder

Private sector

Technology owner/developer

ORIBAGS Innovations (U) Ltd
Email:
info@oribags-innovations.com

Website:
https://paulndiho.com/2011/12/14/a-ugandan-company-oribags-innovations-is-turning-agricultural-waste-into-eco-bags-2/

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000762.

Production of biodegradable bicycle lubricant from sheep hair

Technology name
karnalprocess

Problem statement
Every year, bicycle users apply about 24 million litres of oil to their bicycle chains to lubricate them, polluting the environment.

Executive summary
Bicycle chain lubricants are produced from petroleum. Eco Sheep™ is a biodegradable lubricant, obtained from the sheep's summer coat. The wool is washed and the lanolin is removed by degreasing. This is mixed with vegetable oils and used as a lubricant.

Technology description
Sheep naturally produce lanolin, an oil they secrete in their wool to protect their bodies against moisture and weather. Eco Sheep™ is a fully biodegradable lubricating oil made from this lanolin extracted from sheep's wool. Sheep are sheared in summer and their wool is degreased by washing it in hot water and scrubbing it with either a soapy substance or a volatile solvent. In addition, Eco Sheep™ uses a mixture of other vegetable oils together with lanolin to produce this lubricant. The problem raised by the company is that every year around 24 million litres of petroleum are used as lubricant for bicycle chains, contaminating soil and water, causing a means of transport that respects the environment to end up affecting it. This is why it has developed this 100% biodegradable and non-toxic lubricant.

Market deployment considerations

Environmental considerations

Technology feedstock
sheep wool

Type of process
concentration, extraction, purification

Technology output
lipids

Scale
Farm

TRL
9

Countries
United States

Year
2016

Stakeholder
Private sector

Technology owner/developer
Harper & Hopkins, LLC
Email:

Website:
https://store.ecosheep.com/

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000762.

Use of Ligninolytic Micro organisms

Technology name

karnalprocess

Problem statement

Feed resources in the tropics are high in fiber and low in digestibility, due mainly to non-polysaccharide components. There is therefore need to increase their feeding values by biological treatments to improve the nutritional quality of these feed resources.

Executive summary

This technology subsumes the use of white-rot; Brown-rot and soft rot fungi. White rot fungi are capable of degrading lignin without affecting much of cellulose and hemicelluloses, while Brown rot fungi preferentially attack cellulose and hemi-cellulose. Soft-rot fungi leaves the attacked lignocellulosic material watery-soft and breaks down cellulose and hemicelluloses.

Technology description

Fungal strains are collected from the surrounding and maintained on solid media (for example Potato Dextrose Agar, Formedium, Hunstanton- UK) and stored at room temperature. The dose of application of fungus to feeds varies. In one such treatment, Montañez-Valdez et al. added 250 g of the Pleurotus djamor strain to a 10 kg of maize stover packed by polyethylene bag. The wheat grain spawn of two Pleurotus fungi including P. florida (PF) and P.ostreatus (PO), are used to inoculate the straw, at the rate of 3.5 kg spawn per 100 kg straw fresh weight basis. The nutritive value of low-quality feeds, which has been widely reported using rape straw, wheat straw, rice straw, and corn Stover and sugarcane bagasse can be greatly enhanced using this technology.

Market deployment considerations

Palatability of feed; acceptability by livestock farmers and scaling up challenges after on-farm trials

Environmental considerations

Identification and culture of safe fungi

Technology feedstock

agri-residues, straw

Type of process

fermentation

Technology output

feed

Scale

Farm, Village

TRL

9

Countries

Ethiopia, India, People's Republic of China

Year

2020

Stakeholder

Research and Technological Center

Technology owner/developer

Bahir Dar University, Ethiopia
Email:
bduinfo@bdu.edu.et

Website:
Bimrew Asmare (2020). Biological treatment of crop residues as an option for feed improvement in the tropics: A review. Department of Animal Production and Technology, College of Agriculture and Environmental Sciences, Bahir Dar University, Ethiopia Anim Husb Dairy Vet Sci, doi: 10.15761/AHDVS.1000176

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Vegetable Granules for Vibratory Finishing, Polishing, Sandblast

Technology name
karnalprocess

Problem statement
High production of agriwastes that can become an environmental problem.

Executive summary
Main aim is to valorise agri-food wastes and transforming them in materials used in sand blasting, deburring and polishing as well as additives in many industrial production processes for machining metals, animal feed and restoration work.

Technology description
Granules from hazelnuts, almonds, corn cobs, etc. are produced and used for the following applications:

Products made from different annually renewable raw materials (hazelnuts, almonds, corn cobs, etc.): these fibrous materials are ground to the grain size wanted by the user and are used for sand blasting, deburring, and polishing as well as additives in many industrial production processes for machining metals, animal feed and restoration work.

Soft sandblasting: hazelnuts, almonds, corn cobs, etc. are used for removal of carbon residues and encrustations on metal parts of engines, reactors, metal dies for foundries, moulds for rubber and plastic materials. They don't corrode the metal, so it does not alter the dimensions, finishes or edges of the parts. They are used for removal of unwanted parts on valuable wood beams, statues, monuments, tombs, works of art. Also as a softener for processing in the tannery, fabric, and leather industries.

Deburring objects: the granules of hazelnuts, almonds, corn cobs, etc. are coated with abrasive pastes and are used widely in vibro-finishes and barrelling in various sectors (metal and alloy, plastic material, spectacles, silverware, and gold smithery industries).

Fillers and additives (mixed with resins): for foundry models and for industries that manufacture resins, sealants, and adhesives.

Zootechny and supplements: fibrous support for chemical-pharmaceutical industries that manufacture supplements for zootechny. The granules can be coated with active substances, allowing the user to obtain powder-free granular medicinal products.

Organic Mix for fertilizers and agrochemicals: the granules, as absorbents, may incorporate nutrients

Technology feedstock
almonds, corn cobs, hazelnuts

Type of process
grinding

Technology output
bioadditive, biofertiliser, biomaterial

Scale
Community

TRL
9

Countries
Italy

Year
2010

Stakeholder
Private sector

Technology owner/developer
Agrind
Email:
info@agrind.it

Website:
https://www.agrind.it/en/portfolio/project-number-12/

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and healing principles for different types of agrarian crops.

Market deployment considerations

These technologies are modulable and scalable, as well as used at local or regional level, therefore, very replicable technologies.

Environmental considerations

Feasibility studies with different biomasses should be made.

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Removal of synthetic dyes from wastewater using rice biomass

Technology name
karnalprocess

Problem statement
Rice is grown in more than 75 countries, with annual paddy production amounting to 80 million tonnes, representing 20% of whole rice.

Executive summary
By using rice husks as a bioadsorbent, tartrazine yellow and brilliant blue FCF (both synthetic azo dyes), among others, are removed from wastewater from the agri-food, textile, leather and paper industries.

Technology description
In general, wastewater contains dye concentrations ranging from 10 to 200 mg/L. In its use as a bioadsorbent, rice husk is ground and sieved in order to obtain homogeneous particle size (>50μm). The screenings are washed and dried at 60°C in order to remove adhering organic matter. The adsorption process for both dyes is highly pH-dependent, being favoured at pH 2. The adsorption capacity of rice husk increases with increasing dosage of adsorbent material and initial adsorbate concentration. Regarding the contact time, this is independent of the initial concentration, reaching a constant adsorption after 60min and 90min of contact between the Brilliant Blue FCF and Tartrazine on the rice husk, respectively, for an adsorbent dose of 1.4g. The process is carried out at room temperature.

