EUROPEAN COMMISSION
DIRECTORATE-GENERAL FOR AGRICULTURE AND RURAL DEVELOPMENT

Directorate B. Quality, Reserach & Innovation, Outreach
B.2. Research and Innovation

EIP-AGRI Common format for interactive innovation projects

The interactive innovation approach under the European Innovation Partnership Agricultural Productivity and Sustainability (EIP-AGRI)[1] fosters the development of demand-driven innovation, turning creative new ideas into practical applications thanks to interactions between partners, the sharing of knowledge and effective intermediation and dissemination.

The EIP **common format** consists of a set of basic elements characterising the project and i**ncludes one (or more) "practice abstract"(s)**. The format was developed with two main objectives:
(1) to enable contacting partners and incentivise efficient knowledge exchange, and
(2) to disseminate the results of the project in a concise and easy understandable way to practitioners.
The common format allows providing information all along the life-cycle of the project. The **content of the common format can be updated at any moment** when useful, for instance in an intermediate phase of the project. Project information should at least be available at the beginning (describing the situation at the start of the project, including project title and objectives) and at the end of the project (describing the results/recommendations resulting from the project, including a final project report and one or more practice abstracts).

The **common format** consists in obligatory, recommended and optional elements. Its fields are listed

1) Obligatory elements

- **Title** of the project in native language: short and easily understandable (one key sentence on the project; max 150 characters, word count – no spaces)

- **Title** of the project in English: short and easily understandable (one key sentence on the project; max 150 characters, word count – no spaces)

- **Editor** of the text: person/organisation responsible for delivering the text

- **Project coordinator** (lead-partner) according to the cooperation/consortium agreement: name, address, e-mail, telephone

- **Project partners**: name, address, e-mail, telephone, type of partner (farm holder, advisor, research institute, SME, NGO, or other)

- **Keyword-category** (to be chosen from a pre-defined list of categories)

- **Project period** (starting date, end date)

- **Project status**: ongoing (after selection of the project) or completed (after final payment)

- Main **funding source** (Rural development programme, H2020, or other EU, national/regional or private funds)

• **Total budge**t of the project

• **Geographical location** where the main project activities take place: NUTS 3 level, to enable contacting within/between a climatic/regional entities

• **Final report** (in the form of an annex), including a substantial description of the results - obligatory once the project is completed – to be drafted according to the requirements specific for the funding source

• Practice "abstract":

• **Objective** of the project in native language: what problems/opportunities does the project address that are relevant for the practitioner/end-user, and how will they be solved? - (300-600 characters, word count – no spaces)

• **Objective** of the project in English: what problems/opportunities does the project address that are relevant for the practitioner/end-user, and how will they be solved? - (300-600 characters, word count – no spaces)

• **Short summary for practitioners** in native language on the (final or expected) outcomes (1000-1500 characters, word count – no spaces).

This summary should at least contain the following information:

– Main **results/outcomes** of the activity (expected or final) – The **main practical recommendation(s)**: what would be the main added value/benefit/opportunities to the end-user if the generated knowledge is implemented? How can the practitioner make use of the results?

This summary should be as interesting as possible for farmers/end-users, using a direct and easy understandable language and pointing out entrepreneurial elements which are particularly relevant for practitioners (e.g. related to cost, productivity etc). Research oriented aspects which do not help the understanding of the practice itself should be avoided.

Several practice abstracts may be needed for one project, depending on the size of the project and the number of outcomes/recommendations which are ready for practice.

2) Recommended elements

• **Description of project activities** in native language: (max 600 characters, word count – no spaces): short summary highlighting main project activities.

• **Description of project activities** in English: (max 600 characters, word count – no spaces): short summary highlighting main project activities.

• **Short summary for practitioners** in English: short summary according to guidance (see box above under "practice abstract"; 1000-1500 characters, word count - no spaces)

• **Audiovisual material** which is useful and attractive for practitioners (e.g. YouTube link, videos, other dissemination material)

- **Website** of the project (URL)

- **Links to other website(s)** hosting information on the project (results) that are available <u>after</u> the project has ended, by preference using the existing local/regional/national communication channels that practitioners most often use.