Market deployment considerations

Environmental considerations

Technology feedstock
rice husk

Type of process
grinding

Technology output
purified effluent

Scale
Farm or community

TRL
4

Countries
Portugal

Year
2018

Stakeholder
University

Technology owner/developer
Polytechnic Institute of Leiria

Email:
contact@docplayer.es

Website:
https://docplayer.es/95515214-Remocion-de-colorantes-sinteticos-de-las-aguas-residuales-de-la-industria-alimentaria-usando-como-material-adsorbente-biomasa-de-arroz.html

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000762.

Fish protein hydrolysate from fish farming wastes

Technology name
karnalprocess

Problem statement
Aquaculture production generates waste in the form of discards and effluents, to which must be added the mortality of aquaculture individuals, amounting to ~4% of production.

Executive summary
Fish protein hydrolysates are the result of enzymatic or chemical hydrolysis of the protein fraction of fish or fractions such as muscle, by-products or process waters, presenting interesting properties from a technological and sensory point of view.

Technology description
Hydrolysates can be obtained from any type of fish (whole or by-products). Mainly from muscle or protein-rich fractions. No pre-processing is necessary, although it is advisable to carry out a concentration to reduce transport costs. The raw material must be stored refrigerated or frozen and histamine production must be carefully controlled. The first step is grinding, followed by hydrolysis. After this, the product is sieved to obtain on the one hand the discarded bones and on the other hand the stream with the fish protein, which is centrifuged. From this stage, on the one hand, oils/emulsion is obtained and on the other hand, after a final drying stage, the fish protein hydrolysate. It is typically a cream-coloured powder with a fishy odour. It has about 80 % protein and less than 5 % moisture and less than 11 % fat. There are two types of presentations: soluble fish protein hydrolysate and partially hydrolysed protein.

Market deployment considerations

Environmental considerations

Technology feedstock
fish by-products, fish waste

Type of process
chemical hydrolysis, enzymatic hydrolysis

Technology output
fish protein hydrolysate, protein

Scale
Village, Community

TRL
9

Countries
Spain

Year
2018

Stakeholder
Private sector

Technology owner/developer
AZTI Tecnalia
Email:
info@azti.es

Website:
https://www.azti.es/wp-content/uploads/2018/12/AZTI_guia_VALACUI101218online.pdf

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Livestock feed production from fish by-product silage

Technology name
karnalprocess

Problem statement
The increase of fish by-products (tissues, viscera, etc.) in the processing industry generates a large environmental impact by promoting the proliferation of harmful bacteria. Poultry slurry is a problem on farms as it accumulates, affecting the quality of life of poultry and entailing significant costs in management and disposal.

Executive summary
A liquefaction process prepares the fish for ensiling. This occurs due to the presence of enzymes naturally present in the fish, and is accelerated by the acid, creating suitable conditions for the enzymes to break down the tissues, while limiting the growth of harmful bacteria.

Technology description
Fish silage can be made from all fish species and their respective parts separately. The final quality of the silage depends on the degree of freshness of the raw materials. The fish by-product silage process is based on the liquefaction of raw materials such as fish viscera and skin. It starts with grinding, followed by an acidification process, where acids, enzymes and lactic acid producing bacteria are added to break down the tissues. The mixture is then shaken to homogenise the medium. Finally, this mixture is ensiled and the silage product obtained is heated, centrifuged and two products are obtained, protein hydrolysate and silage oil. The former is used in aquaculture for the growth of species other than the species of origin and as an organic agricultural fertiliser. The resulting oil is used for biodiesel production.

Market deployment considerations

Environmental considerations

Technology feedstock
fish by-products, fish waste

Type of process
liquefaction

Technology output
fish silage

Scale
Village, Community

TRL
6

Countries
Spain

Year
2018

Stakeholder
Private sector

Technology owner/developer
Azti tecnalia
Email:
info@azti.es

Website:
https://www.azti.es/wp-content/uploads/2018/12/AZTI_guia_VALACUI101218online.pdf

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000762.

Feed formulation/mixing

Technology name
karnalprocess

Problem statement
The use of low-quality forage, such as cereal stover, as the major feedstuff in ruminant diets can limit both energy density and intake.

Executive summary
Supplementation of low-quality forage with legumes will increase diet utilization to some extent, but for higher levels of production, increased dietary energy density through the use of higher quality forage and some grain may become of interest to livestock producers. Legume fodder such as cowpea can remain an important part of these higher energy diets.

Technology description
Cowpea (Vigna unguiculata [L.] Walp.) is an annual legume grown throughout the semiarid tropics, where it is valued as both human and livestock food. It is drought tolerant, can be grown on relatively poor soils, and fixes nitrogen, thereby improving soil fertility. In addition to grain, cowpea can produce good yields of fodder for ruminant feeding systems. In Africa, cowpea is widely intercropped with maize, sorghum and millet. Cowpea is intergrated with sorghum to boost the nutritional component. This is done by having the cowpea cut into small pieces by the chaff cutter and mixed in a feed miller. An animal nutritionist is needed to determine the inclusion rates. A Near infra red machine for nutritional analysis is also needed.

Market deployment considerations
The product is safe to be deployed in the market.

Environmental considerations
Environmental friendly

Technology feedstock
cowpea, sorghum

Type of process
milling

Technology output
livestock feed, protein

Scale
Community

TRL
9

Countries
Nigeria

Year
2005

Stakeholder
Research and Technological Center

Technology owner/developer
ILRI and IITA

Email:
ILRIdataprivacysupport@cgiar.org

Website:
https://cgspace.cgiar.org/rest/rest/bitstreams/886f96f2-65ee-4fa1-81c7-65a6281a28e9/retrieve

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Development of functional materials from natural fibres

Technology name
karnalprocess

Problem statement
Agricultural waste entails a management cost that represents an environmental impact. Moreover, society is demanding new materials made from less toxic compounds.

Executive summary
The technology developed produces functional materials through the use of natural fibres and bio-resins, which avoids the use of chemical additives/adhesives. Two types of materials have been developed, STRAWave and TRAshell, and it is possible to use straw or coconut fibres.

Technology description
The technology has been developed by the BioMat/ITKE - Faculty of Architecture at the University of Stuttgart. The products are made from recycled natural agricultural fibres combined with thermosetting bio-resins. The natural fibres are ground and combined separately with the bio-resins and moulded in a closed vacuum press in custom-designed moulds to achieve the required final shape pattern. In the case of STRAWave, different wave and colour designs were applied. The products can be used in non-structural façade cladding systems and interior cladding. STRAWave panels measure around 400 x 400 mm. In the case of TRAShell, this is a 300x 300 x 300 x2-5 mm carcass with glossy additives applied to suit exterior façade use. The business model is based on licensing, available to industrial partners in the fields of interior architecture, automotive interiors, plastics industry and wood composites. The process can be "do-it-yourself" and does not require specific training or high operating costs.

Market deployment considerations

Environmental considerations

Technology feedstock
agri-residues, corn cobs, corn stover, cotton feed stocks, crop residues, straw, waste fibres, wheat straw

Type of process
moulding

Technology output
biofibres

Scale
Farm

TRL
9

Countries
Germany

Year
2019

Stakeholder
University

Technology owner/developer
BioMat/ITKE - Fac. Arquitectura - Univ. Stuttgart
Email: info@materialdistrict.com

Website: https://materialdistrict.com/material/strawave/

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000762.

Pelletising- Use of cassava in livestock and aquaculture feeding programs

Technology name

karnalprocess

Problem statement

Despite recognized nutritional shortcomings, all parts of cassava can be successfully used in livestock and aquaculture feeding programs. Various studies document the replacement value of processed cassava root/ peels as an energy ingredient when paired with appropriate nitrogen sources, substituting for maize at up to ~40% of total diets in cattle, 20 to 50% in small herbivores (goats, sheep, rabbits), and up to 100% in swine diets, 10 to 40% in various poultry diets, and 15–30 to 60% in aquaculture diets (depending on species/age). Further, in aquaculture, cassava starch acts as a natural pellet binder.

Executive summary

On a global scale, cassava (Manihot esculenta) represents both an important human food resource and, in many regions, an underutilized animal feed ingredient. Cultivated in tropical/subtropical environments, cassava can be grown on marginal lands; it is relatively drought-hardy, and all parts of the plant can be utilized; and its roots comprise an energy staple in many regions. In recent years, the African continent produced ~60% of the global cassava crop (256 million tonne) through targeted efforts to develop improved varieties; yet only a small fraction is utilized for animal feeding programs throughout Africa. Potential for increased utilization is vast, particularly of unused or underused fractions and residues such as peels.

Technology description

The first step is usually washing, followed by peeling, drying and pelletizing.The key innovation is to grate the peels, and then squash them in a hydraulic press to rapidly remove the liquid.The process produces a kind of 'cassava peel cake', which is then grated again, forming particles of uniform size, which dry out in a matter of hours. The resulting product - called "High Quality Cassava Peels" or HQCP -- has just 10-12 percent moisture content and keeps for six months.

The high-fibre coarser particles can be separated out for pig and ruminant feed, while the higher-protein finer particles can be given to poultry (Drying, fermentation and enzyme treatments improve utilization of cassava peel fractions for monogastrics and polygastrics). Dryers, hydraulic press machine and pelletizing equipment needed.

Market deployment considerations

Cassava use as livestock feeds reguires pre-treatment before being fed to livestcok due to presence of antinutritive factors.

Environmental considerations

The byproducts are safe to the environment

Technology feedstock

cassava starch, potato peelings, cassava peels

Type of process

pelletising

Technology output

feed, livestock feed, poultry feed

Scale

Village, Community

TRL

9

Countries

Nigeria

Year

2014

Stakeholder

Research and Technological Center

Technology owner/developer

ILRI

Email:
ILRI-Kenya@cgiar.org

Website:
https://www.ilri.org/publications/use-cassava-livestock-and-aquaculture-feeding-programs

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Densified Total Mixed Ration Blocks

Technology name
karnalprocess

Problem statement
Feed is the major input cost for livestock production. Poor nutrition of animals has been identified as the major constraint to animal production across the developing world (FAO, 2000) chiefly due to
1. an acute shortage of feed resources.
2. lack of efforts to increase green forage production and to improve the management of degraded and unmanaged pastures.
3. Improper management of feed resources, especially that of the bulky and fibrous crop residues, and wastage through burning
Thus, there is an urgent need to optimize the use of the limited feed resources, especially straws for ruminant feeding.

Executive summary
The first step in the process of making straw-based feed blocks is the grinding of concentrate ingredients, followed by their mixing and addition of the feed additives. This is then followed by mixing of these ingredients and straw in proper proportions along with addition of molasses in a specifically designed TMR mixer, taking care that mixing is uniform and ingredients are not separated due to gravity. Finally, the weighed quantity of the mixed stuff is transferred into a hydraulic press to get the final product – the DTMRB.

Technology description
A grinder (hammer mill) and a mixer are required for making a normal concentrate mixture. A specially designed TMR Mixer is required for mixing weighed quantities of low density crop residue (straws, stovers, bagasse, dried forest grasses, dried tree leaves etc.) and the high-density concentrate. Molasses and any other liquid feed additive are also added at this stage. The mixing is done through vertical motion, so that there is no separation due to gravity. Weighed quantity of the mixed ingredients is transferred into densification machine (Works on the principle of hydraulic compression) which compresses the forage and concentrate mixture into densified complete feed block.

Market deployment considerations
Market is available. Issues of storage and binding material used

Environmental considerations
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Technology feedstock
straw, wheat straw, corn stover, cotton feed stocks, soy

Type of process
pelletising

Technology output
animal feed

Scale
community

TRL
9

Countries
India

Year
2012

Stakeholder
Research and Technological Center

Technology owner/developer
National Dairy Research Institute, Karnal, India
Email:
support.it@icar.gov.in

Website:
FAO. 2012. Crop residue based densified total mixed ration – A user-friendly approach to utilise food crop by-products for ruminant production, by T.K. Walli, M.R. Garg & Harinder P.S. Makkar. FAO Animal Production and Health Paper No. 172. Rome, Italy.

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Uromin lick (UML)/urea-molasses-multi-nutrient blocks (UMMB)

Technology name

karnalprocess

Problem statement

An assessment of the nutritional status of dairy animals showed these animals were being offered highly imbalanced diets, deficient in protein; energy and minerals. The deficiency in minerals and salt reflected in the reproductive problems of animals in these areas.

Executive summary

UMMB is a convenient and inexpensive method of providing a range of nutrients to animals. It can improve the digestion of low-quality roughages by satisfying the requirement of rumen microorganisms, creating a better environment for fermentation and increasing production of microbial protein and volatile fatty acids. Urea, after hydrolysis to ammonia in the rumen, provides a nitrogen source for the rumen microbes, while molasses acts as a source of readily-fermentable energy.

Technology description

The conventional UMMB weighing 3 kg contains (g): molasses 900, urea 300, mustard cake 300, de-oiled rice bran 300, wheat flour 450, mineral mixture 450, calcium oxide 120, salt 120 and guar gum 60. The required quantity of molasses and urea are weighed and mixed in a 25 kg capacity iron pan. The guar gum is added to the urea-molasses mixture as a binder. A premix of other ingredients is prepared; calcium oxide is the last ingredient to be added to this premix in the iron pan with rapid stirring. Two to eight UMMBs may be prepared at a time, either in a manually operated (for small/marginal/landless dairy farmers) or electrically powered (for commercial production) block-making machine.

Market deployment considerations

Market is available

Environmental considerations

The hardness of the blocks affect intake

Technology feedstock

agri-residues

Type of process

pelletising

Technology output

animal feed

Scale

Community

TRL

9

Countries

India

Year

2011

Stakeholder

Research and Technological Center

Technology owner/developer

National Dairy Research Institute, Karnal, India
Email:
support.it@icar.gov.in

Website:
FAO. 2011. Successes and failures with animal nutrition practices and technologies in developing countries. Proceedings of the FAO Electronic Conference, 1-30 September 2010, Rome, Italy. Edited by Harinder P.S. Makkar. FAO Animal Production and Health Proceedings. No. 11.

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Rome, Italy.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000762.

Valorisation of non-food-grade milk by casein extraction and conversion

Technology name

karnalprocess

Problem statement

One hundred million tonnes of milk are discarded annually because it is considered unfit for food consumption (due to thermal degradation, cellular problems or germs).

Executive summary

In a simple process, casein is extracted from milk and processed without the addition of chemicals to obtain various products such as biopolymers (automotive, clothing, home textiles, cosmetics or medical applications).

Technology description

Casein (milk protein) is produced through a precipitation process and then plasticised with water at moderate temperature in a continuous kneading process. The resulting biopolymer is pressed through a spinner in a melt spinning process. Since the process takes place at less than 100°C, the special properties of the milk can be maintained (the resulting products being suitable for people with allergies and topical problems). The production of 1 kg of biopolymer takes place in 5 minutes and requires 2 litres of water. The products are marketed by the company QMILK. Used in cosmetics, it is produced in the form of micro beads, being antibacterial and hypoallergenic for skin cleansing. Used in the textile field, it is antibacterial, self-regulates temperature and absorbs moisture. As a functional material, it can be produced in granules or in sheets/films. In general, the product resulting from the process is free of isocyanate, halogens, solvents, hazardous plasticisers, silver, triclosan and zinc oxide.