3) Optional elements

- [additional fields are available for additional practice abstracts]: **Practice "abstract"** <u>in</u> <u>native language</u>: short summary according to the guidance in the text box above (max. 1500 characters, word count – no spaces)]
- [additional fields are available for additional practice abstracts]: **Practice "abstract"** <u>in English</u>: short summary according to the guidance in the text box above (max. 1500 characters, word count – no spaces)]
- **Description of the context of the project** (e.g. drivers in legislation/ markets or other causes that were at the origin of the project, etc.)

- **Additional information** on the project as required by the specific guidance at national / regional level (e.g. for detailed monitoring purposes)

- **Additional comments**: free text field which can be used by the editor e.g. for listing facilitating elements or
obstacles for the implementation of the produced results, for suggestions for future actions/research, for messages to consumers, etc.

Context:

Rural Development Policy 2014-2020 and the European Union Research and Innovation Policy "Horizon 2020" both aim at demand-driven innovation and complement each other in providing opportunities for EIP interactive innovation projects. Rural development programmes are applied within a specific programme region, whilst H2020 research goes beyond this scale by funding innovative actions at transnational level. Rural development Operational Groups and interactive and practice-oriented projects under Horizon 2020, such as multi-actor projects and thematic networks, will feed the EIP-AGRI web database for practitioners using the common format.

Under the EIP-AGRI, synergies and complementarities have been developed between the Horizon 2020 EU research policy and the rural development policy under the CAP. Therefore, they all use the same EIP-AGRI web database. Moreover, all Horizon 2020 multi-actor projects are strongly recommended to involve relevant interactive innovation groups operating in the EIP-AGRI context, such as rural development Operational Groups. Multi-actor projects may provide potential innovative material to rural development Operational Groups for further development and vice versa. The EIP-AGRI network is there to link them.

Why an EIP-AGRI common format?

Communicating about projects, activities and results - both during and after the project's lifetime – at the EU level is much easier through the use of a common format for practice-oriented projects. Such common format **facilitates the knowledge flow and enables contacting** of farmers, researchers and all other actors involved in innovation projects. The content of the common format was developed and agreed at EU level thanks to the work of the Standing Committee for Agricultural Research (SCAR)[2]. Using the common format for practice oriented projects will also give visibility to actors involved and enable measuring impact and rewarding of researchers' work for practice, in an analogue approach to research abstracts in peer reviewed journals.

How will the information in the EIP common format be shared?

The **EIP-AGRI website**[3] will host and share the information at the EU level.. The EIP-AGRI common format is recommended to all projects that wish to provide information on their concrete outcomes for practitioners. These include interactive and practice-oriented innovation projects funded by sources other than rural development programmes and Horizon 2020, for instance national/ regional funding, Interreg, etc.

Which projects will use the common format?

The common element between the 3 types of projects listed below in more detail is that they all envisage implementing the EIP-AGRI interactive innovation approach, and all deliver outputs that are expected to be useful for practitioners.

1. Multi-actor projects

The H2020 **multi-actor approach**[4] aims at demand-driven innovation: research projects' objectives and planning are targeted to needs/problems and opportunities of end-users, and should result in practical knowledge which is easy understandable and accessible. The approach requires that end-users and multipliers of research results, such as farmers, farmers' groups or advisors are closely involved throughout the whole project period. This should lead to innovative solutions that are more likely to be applied in the field, because those who need the solutions will be involved right from the start and will bring in complementary practical knowledge: from defining the questions, to planning, to implementing research work, to experiment and right up until possible demonstration and dissemination.

2. Thematic networks

Thematic networks[5] are a particular format of multi-actor projects that aims to compile knowledge ready for practice in a specific field. This knowledge should be easily understandable for practitioners, stay available beyond the project period, and also be shared through the EIP-AGRI network. Thematic networks will summarise and present best practices and research results with a focus on themes and issues that are "near to be put into practice", but not sufficiently known yet by practitioners.

3. EIP Operational Groups

Operational Groups[6] are multi-actor projects funded under the rural development policy. They have an obligation to make the plans and results of their work available for others in the EIP network to use. The use of the EIP-AGRI common format for reporting on operational group projects through the EIP-AGRI network will definitely play an important role in this regard, as it will help connecting Operational Groups funded under rural development with Horizon 2020 research consortia on specific topics and themes.

What are common elements for the "interactive" innovation projects developed under the EIP-AGRI?
In the **interactive innovation model**, building blocks for innovation are expected to come from science, but also from practice and intermediaries, such as farmers, advisors, businesses, NGOs, etc. Key for interactive innovation is to include existing (sometimes tacit) knowledge into building innovative solutions, which is crucial for tackling complex challenges in a holistic approach. In interactive innovation projects, end-users and practitioners are involved, not as a study-object, but in view of using their entrepreneurial skills and practical knowledge for developing the solution or opportunity and creating co-ownership. Innovation generated with an interactive approach tends to deliver solutions that are well adapted to real circumstances and easier to implement since the wider participation speeds up the acceptance and dissemination of new ideas. In short, the focus of interactive innovation is: "an idea put into practice with success". A new idea turns into a genuine innovation only if it is widely adopted and proves its usefulness in practice.

EIP-AGRI: "Ideas, put into practice, with success"

Having potential innovative knowledge is one thing, turning it into reality is

[1] The European Innovation Partnership for Agricultural productivity and Sustainability (EIP-AGRI) was launched by the European Commission in 2012. It aims to foster a competitive and sustainable agriculture and forestry sector that "achieves more from less": http://ec.europa.eu/eip/agriculture/en/content/eip-agri-part-
[2] The SCAR Strategic Working Group on Agricultural Knowledge and Innovation Systems (SWG AKIS) developed the common format on the basis of experience in Member States
[3] http://ec.europa.eu/eip/agriculture/
[4] http://ec.europa.eu/research/participants/data/ref/h2020/wp/2016_2017/main/h2020-wp1617-food_en.pdf p.10 definition of multi-actor approach
[5] http://ec.europa.eu/research/participants/data/ref/h2020/wp/2016_2017/main/h2020-wp1617-food_en.pdf p.139 Thematic Networks compiling knowledge ready for practice
[6] See section 4.1 of the rural development EIP guidelines http://ec.europa.eu/eip/agriculture/sites/agri-eip/files/pb_guidelines_eip_implementation_2014_en.pdf

Project identification

Please indicate whether the information refers to a multi-actor project or a thematic network	Multi-actor project

Project Information

Project identifier (see INSTRUCTIONS)	2019H2020_862834_AQUACOMBINE
Title of the project in native language (*can be the language of the coordinator / one of the partners - otherwise repeat the title in English*)	Integrated on-farm Aquaponics system for co-production of fish, halophyte vegetables, bioactive compounds and bioenergy
Title of the project in English (*provide the project ACRONYM + short title within the characters limit*)	Integrated on-farm Aquaponics system for co-production of fish, halophyte vegetables, bioactive compounds and bioenergy

Geographical location

Country (*of the coordinator*)	Denmark
Main geographical location (NUTS3) (of coordinator - *for geolocalisation on map*)	Denmark
Editor of the text: person/organisation responsible for delivering the text	Aalborg University

Project coordinator (lead-partner) according to the cooperation/consortium agreement:

Name	Mette Hedegaard Thomsen
Address	Niels Bohrsvej 8, DK-6700 Esbjerg
E-mail	mht@et.aau.dk
Telephone	0045 9356 2196