Market deployment considerations

Environmental considerations

Technology feedstock

milk waste

Type of process

polymerisation

Technology output

biopolymer

Scale

Farm

TRL

9

Countries

Germany

Year

2014

Stakeholder

Private sector

Technology owner/developer

QMILK

Email:
financial@theguardian.com

Website:
https://www.theguardian.com/sustainable-business/sour-milk-fibres-textiles-qmilk

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Melt compounding of agri-food wastes biomass

Technology name
karnalprocess

Problem statement
Global needs of researching and developing bioplastics from agri-wastes.

Executive summary
This technology produces bioplastics and biodegradable plastics to valorise agricultural wastes.

Technology description
The proposed solution is a series of physical process, starting with drying and grinding the agricultural wastes. Then adding them to an extruder with thermoplastic polymers (it can be a biodegradable thermoplastic polymers). Then, inside the compounding line, where the input is mixed, temperature increases, and the heated mixture comes out of the machine as a combined biopolymer or bioplastic.

Market deployment considerations
This technology is modulable, the main machine is an extruder, that melts and binds different compounds. It favours to use local agri-wastes and use them for bioplastics making. To reach the amount of biomass needed to be feed to the machine (extruder).

Environmental considerations
Biopolymers can be composted if they are bio-compostable, although their market price is higher than the non-compostable ones.

Technology feedstock
agri-residues, corn cobs, rice husk, waste fibres

Type of process
polymerisation

Technology output
bioplastics, biopolymer

Scale
Village, Community

TRL
9

Countries
Italy

Year
2000

Stakeholder
Private sector

Technology owner/developer
Proplast

Email:

info@proplast.it

Website:

https://www.mdpi.com/2073-4360/13/9/1471

https://www.proplast.it/technical-services/materials-engineering/

https://journals.scholarsportal.info/details/02540584/v180icomplete/284_rbmaeppcpapt.xml

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Conversion of cotton waste into biodiesel and animal feed

Technology name
karnalprocess

Problem statement
Energy shortage in Kenya.

Executive summary
Conversion of cotton waste into biodiesel to power vehicles, the factory and farm machinery.

Technology description
It is a chemical process through which the waste oil is converted into biodiesel and the solid in animal feed. The industry operates on a commercial level with a production capacity of 10.000 Litres per month of biodiesel and 70 tons of animal feed with a market of 1.200 farmers and 3 institutions including the United Nations in Nairobi. It produces high quality fuel and animal feed, through a simple process, in areas with adequate feedstock. It can be developed further for glycerine extraction and detergent production.

Market deployment considerations
It produces high quality fuel and animal feed, through a simple process, in areas with adequate feedstock.

Environmental considerations
No, it is already working and is having a positive impact on the community. With more feedstock it can be scaled rapidly.

Technology feedstock
cotton seeds

Type of process
biorefinery, refining

Technology output
animal feed, biodiesel

Scale
Community

TRL
9

Countries
Kenya

Year
2013

Stakeholder
Private sector

Technology owner/developer
Zayn Agro Industries Limited
Email:
zaynagro@cotton-africa.com

Website:
https://www.reuters.com/article/kenya-farming-environment-idUKL4N233366

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000762.

SMARt-CHP (1)

Technology name
karnalprocess

Problem statement
Demonstrate an innovative, small-scale, mobile power production unit, which uses the agricultural residues generated in rural areas.

Executive summary
The SMARt-CHP prototype is a mobile and modular 5kWel and 12 KWth CHP unit that fits in the size of a container and combines the technologies of gasification and internal combustion engines.

Technology description
The SMARt-CHP unit consists of a gasification reactor combined with an internal combustion engine and adjusted to work on producer gas for electrical power and heat. The unit was built in Thessaloniki and transported to the premises of the two associated beneficiaries. The feedstock was made up of grape, peach and olive kernels that had been collected from the region of Western Macedonia. The unit has operated for more than 3000 hours with a variety of solid waste streams from agro-industry such as grape pomace, olive and peach kernels, almond shells etc. Also, the unit would operate close to the place of feedstock origin, thus minimising transportation and logistic costs.

Market deployment considerations
Residual biomass can constitute an extra income for farmers based on the current market prices of electricity and heat, while simultaneously contributing to CO_2 emissions reduction and ecological impacts on the environment.

Environmental considerations

Technology feedstock
agri-residues, food waste, plant waste, straw, wheat straw, wood chips, woody waste

Type of process
thermal process

Technology output
biochar, electrical energy, heat

Scale
Farm

TRL
6

Countries
Greece

Year
2012

Stakeholder
University

Technology owner/developer
Aristotle University of Thessaloniki
Email: contact@bio2chp.com

Website: http://www.bio2chp.com/

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for Research & Innovation

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Valorisation of mango waste for healthy bakery products

Technology name

karnalprocess

Problem statement

The world's high mango production produces by-products (peel and seeds) during processing, which have no commercial value and are also a problem of contamination.

Executive summary

Basic physical techniques such as drying and sieving can produce a powder from mango wastes, rich in antioxidants and dietary fibre, suitable for human consumption. This technique focuses on producing additives for healthy bakery products that reduce the glycaemic index after consumption.

Technology description

After the mango is squeezed to extract the pulp, the peel, the bagasse and its seed remain, which are equivalent to 35-65% of the initial weight of the fruit. Mango peel is rich in dietary fibre (pectin, cellulose and hemicellulose), proteins, reducing sugars, bioactive compounds such as carotenoids, vitamin C and phenolic compounds. These by-products are dried at 60ºC for approximately 24h, using a convection oven with air circulation. After drying, they are ground to a fine powder which is then sieved through a 150 micron sieve. This powder is added as a supplementary flour together with the baker's flour and yeast in the 'dry' dough mix. The baking of the bakery product (muffin, cake, sponge cake...) follows the conventional steps. The consumer, after ingesting the muffin enriched with phenolic substances (difficult to digest and insoluble substances) decreases the rate of starch hydrolysis and may modulate the postprandial glucose response in vivo.

Market deployment considerations

Applicability at pilot scale is not demonstrated

Environmental considerations

Technology feedstock

mango by-products

Type of process

thermal process

Technology output

fortified food ingredients

Scale

Farm

TRL

6

Countries

Mexico

Year

2014

Stakeholder

University

Technology owner/developer

Technological Institute of Tepic, Integral Laboratory of Food Research

Email:
expresso-support@bepress.com

Website:
https://www.sciencedirect.com/science/article/pii/S0963996915000861?via%3Dihub

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European Union Funding
for Research & Innovation

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Torrefaction of wheat stubble into pellets for solid biofuels

Technology name
karnalprocess

Problem statement
The high domestic consumption of firewood produces a high level of pollution, producing wheat stubble. The habitual practice of burning wheat stubble also contributes to this pollution.

Executive summary
Wheat stubble biomass has an irregular size, low density and low calorific value, among others. By means of a torrefaction process (thermal process carried out at moderate temperatures in an inert environment), a significant increase in retained energy and calorific value was obtained at moderate operating conditions below 150°C.

Technology description
Wood biomass is a fuel widely used for domestic heating. This high consumption of wood directly affects air pollution and usually people are exposed to concentrations of Particulate Matter below 2.5 µm (PM2.5) above 20 mg/m3. Some countries are currently investing in the generation of pellets as an alternative to forest biomass, as wheat stubble can be abundant. Moreover, the usual practice for eliminating this stubble is burning, which generates a great environmental impact. Despite the unpromising characteristics of this biomass (irregular size, low density, low calorific value, among others), the Universidad de la Frontera has optimised a torrefaction process (a thermal process carried out at moderate temperatures in an inert environment) to generate pellets from wheat stubble. The pellet (black pellet) produced at pilot scale with this torrefied biomass was characterised according to the European standard ISO 17225-1 (2014). An increase in bulk density from 469 kg/m3 to 568 kg/m3 was achieved due to the torrefaction pre-treatment.