Project period:

start year (YYYY)	2019
end year (YYYY)	2023
Project status: ongoing (after selection of the project) or completed (after final payment)	ongoing
Main **funding source** (Rural development programme, H2020, or other EU, national/regional or private funds)	H2020
Total budget of the project (total costs - in euros)	9.789.883,00
Objective of the project in English: what problems/opportunities does the project address that are relevant for the practitioner/end-user, and how will they be solved? - (300-600 characters, word count – no spaces)	The AQUACOMBINE project aim to demonstrate combined aquaculture and halophyte farming using the principles of circular economy, where waste is recovered and utilised within the system to create both internal value and new products. Excess nutrients from the fish production will be used as fertiliser for halophyte plants and filtered through a microbial water treatment system to enable recirculation of the water back into the aquaculture tanks. All parts of the halophyte biomass will be used for production of multiple products such as food, feed, botanical extracts and pure bioactive compounds, as well as biogas from the final residues. This combined aquaculture, farming, and bioprocessing can help

Objective of the project in native language (*can be the language of the coordinator / one of the partners - otherwise indicate "see objectives in English"*) (300-600 characters, word count – no spaces)	See objectives in English.

Project partners (mandatory information) - *N.B. : "Name" can be that of the Organisation or of a contact person - "Address" should include the country*

	Name	Address	E-mail	Telephone	Type of partner
project coordinator (lead partner) *from PROJECT INFORMATION*	Mette Hedegaard Thomsen	Niels Bohrsvej 8, DK-6700 Esbje	mht@et.aau.dk	0045 9356 2196	research institute
project partner	Mette Hedegaard Thomsen	Niels Bohrsvej 8, DK-6700 Esbje	mht@et.aau.dk	0045 9356 2196	research institute
project partner	Lulea Tekniska Universitet	UNIVERSITETSOMRADET PORSON, LULEA 971 87, Sweden	paul.christakopoulos@ltu.se	+46920492510	research institute
project partner	FRIED WILHELM LEIBNIZ U	Welfengarten 1, HANNOVER 30	Jutta.Papenbrock@botanik.uni-han	+49 511 762 3788	research institute
project partner	HOCHSCHULE BREMERHA	AN DER KARLSTADT 8, BREMI	agottschalk@hs-bremerhaven.de	+49 471 4823260	research institute
project partner	UNIVERSITE CATHOLIQUE	PLACE DE L UNIVERSITE 1, LOUVAIN LA NEUVE 1348, Belgium	iwona.cybulska@uclouvain.be	+32 (0)10 47 25 22	research institute
project partner	HOCHSCHULE FLENSBUR	KANZLEISTRASSE 91-93, FLENSBURG 24943, Germany	hinrich.uellendahl@hs-flensburg.de	+49 (0) 461 805 129	research institute
project partner	UNIVERSIDADE DE AVEIR	CAMPUS UNIVERSITÁRIO DE SANTIAGO, AVEIRO 3810-193, Portugal,	sofia.g.guilherme@ua.pt	+351234370200	research institute
project partner	CIIMAR - Centro Interdiscipli	Rua dos Bragas 289, Porto 405	bcostas@ciimar.up.pt	+351223401800	research institute
project partner	CELABOR SCRL	AVENUE DU PARC 38 ZONING DE PETIT RECHAIN, HERVE CHAINEUX 4650, Belgium	stephane.kohnen@celabor.be	003287322454	SME
project partner	ENVIROHEMP SL	POL IND ALOA CALLE A NAVE 03, PUENTE LA REINA 31100, Spain	project@envirohemp.com	+34601000042	SME
project partner	RIASEARCH, UNIPESSOAL	RUA DO FAROL, N.131, TORRAO DO LAMEIRO, AVEIRO, OVAR 3880 394, Portugal	ruirocha@riasearch.pt	+351 939 412 836	SME
project partner	ALPHA AQUA A/S	JOHN TRANUMS VEJ 23, ESBJERG 6705, Denmark	pak@dk.alpha-aqua.com	+45 5155 9735	SME
project partner	LUCAS CORINNE	RUE DU MOULIN 4, LA TURBALLE 44350, France	lesdouceursdumarais@hotmail.con	06-84-41-27-22	SME
project partner	DK Beauty A/S	PEDER LARSENS VEJ 3, BRAN	bjarke@dkbeauty.dk	+45 7930 4130	SME
project partner	Thise Mejeri amba	n Sundsorevej 62, Roslev 7870,	anne.bergolsen@thise.dk	+4597578001	SME
project partner	FOOD-PROCESSING INITIA	RITTERSTRASSE 19, BIELEFELD 33602, Germany	norbert.reichl@foodprocessing.de	0049 521 98640 70	SME
project partner	ADRAL - AGENCIA DE DES	RUA 24 DE JULHO 1 1 E, EVOR	daniel.janeiro@adral.pt	00351266769150	SME

Consent for publication

Keyword - category

Keyword - category 1	Halophyte
Keyword - category 2	Salicornia
Keyword - category 3	Phyto-chemicals
Keyword - category 4	bioprocessing
Keyword - category 5	bio-energy
Keyword - category 6	aquaponic systems
Keyword - category 7	
Keyword - category 8	
Keyword - category 9	
Keyword - category 10	

Audiovisual material which is useful and attractive for practitioners (e.g. YouTube link, videos, other dissemination material)

Title/description (in English)	URL
	http://
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Official website of the project

Title/description	URL
Official website of the project	http://www.aquacombine.eu

Links to other website(s) hosting information on the project (results) that are available after the project has ended, by preference using the existing local/regional/national communication channels that practitioners most often use.

Title/description	URL
	http://
	http://
	http://
	http://
	http://

Practice "abstract" 1:

Several practice abstracts may be needed for one project, depending on the size of the project and the number of outcomes/recommendations which are ready for practice.

Short title in English

Halophytes versus glycophytes – various adaptations to salinity

Short summary for practitioners in english on the (final or expected) outcomes (1000-1500 characters, word count – no spaces). *Do not complete if the summary below is completed in English*

This summary should at least contain the following information:

- Main **results/outcomes** of the activity (expected or final)
- The **main practical recommendation(s)**: what would be the main added value/benefit/opportunities to the end-user if the generated knowledge is implemented? How can the practitioner make use of the results?

This summary should be as interesting as possible for farmers/end-users, using a direct and easy understandable language and pointing out entrepreneurial elements which are particularly relevant for practitioners (e.g. related to cost, productivity etc). Research oriented aspects which do not help the understanding of the practice itself should be avoided.

Increased salt concentration in the soil leads to stress reactions in plants, such as growth inhibition and low productivity in glycophytes, which are the majority of crop plant species used in agriculture. Glycophytes are plants that grow in non-saline conditions, so their growth and productivity are drastically affected by salinity. In glycophytes, sensitivity to salt has been associated with an inability to remove sodium ions effectively from the cytoplasm in order to protect salt-sensitive metabolic processes. Effective strategies for halophytes, salt-tolerant plants, to cope with salinity stress are at the cellular level and at the whole plant level. Halophytes are able to grow at high salinities above 200 mM (11.68 g/L NaCl) because they can protect themselves from excess of salt from the soil and water. Their tolerance depends on the species. Thus, some halophyte species such as Tripolium pannonicum, Salicornia spp., and Crithmum maritimum are considered salt-tolerant species with a promising potential for use in soils degraded by salinity. In the course of their evolution, different physiological mechanisms have been developed to cope with numerous stress conditions including the restriction of Na+ uptake and exclusion, cellular compartmentalization of Na+ in the vacuole, antioxidant regulation, compatible solutes (osmolytes), morphological adaptations (e.g. salt bladders), among others. The productivity of halophytes depends on several factors including agronomic management, weather, soil salinity, plant species, among others. However, the productivity of some halophytes can be comparable with glycophytes.