Market deployment considerations

Environmental considerations

Technology feedstock
straw, stubble wheat

Type of process
thermal process

Technology output
biochar, pellets

Scale
Farm

TRL
9

Countries
Chile

Year
2017

Stakeholder
University

Technology owner/developer
Universidad de la Frontera, Temuco-Chile
Email: comunicaciones@ufrontera.cl

Website: https://www.avebiom.org/sites/default/files/BIE/BIE_37-Septiembre_2017.pdf

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Nutrient recovery from livestock by-products by thermochemical process (pyrolysis)

Technology name

karnalprocess

Problem statement

The direct agricultural use of by-products of the livestock industry with protein content provides a high environmental risk due to possible trans- and recontamination by human and animal pathogens.

Executive summary

The aim of the 3R Zero emission technology is the recovery of nutrients through the valorisation of animal by-products into high-value organic phosphorus fertilisers and bio-oils by integrated thermal and biotechnological recycling means. The products are "Animal BioChar" - organic biophosphate fertiliser and NPK bioformulations.

Technology description

ABC (Animal Bone Char) - Biophosphate fertiliser is made from different types of food-grade animal bone grindings, which are heated up to 850 °C. During this advanced pyrolysis (reductive thermal processing) all volatile and protein-based substances are removed, resulting in a highly macro-porous apatite-type mineral composed of hydroxyapatite (70-76%), $CaCO_3$ (7-13%) and carbon (8-11%). The output products are of high quality and sterile and can be used for agricultural and environmental applications (adsorbents). The process is flexible in terms of the inputs to be used as it can handle a wide range of organic materials. The operational prototype has been successfully demonstrated between 2005 and 2019 and will be scaled up to an average scale of 2,500 t/year in 2020, with the next level being 20,800 t/year. In economic terms, it requires low investment and low operation and maintenance costs. Finally, there is the possibility to combine the system with biogas and composting processes. This technology has been developed with the support of the European Union through the different Framework Programmes (FP6, FP7 and H2020).

Market deployment considerations

Implementation plans in EU27, USA, Japan and Australia.

Environmental considerations

Technology feedstock

livestock waste

Type of process

thermal process

Technology output

biofertiliser

Scale

Village, Community

TRL

6

Countries

Hungary

Year

2019

Stakeholder

Private sector

Technology owner/developer

Terra Humana Ltd.
Email:
biochar@3ragrocarbon.com

Website:
https://biophosphate.net/sites/default/files/2021-02/abc_biophosphate_fact_sheet.pdf

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Obtaining bioenergy and nutrients from poultry slurry

Technology name
karnalprocess

Problem statement
Poultry slurry is a problem on farms as it accumulates, affecting the quality of life of poultry and involving significant costs in management and disposal.

Executive summary
Fluidised bed combustion produces heat energy, ash (which can be used as PK fertiliser) and electricity (when combined cycle technology is incorporated). The boiler is capable of generating a thermal output of 500 kWh, sufficient to provide hot water at 850°C required for distribution to the hatcheries.

Technology description
After the birds have been removed, the slurry is collected and taken to a bio-secure fuel storage area, kept at low negative pressure. An innovative bulk handling system called the BHSL Toploader is then used to transfer the slurry from the storage area to the combustion plant at a rate of 5 tonnes/day. This low energy system is automated, minimising interaction with the slurry and farm personnel. Fluidised bed combustion uses a heated sand bed suspended (fluidised) within a rising air column to burn slurry (and potentially many different types of biomass) at 850°C for 2 seconds, even with varying moisture content. The surplus heat is available to produce renewable energy for on-farm use or export to the grid. The biggest savings come from the consumption of propane for heating the hatchery. By removing the slurry and providing the optimum temperature, the next batch of birds thrive in the warm, dry, optimally ventilated, low ammonia conditions, gaining weight for every kg of grain fed to them. Thus, the slurry produced is drier and less smelly.

Market deployment considerations

Environmental considerations

Technology feedstock
poultry slurry

Type of process
thermal process

Technology output
thermal energy

Scale
Farm

TRL
9

Countries
Ireland

Year
2019

Stakeholder
Private sector

Technology owner/developer
BHSL Hydro
Email:
sales@bhsl.com

Website:
http://www.bhslhydro.com/how-it-works-new/

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Thermo-chemical treatment for obtaining activated carbon and synthesis gas

Technology name
karnalprocess

Problem statement
Municipal solid waste, having a diverse composition, makes the management process difficult, especially when the final step is incineration, which can result in the emission of chemical compounds.

Executive summary
An advanced modular thermal process produces synthesis gas and activated carbon. The gas is conditioned for use in power generation. The activated carbon can be reintroduced into the process as a fuel or sold as a commodity and used as a filter medium or for soil remediation.

Technology description
The process has been developed by Premier Green Energy, resulting in its Prima conversion technology, which is an integrated multi-stage process based on pyrolysis. In the initial phase, the pre-treated feedstock (drying and grinding) is fed into a kiln rotary furnace. This is preheated to 750°C±50°C and has a reduced oxygen atmosphere to prevent combustion of the feedstock. In a continuous and highly automated process, the feedstock is converted into syngas and char. In a secondary stage, the syngas is recovered and transferred to a dry gas cracking tower. In a subsequent integrated stage, the syngas is channelled into a multi-stage wet gas cleaning process (spray tower, full bed tower with dehumidifier and activated carbon filter pass). Finally, the dry, clean and conditioned syngas is fed to a gas engine and burned to generate clean, renewable electricity. The carbon stream is recovered and can be burned as fuel to instigate and maintain the pyrolysis process or can be used for alternative commercial applications.

Market deployment considerations

Environmental considerations

Technology feedstock
agri-residues, Municipal solid waste

Type of process
thermal process

Technology output
activated carbon, biochar

Scale
Farm, Village, Community

TRL
9

Countries
Ireland

Year
2017

Stakeholder
Private sector

Technology owner/developer
Premier Green Energy
Email:
info@pge.ie

Website:
https://www.pge.ie/technology/description/

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000762.

Pyrolysis, carbonization

Technology name
karnalprocess

Problem statement
High production of agriwastes that can become an environmental problem.

Executive summary
Biochar production and waste recycling.

Technology description
The feedstock is subjected to low-temperature pyrolysis (combustion without oxygen, 450-600 degrees C), as a result of which charcoal/biocharis formed

Market deployment considerations
Fully automatisation of the process

Environmental considerations
The technology is eco-friendly, so it will help to save African environment

Technology feedstock
agri-residues

Type of process
thermal process, pyrolysis

Technology output
biochar

Scale
Farm, Village, Community

TRL
9

Countries
South Africa

Year
2017

Stakeholder
Private sector

Technology owner/developer
GreenPower Ltd

Email:

greenpower@greenpower.es

Website:

https://greenpower.equipment/produkciya/continuous-charcoal-kiln-bio-kiln/

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Pyrochemy

Technology name
karnalprocess

Problem statement
High production of agriwastes that can become an environmental problem.

Executive summary
Pyrochemy is a renewable energy technology developed by PyroGenesys, it was developed as a carbon removal system for converting agricultural waste to renewable electricity, process heat & biofuels.