Short title in native language

Halophyten versus Glycophyten – verschiedene

Short summary for practitioners in <u>native language</u> (*can be the language of the coordinator / one of the partners - otherwise in English*) (1000-1500 characters, word count – no spaces). This summary should at least contain the following information: − Main **results/outcomes** of the activity (expected or final) − The **main practical recommendation(s)**: what would be the main added value/benefit/opportunities to the end-user if the generated knowledge is implemented? How can the practitioner make use of the results? This summary should be as interesting as possible for farmers/end-users, using <u>a direct and easy understandable language</u> and pointing out entrepreneurial elements which are particularly relevant for practitioners (e.g. related to cost, productivity etc). Research oriented aspects which do not help the understanding of the practice itself should be avoided.	Eine erhöhte Salzkonzentration im Boden führt bei nicht salztoleranten Pflanzenarten zu Stressreaktionen wie Wachstumshemmung und geringerer Produktivität. Diese Glykophyten machen den Großteil der angebauten Nutzpflanzen aus. Bei Glycophyten wird die Salzempfindlichkeit mit der Unfähigkeit in Verbindung gebracht, Natriumionen wirksam aus dem Cytoplasma zu entfernen, um salzempfindliche Stoffwechselprozesse zu schützen. Wirksame Strategien für Halophyten zur Bewältigung von Salzstress liegen auf der zellulären Ebene und auf der Ebene der gesamten Pflanze. Halophyten sind in der Lage, bei hohen Salzgehalten über 200 mM (11,68 g/L NaCl) zu wachsen, da sie sich vor überschüssigem Salz aus dem Boden und dem Wasser schützen können. Ihre Toleranz hängt von der jeweiligen Art ab. So gelten einige Halophytenarten wie Tripolium pannonicum, Salicornia spp. und Crithmum maritimum als salztolerante Arten mit einem vielversprechenden Potenzial für den Einsatz in Böden, die durch einen hohen Salzgehalt gekennzeichnet sind. Im Laufe ihrer Evolution wurden verschiedene physiologische Mechanismen entwickelt, um mit zahlreichen Stressbedingungen fertig zu werden, darunter die Beschränkung der Na+-Aufnahme und -Ausscheidung, die zelluläre Kompartimentierung von Na+ in der Vakuole, die Regulierung durch Antioxidantien, kompatible Solute (Osmolyte), morphologische Anpassungen (z. B. Salzdrüsen) und andere. Die Produktivität von Halophyten hängt von mehreren Faktoren ab, u. a. von den landwirtschaftlichen Kulturtechniken, dem Wetter, dem Salzgehalt des Bodens und der Pflanzenart. Die Produktivität einiger Halophyten ist mit der von Glycophyten vergleichbar.

Practice "abstract" 2:

Several practice abstracts may be needed for one project, depending on the size of the project and the number of outcomes/recommendations which are ready for practice.

Short title in English

Three promising salt-tolerant species – Characteristics and differences

Short summary for practitioners in english on the (final or expected) outcomes (1000-1500 characters, word count – no spaces). *Do not complete if the summary below is completed in English*

This summary should at least contain the following information:

- Main **results/outcomes** of the activity (expected or final)
- The **main practical recommendation(s)**: what would be the main added value/benefit/opportunities to the end-user if the generated knowledge is implemented? How can the practitioner make use of the results?

This summary should be as interesting as possible for farmers/end-users, using a direct and easy understandable language and pointing out entrepreneurial elements which are particularly relevant for practitioners (e.g. related to cost, productivity etc). Research oriented aspects which do not help the understanding of the practice itself should be avoided.

Halophytes are, by definition, plants that can complete their life cycle under a salt concentrations of at least 200 mM (11.68 g/L NaCl). The three halophyte species Salicornia spp., Tripolium pannonicum and Crithmum maritimum can be cultivated in saline soils or irrigated with seawater. The plants can also extract salts from the growing medium and thus desalinate soils. Salicornia spp. are obligate halophytes, they needs salt for their growth. These species have, e.g. root and stem anatomical features resulting from adaptation to salinity stress. Salicornia europaea produces a fresh biomass of 44 t/ha in 5 weeks after transplanting in hydroponics, but increased to 104 t/ha at 10 g/L NaCl and 121 t/ha at 20 g/L NaCl in the culture medium. Tripolium pannonicum also has several mechanisms to cope with salt stress including changes in the anatomical structure, transport and compartmentalization of salt in the vacuole and production of secondary metabolites. Although this species can grow under high saline environments (up to 40 g/L NaCl), its productivity decreases with increasing salinity. Under non-saline conditions the fresh biomass production is 45 t/ha in 5 weeks after transplanting, but it decreases to 36 t/ha at 10 g/L NaCl and to 12 t/ha with 20 g/L NaCl. Crithmum maritimum is also a facultative halophyte; under saline conditions it is able to accumulate sodium in its tissues and increase metabolite production, and also enhance activities of antioxidant enzymes to cope with salt stress. However, biomass production decreases under saline conditions. The biomass productivity is also lower compared to Tripolium and Salicornia. Therefore, the productivity depends on the saline stress conditions as well as the plant species.