Technology description
Pyrochemy utilises the Pyrolysis process combined with state of the art compact containerised technology. The Pyrochemy unit has the advantage of being transportable to remote locations worldwide with ease. The Pyrochemy unit can then use waste biomass from these locations to generate electricity, heat and biofuels. The Pyrochemy process utilises Pyrolysis, the rapid heating of biomass in the absence of oxygen. Without oxygen, instead of combusting at high heats the biomass goes through pyrolysis to create energy and nutrient rich products. The pyrolysis process produces a number of products: the carbon content of the biomass is turned into biochar which can be spread on fields to increase crop yields and directly contributes to carbon sequestration. Hot syngas is also produced which can be used to drive a steam generator and steam turbine to create electricity, or it can be condensed into bio oil which can be upgraded to Kerosene or Diesel. The Pyrochemy unit is designed to use waste biomass as its feedstock. Initial configurations are for harvest waste of common staple foods such as cassava, rice, soy and groundnut. But it can be configured to any harvest waste. The Pyrochemy technology can be upscaled to fit most needs. Current scaling is focussing on rural mini grids, small-medium sized rural communities of up to 300. There is also a focus on farming communities to provide energy for farming and post farm processing equipment. These are particularly attractive as they often have large amounts of waste biomass.

Market deployment considerations
Demand: there will always be a demand for more efficient and effective power generation technologies that are capable of delivering quality power, electricity, heat and fuel, to communities that need it most. Pyrochemy can achieve this across a number of scales, its modular design means it is easy to scale up and down relevant to the communities need.

Supply: Pyrochemy requires a supply of biomass, Africa produces massive amounts of harvest waste to feed its ever growing population, to the point where some communities are being affected by the toll the waste takes on the land. Harvest waste management is ineffective and can damage what was once fertile land. The Pyrochemy solves this issue by creating a use for the waste, removing it from the community and creating incredible products which can even increase land fertility.

Technology feedstock
cassava starch, groundnut, groundnut shells, soy, cassava peels

Type of process
thermal process

Technology output
biochar, bio-oil, syngas

Scale
Farm, Village, Community

TRL
5

Countries
United Kingdom

Year
2017

Stakeholder
Private sector

Technology owner/developer
PyroGenesys LTD

Email:
admin@pyrogenesys.com

Website:
https://pyrogenesys.com/

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PyroGenesys has been part of several bioeconomy implementation projects including:

Rural Industrialization via Energy Technologies (RIVET), using Human-Centred Design (HCD) to understand how best to integrate our technology in a way that will positively change the attitude, skills and knowledge of garri frying women in the host communities in Nigeria. https://pyrogenesys.com/portfolio/rivet/

Energy Access Africa (EAA), The EAA project would ultimately ensure that even remote Sub-Saharan African communities have access to renewable power generated and distributed by PyroGenesys and our supply chain partners in Sierra Leone. https://pyrogenesys.com/portfolio/eaa/

Ethiopian Mini-grid Extensions & Energy Storage (EMEES), a Feasibility Study which will assess the viability of setting up an in-country Pyrochemy demonstration plant in Ethiopia. https://pyrogenesys.com/portfolio/emees/

Environmental considerations

The biggest impact would be shipping the unit to Africa. However, the Pyrochemy technology has the ability to offset its carbon footprint very quickly, and once on site its is incredibly efficient. As production increases, manufacturing would be moved to Africa, mitigating the environmental impacts of transport and creating local jobs in the process.

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Reuse of olive wash water in agriculture as a biofungicide

Technology name
karnalprocess

Problem statement
Olive mill wastewater is a major environmental problem due to its high organic load, phytotoxicity and antimicrobial properties. There is an opportunity to use it as a fungicide and bactericide.

Executive summary
Waste water from olive mills generated during the extraction of olive oil by traditional milling and pressing processes is considered to be an agro-industrial by-product rich in phenolic compounds. The quantities and physico-chemical characteristics depend on the used oil extraction system, the olives and the operating conditions.

Technology description
95% of the world's olive oil production produces olive mill wastes that have become a serious environmental problem, due to their high chemical oxygen demand and organic load, and because they resist biodegradation due to their high content of phenolic compounds. The phytotoxic and antimicrobial properties of olive mill wastes have been addressed as a negative attribute limiting the beneficial reuse of olive mill effluents. The valorisation of olive mill wastes is certainly more desirable than their treatment, which is usually applied with destructive methods with respect to their phenolic compounds.
The solution proposed is to used this as an addition to irrigation water. The accumulation of phenolic compounds, quinones and other compounds in plants affected by pathogens positively helps to reinforce the defence and resistance mechanisms against fungi, bacteria and other micro-organisms. Plant disease verticillosis, caused by Verticillium dahliae, is one of the most destructive plant pathogenic diseases known worldwide. Irrigation of agricultural fields with this water has proven to be an eco-friendly alternative for the protection of crops against V. dahliae.

Market deployment considerations

Environmental considerations

Technology feedstock
olive washing water

Type of process
washing

Technology output
biofungicide

Scale
Farm or community

TRL
4

Countries
Morocco

Year
2017

Stakeholder
University

Technology owner/developer
Cadi Ayyad University
Email:
expresso-support@bepress.com

Website:
https://www.sciencedirect.com/science/article/pii/S0048969716321982

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Making of packaging materials from zero carbonisation process

Technology name
karnalprocess

Problem statement
Waste is a growing problem in Uganda. Every citizen disposes at least half a tonne of trash each year. Only 55% of the solid waste generated in Kampala is collected and managed. And most Ugandan enterprises and institutions still send over 90% of recyclable materials to the landfill or incinerate them. This compromises the environment and creates pollution that lowers the quality of life for all Ugandans.

Executive summary
Circular economy model is promoted in Uganda so that people know that their waste is gold.

Technology description
The hand bags are made from agricultural products using zero carbon production process. The agricultural wastes are delivered through the waste suppliers, then it is sorted and the appropriate ones are mixed with water in carbon process and a straw board paper is developed. A multi take low zero carbon production process is used.

Market deployment considerations
Market is available

Environmental considerations
The products are enviromentally friendly

Technology feedstock
agri-residues, plant waste

Type of process
carbonisation

Technology output
biodegradable bags

Scale
Community

TRL
9

Countries
Uganda

Year
2007

Stakeholder
Private sector

Technology owner/developer
Oribag Innovations
Email:
info@oribags-innovations.com

Website:
http://oribags-innovations.com/

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Refining water void of heavy metals

Technology name
karnalprocess

Problem statement
Some water sources in Uganda especially River Nyamwamaba, in Kasese, is affected with heavy metals. This technology sets out to forestall such a challenge by ensuring that water is purfied through this biosebent technology.

Executive summary
This technology uses locally available biological materials especially agricultural waste to remove heavy metals from water and waste water. This effort alone contributes towards the acheivement of sustainable development goals 6, 11 and 13. Besides the technology provides an economical alternative for removing toxic heavy metals from industrial waste water thus aiding in enviromental remediation. The project is being implemented in Kasese, district in Nyamwamba valley and, to make the project as low cost as possible, coffee husks and cotton seed cakes are used as bisorbents.

Technology description
The removal of heavy metals is done through a physiochemical process that occurs naturally in the biomass which allows it to passively concentrate and bind its contaminants onto its cellular structure. The entire process is called bisorption and the biomass used in this application is called a biosorbent.

Market deployment considerations
No market barrier since there are few players

Environmental considerations
Ecofriendly

Technology feedstock
coffee husk, cotton feed stocks

Type of process
physio-chemical

Technology output
purified clean water

Scale
Farm

TRL
4

Countries
Uganda

Year
2015

Stakeholder
University

Technology owner/developer
Gulu University

Email:
pro@gu.ac.ug

Website:
https://gu.ac.ug/

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Production of Biodiesel from eggshells

Technology name
karnalprocess

Problem statement
Used vegetable oil can become a relevant contaminant if delivered to rivers and auriferous areas.

Executive summary
The biodiesel is green fuel produced from various sources. At NARO biodiesel is produced by converting vegetable oil into fuel. Re-use and overuse of vegetable oils results into production of compounds that can lead to cancer in human beings. Poor exposure of such oils is also a municipal catastrophe as the highly vicious oil can clog water ways and limit the flow water causing clogs and affecting municipal waste management. As such conversion of waste oil into bio diesel alleviates its overuse, provides for better waste management practices, while generating fuel that is environmentally sound. Bio diesel can be used to make animal feed making machines, small house generators, walking tractors for clearing the land.

Technology description
This technology involves the production of calcium based catalyst from egg shells and use of Cassava waste, derived from ethanol and methanol, producing biodiesel. The breakdown of this used oil, in the presence of such catalyst, produces biodiesel while the residues include glycerol-based compounds that can be further processed into glycerine or used in production of other high energy compounds such as briquettes.

Market deployment considerations
High cost for used vegetable oil and competition of the waste oil with re-users (especially roadside vendors).

Environmental considerations
The byproducts are safe to the environment

Technology feedstock
egg shells

Type of process
refining

Technology output
biodiesel

Scale
Community

TRL
9

Countries
Uganda

Year
2017

Stakeholder
Research and Technological Center

Technology owner/developer
NARO
Email:
info@narouniversitario.com.mx

Website:
https://newvision.co.ug

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Biomass Utilization by Sustainable Harvest for biochar stove - BUSH project

Technology name
karnalprocess

Problem statement
While bush encroachment constitutes an immense challenge for Namibia, it also opens significant commercial, as well as unprecedented socio-economic and ecological opportunities, with the sustainable utilization of related biomass for biochar production

Executive summary
The project titled Biomass Utilisation by Sustainable Harvest (BUSH) ran from November 2018 to July 2021. The sub-project on 'Biochar Production, Processing and Testing', looked at how biochar can create income for farmers and entrepreneurs as well as benefits for crop and rangelands.

The project developed prototypes for stoves that heat water or allow cooking while producing biochar.

Technology description
Portable stoves have been developed as prototypes that use agricultural waste, wood cuttings and native bushes as feedstock for the production of biochar. The stoves also heat water and allow cooking during their operation

Market deployment considerations
Biochar is made accessible to many Namibians. It can also be instrumental in rangeland restoration and horticulture production: adding biochar to soils can create housing for beneficial microbes, return minerals and increase water holding capacity. The optimization of the technology will continue in DIVAGRI H2020 project.

Environmental considerations

Technology feedstock
agri-residues, wood chips

Type of process
thermal process

Technology output
biochar, heat

Scale
Lab

TRL
3

Countries
Namibia

Year
2021

Stakeholder
Producers associations or cooperatives

Technology owner/developer
Namimbia University of Science and Technology (NUST)
Email:
Evert Strydom
estrydom@nust.na

Website:
https://www.nust.na/?q=news/biomass-project-impacts-namibia%E2%80%99s-bioeconomy-development
https://allafrica.com/stories/202110250631.html

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Household biogas digester

Technology name

karnalprocess

Problem statement

In Sub-Saharan Africa and especially Ghana, the use of renewable energy such as biogas is highly under-developed thus accounting for the country's over-reliance on natural gas and other fossil-based fuels for electrical power generation . It is, therefore, very crucial for Ghana to expand the production of renewable energy such as biogas from food wastes, black water (waste water comprising human faeces, urine and flush water) for both industrial and household consumption. Consequently, coming up with an innovative and good technological design for household biogas production is very imperative.

Executive summary

A household biogas digester piloted in a slum called Terterkessim in the K.E.E.A. Municipality of the Central Region of Ghana. A 2-seater toilet compartment was constructed on a pilot manually-stirred, fixed pyramidal-dome-shaped single-stage household biogas digester for a compound house of 32 persons in the Terterkessim slum. The pyramidal dome-shape biogas digester was constructed on an abandoned septic tank meant to contain faeces from the toilets. Blocks and concrete were used for the construction. The digester has a rectangular sub-surface base and a pyramidal gas holder above the surface of the soil. It also has a two-blade manual stirrer, a ball bearing affixed at the bottom and a handle to manually mix the content of the digester. A solar-photovoltaic was installed on the roof of the toilet connected to the digester to heat the content to a hyper-thermophilic condition for hygienising the digestate.

Technology description

The single-stage innovative household biogas digester constructed in Terterkessim slum composed of 3 chambers which were originally designed for a septic tank system. The septic tanks were connected to a two-unit toilet meant for that household. The first chamber was the biggest and was converted into the main single-stage household biogas digester in which the AD process occurred. It had a total volume of 8.64 m3. Adjoining the main reactor was a compensation tank which had a tunnel from the main digestion chamber. The compensation tank was about 3.17 m3. Within the compensation tank were steps designed to help with settling of particles as well as directing clear effluent to be discharged into the next chamber, the effluent collection and storage tank. The effluent collection and storage tank had a total volume of 4.52 m3. It had an effluent discharge pipe for overflow into a collection container for agricultural usage. The digester could produce about 2.52 Nm3CH4/(kgCOD.d) which could be burnt for at least 8 hours for purposes such as cooking and heating in the households in the slum.

Market deployment considerations

Environmental considerations

An average COD removal of 97.6% was recorded for the digester.

Technology feedstock

agri-residues, food waste, waste

Type of process

anaerobic digestion, thermal process

Technology output

biofertiliser, biogas, heat

Scale

Lab

TRL

3

Countries

Ghana

Year

2021

Stakeholder

Private sector

Technology owner/developer

University of Cape Coast
Email:
Isaac Mbir Bryant
ibryant@ucc.edu.gh

Website:
https://www.intechopen.com/chapters/76104

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Farm-based lignocellulosic biorefinery

Technology name

karnalprocess

Problem statement

The biorefinery approach uses farm residues to produce bio-materials and energy, without competing with food production. The focus is the production of the platform chemical hydroxymethylfurfural for biobased plastics.

Executive summary

This is a pilot research project that involves the creation of a biorefinery plant at the university's "Unterer Lindenhof" research station. The vision is to design a small-scale plant for farm use that uses both biogenic plant residues and agricultural by-products to produce a wide range of raw materials and energy sources, without competing with food production.

Technology description

In the center of the biorefinery, there is an existing biogas plant. The whole concept is demonstrated in the research station "Lindenhöfe" of the University of Hohenheim. The mass flows of the research-station, which is a farm, are used as input of the biorefinery. For the utilization of agricultural residues via the production of the bio based basic chemical 5-hydroxymethylfurfural (HMF for short) a pilot plant was built up. In this process, the carbohydrates in the (residual) biomass react in aqueous medium under pressure and elevated temperature (hydrothermal conditions) to form HMF. The different chemical-functional groups of this reactive molecule allow a variety of chemical modifications and make HMF a versatile renewable basic building block. For this reason, it is also one of the 12 most important bio based platform chemicals of the future. For example, oxidation of 5-HMF produces the platform chemical FDCA, which can replace petrochemical-based terephthalic acid (TA) in all its polymer applications. Currently, one of the best studied polymer applications is polyethylene furanoate (PEF), a high-performance bio-based polymer with excellent physicochemical properties compared to PET. This leads to lower energy requirement in further processing and thus the environmental impact. In addition, PEF has higher gas barriers by a factor of 10. The structural similarity to PET allows, in addition to single-grade recycling, the mixing with PET.

Market deployment considerations

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Environmental considerations

In the case of PEF, a saving of approx. 4.6 kg of CO_2 per kg of plastic is possible.

Technology feedstock

wood chips, grass, straw, wheat straw

Type of process

anaerobic digestion

Technology output

hydroxymethylfurfural (HMF), activated carbon

Scale

Farm

TRL

6

Countries

Germany

Year

2021

Stakeholder

University

Technology owner/developer

University of Hohenheim
Email:
bioraffinerie@uni-hohenheim.de

Website:
https://konversionstechnologie.uni-hohenheim.de/en/118578/biorefinery-pilot-plant

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Biogasdoneright®

Technology name
karnalprocess

Problem statement
It is used for a sustainable agriculture to address the simultaneous demands of food, energy, and environmental security. Biomasses are converted to biogas and thence to electricity, heat and / or biomethane; stable carbon and plant nutrients are recycled to the fields by applying effluent digestate avoiding the greenhouse gases (GHG) emissions and other environmental impacts associated with fossil-based fertilisers.