Short title in native language

Drei vielversprechende salz-tolerante Pflanzenarten – Merkmale und

Short summary for practitioners in <u>native language</u> (*can be the language of the coordinator / one of the partners - otherwise in English*) (1000-1500 characters, word count – no spaces). This summary should at least contain the following information: − Main **results/outcomes** of the activity (expected or final) − The **main practical recommendation(s)**: what would be the main added value/benefit/opportunities to the end-user if the generated knowledge is implemented? How can the practitioner make use of the results? This summary should be as interesting as possible for farmers/end-users, using <u>a direct and easy understandable language</u> and pointing out entrepreneurial elements which are particularly relevant for practitioners (e.g. related to cost, productivity etc). Research oriented aspects which do not help the understanding of the practice itself should be avoided.	Halophyten sind per Definition Pflanzen, die ihren Lebenszyklus unter einer Salzkonzentration von mindestens 200 mM (11,68 g/L NaCl) vollenden können. Die drei Halophytenarten Salicornia spp., Tripolium pannonicum und Crithmum maritimum können in salzhaltigen Böden angebaut oder mit Meerwasser bewässert werden. Die Pflanzen können auch Salze aus dem Nährboden extrahieren und so Böden entsalzen. Salicornia spp. sind obligate Halophyten, d.h. sie benötigen eine gewisse Menge an Salz für ihr Wachstum. Diese Arten haben z. B. anatomische Merkmale im Wurzel- und Stängelbereich, die auf die Angepasstheiten an den Salzstress zurückzuführen sind. Salicornia europaea produziert in 5 Wochen nach dem Umpflanzen in Hydrokulturen eine frische Biomasse von 44 t/ha, die jedoch bei 10 g/L NaCl auf 104 t/ha und bei 20 g/L NaCl im Kulturmedium auf 121 t/ha ansteigt. Tripolium pannonicum verfügt ebenfalls über mehrere Mechanismen, um mit Salzstress fertig zu werden, darunter Veränderungen in der anatomischen Struktur, Transport und Kompartimentierung von Salz in der Vakuole und Produktion von Sekundärmetaboliten. Obwohl diese Art auch in stark salzhaltiger Umgebung (bis zu 40 g/L NaCl) wachsen kann, nimmt ihre Produktivität mit zunehmendem Salzgehalt ab. Unter nicht-salzhaltigen Bedingungen beträgt die Produktion frischer Biomasse 45 t/ha in 5 Wochen nach dem Einpflanzen, aber sie sinkt auf 36 t/ha bei 10 g/L NaCl und auf 12 t/ha bei 20 g/L NaCl. Crithmum maritimum ist ebenfalls ein fakultativer Halophyt; unter salzhaltigen Bedingungen ist er in der Lage, Natrium in seinen Geweben zu akkumulieren und die Produktion von Metaboliten zu erhöhen sowie die Aktivität antioxidativer Enzyme zu steigern, um den Salzstress zu bewältigen. Allerdings nimmt die Biomasseproduktion unter salzigen Bedingungen ab. Auch ist die Produktivität der Biomasse im Vergleich zu Tripolium und Salicornia geringer. Die Produktivität hängt also sowohl von den Salzstressbedingungen als auch von der Pflanzenart ab.