Executive summary
Biogas production in rethinking innovative agricultural systems to produce food and bioenergy achieving large environmental benefits.

Technology description
Biogas is produced from the anaerobic decomposition of organic feedstock such as manure, agricultural residues, agro-industrial by products, energy crops, food waste. These residues are placed into anaerobic digesters (biogas plant) in which specific microorganisms at controlled conditions break down the organic materials producing biogas and digestate. Pre-treatment technology (i.e.: mechanical devices, trace elements supplementation, enzymes) can be used to optimize the process. The effluent from anaerobic digestion is called digestate and it is a natural fertiliser. It is returned to the land by irrigation ("fertigation") recycling a large fraction of the mineral nutrients and increasing soil carbon levels with soil fertility benefits (organic farming).

Market deployment considerations
Anaerobic digestion is a very scalable technology in terms of plants size and feedstock/biomasses exploiting. To implement anaerobic digestion widespread in Africa, capital and operational costs reduction and small-scale technology development are key aspects for the market deployment.

Environmental considerations
No, negative relevant environmental impact. On the contrary, a primary cause of illness and reduced life expectancy in sub-Saharan Africa is open-fire cooking and heating with wood. Using anaerobic digestion at the African village level to process animal wastes, crop residues, and energy crops could improve soils providing some electricity and biogas for heating and cooking.

Technology feedstock
manure, orange peel, olive pomace, Opuntia, Moringa oleifera

Type of process
anaerobic digestion

Technology output
biofertiliser, biogas

Scale
Farm, Village, Community

TRL
9

Countries
Italy

Year
2000

Stakeholder
Research and Technological Center

Technology owner/developer
CRPA (Centro Ricerche Produzioni Animali)
Email:
info@crpa.it

Website:
https://farmingforfuture.it/

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Biooxidation of livestock manure and GHG emissions reduction

Technology name
karnalprocess

Problem statement
GHG emissions or the contamination of aquifers produced by organic waste production.

Executive summary
Composting is a tool within the circular economy through which organic waste is valorised by transforming it into fertiliser with high added value. It provides a solution to the management of organic waste that can be a problem due to its negative effects on the environment, such as GHG emissions or the contamination of aquifers through leaching.

Technology description
It is an aerobic biological process where organic matter is oxidised by different microorganisms, mainly fungi and bacteria, which degrade this matter and transform the organic waste into a stable product, free of pathogens and weed seeds. It must be carried out under controlled conditions to obtain quality compost. The most influential parameters are temperature, pH, humidity, C/N ratio and aeration. The advantages of composting are multiple, as in addition to achieving adequate waste management, a product is obtained which, when applied to the soil, has many social, environmental and economic benefits. On the one hand, the use of inorganic fertilisers is reduced, as compost is an alternative to chemical fertilisers and can be used as a substitute for them, which, in turn, means savings in fertiliser costs due to the substitution of inorganic fertilisers in agriculture. It also reduces the demand for irrigation water because compost increases the water retention capacity of the soil, a fact to be taken into account in areas where water availability is limited and in a global context in which water resources are becoming increasingly scarce.
Compost applied to the soil also provides other benefits to the cultivated land, and therefore to the farmer, as this substrate provides beneficial micro-organisms that increase their activity on the organic matter in the compost. This microbial community produces biostimulant substances or plant growth regulating compounds and are capable of suppressing certain pathogens, which results in better crop development.

Market deployment considerations
It is a process that can be carried out with little technology and the investment needed for control is low. Space and time are needed for the process to be adequate and to produce quality compost. Information is widely available and easily accessible.

Environmental considerations
No, negative relevant environmental impact. It would result in less water being needed for crops, which is a very interesting process particularly in areas where water is a scarce resource.

Technology feedstock
organic waste, manure, agri-residues, tree bark, wood chips

Type of process
anaerobic co-digestion, anaerobic digestion

Technology output
biofertiliser

Scale
Farm, Village, Community

TRL
9

Countries
Spain

Year
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Stakeholder
Research and Technological Center

Technology owner/developer
Castilla y León Agricultural Technology Institute (ITACYL).
Email:
suelos@itacyl.es

Website:
https://www.compostaenred.org
https://www.fao.org/3/i3388s/I3388S.pdf
https://www.juntadeandalucia.es/export/drupaljda/COMPOSTAJE_2014_OK_BAJA.pdf
http://www.compost.org/

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Production of 5-HMF (5-Hydroxymethylfurfural) from inulin-containing wastes

Technology name
karnalprocess

Problem statement
Chicory roots are an environmental management problem.

Executive summary
Through a hydrothermal synthesis, 5-HMF is produced using waste containing hexoses and monomeric sugars. This technology can establish synergies with biogas production within the biorefinery concept and reduce transport costs for the supply of a decentrally implemented conversion plant.

Technology description
Sugars are extracted through a counter-current diffusion leaching process using only water (without contaminants such as sulphur, which is usually found in today's HMF). The resulting effluent is purified and then undergoes catalysed acid conversion. The main by-products are leached root chips, CaCO3 sludge (peptides, anions, degraded proteins, colloids) that can be used as fertiliser and process water containing low molecular weight compounds that can be used in biogas production. During the conversion of biogas to electricity, excess heat is produced which can be used for the extraction and conversion of the sacchar solution. The process can also be applied to wastes from other crops with high inulin content such as Jerusalem artichoke, dandelion or scorzonera.
5-HMF is of particular interest for the production of polyethylene furanoate (PEF), a 100% renewable and sustainable alternative to polyethylene terephthalate (PET) for beverage and food packaging. The major benefits are lower material usage (in terms of weight) while maintaining quality and stability criteria and reducing transport costs.

Market deployment considerations
Lower conversion ratio compared to using a two-phase leaching agent

Environmental considerations

Technology feedstock
chicory

Type of process
cascade processing

Technology output
furfural

Scale
Farm

TRL
5

Countries
Germany

Year
2017

Stakeholder
University

Technology owner/developer
University of Hohenheim
Email:
post@uni-hohenheim.de

Website:
https://www.uni-hohenheim.de/organisation/projekt/5-hydroxymethylfurfural-from-inulin-containing-crops

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Multistage anaerobic digestion process

Technology name

karnalprocess

Problem statement

High production of agriwastes that can become an environmental problem.

Executive summary

Treatment of any kind of agricultural and residential biowaste/residues.

Technology description

It is a mechanical-chemical or a mechanical-thermal pre-treatment with separation of non-fermentable solids followed by a multistep anaerobic digestion and final concentration of mineral nutrients.

Market deployment considerations

Environmental considerations

Engineering, maintenance and operational skills on a professional/business base are necessary, but the system's design is made to easily install it everywhere on earth, i.e. the parts are easily available and a cheap, most of them even very cheap.

Technology feedstock

agri-residues, manure, plant waste

Type of process

cascade processing, anaerobic digestion, chemical treatment, thermal process

Technology output

biofertiliser, biogas, compost

Scale

Farm, Village, Community

TRL

6

Countries

Germany

Year

2010

Stakeholder

Private sector

Technology owner/developer

xHochschule Flensburg Flensburg, Schleswig-Holstein, University of Applied Sciences
Email:
privacy@researchgate.net

Website:
https://www.researchgate.net/publication/317132804_A_combination_anaerobic_digestion_scheme_for_biogas_production_from_dairy_effluent-CSTR_and_ABR_and_biogas_upgrading

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