Practice "abstract" 3:	*Several practice abstracts may be needed for one project, depending on the size of the project and the number of outcomes/recommendations which are ready for practice.*
Short title in English	Cultivation of halophytes under hydroponic conditions
Short summary for practitioners in english on the (final or expected) outcomes (1000-1500 characters, word count – no spaces). *Do not complete if the summary below is completed in English* This summary should at least contain the following information: − Main **results/outcomes** of the activity (expected or final) − The **main practical recommendation(s)**: what would be the main added value/benefit/opportunities to the end-user if the generated knowledge is implemented? How can the practitioner make use of the results? This summary should be as interesting as possible for farmers/end-users, using a direct and easy understandable language and pointing out entrepreneurial elements which are particularly relevant for practitioners (e.g. related to cost, productivity etc). Research oriented aspects which do not help the understanding of the practice itself should be avoided.	Plants can be grown in different media, also just in a watery solution containing all necessary mineral nutrients for optimal growth, a so-called hydroponic culture. Plants may grow with their roots exposed to the nutritious liquid, or, in addition, the roots may be physically supported by an inert material. Growing plants in hydroponic culture has several advantages including efficient use of nutrients, higher yields, use of less space, higher water use efficiency, among others. Different halophytes including Salicornia europaea, Tripolium pannonicum and Crithmum maritimum can be cultivated in hydroponics in a greenhouse, exposed with artificial light, as demonstrated at the Leibniz University Hanover. Polypropylene containers (400 mm x 300 mm x 175 mm) with a capacity of 16 L are used, filled with 13 L of a nutrition solution (Hoagland). The water is constantly aerated by small compressors and one air stone in the middle of each tank. The hypocotyl is fixed with soft foam in 35 mm holes. The water level is adjusted constantly in each tank with tap water to compensate for evapotranspiration. Each container hosts eight plants. According to the results, high amounts of biomass can be produced under hydroponic conditions. However, the productivity depends on the salinity in the medium and on the plant species. The highest fresh mass production of Tripolium was 45 t/ha in 5 weeks after transplanting in hydroponics, while Crithmum yielded 30 t/ha fresh mass in 11 weeks after transplanting. Salicornia yielded up to 121 t/ha fresh mass in 5 weeks after transplanting but with a salinity of 20 g/L NaCl in the culture medium. Therefore, halophytes have a great potential to be cultivated in hydroponics producing high yields.
Short title in native language	Kultivierung von Halophyten unter hydroponischen Bedingungen

Short summary for practitioners in <u>native language</u> (*can be the language of the coordinator / one of the partners - otherwise in English*) (1000-1500 characters, word count – no spaces). This summary should at least contain the following information: − Main **results/outcomes** of the activity (expected or final) − The **main practical recommendation(s)**: what would be the main added value/benefit/opportunities to the end-user if the generated knowledge is implemented? How can the practitioner make use of the results? This summary should be as interesting as possible for farmers/end-users, using <u>a direct and easy understandable language</u> and pointing out entrepreneurial elements which are particularly relevant for practitioners (e.g. related to cost, productivity etc). Research oriented aspects which do not help the understanding of the practice itself should be avoided.	Pflanzen können in verschiedenen Medien kultiviert werden, so auch nur in einer wässrigen Lösung, die alle für ein optimales Wachstum erforderlichen Mineralstoffe enthält, einer sogenannten Hydrokultur. Die Pflanzen können mit ihren Wurzeln in der nährstoffhaltigen Flüssigkeit wachsen, oder die Wurzeln können zusätzlich durch ein inertes Material gestützt werden. Der Anbau von Pflanzen in hydroponischer Kultur hat mehrere Vorteile, darunter die effiziente Nutzung von Nährstoffen, höhere Erträge, geringerer Platzbedarf und eine effizientere Wassernutzung. Verschiedene Halophyten wie Salicornia europaea, Tripolium pannonicum und Crithmum maritimum können in Hydrokultur in einem Gewächshaus mit künstlichem Licht kultiviert werden, wie an der Leibniz Universität Hannover im Institut für Botanik gezeigt wurde. Es werden Polypropylenbehälter (400 mm x 300 mm x 175 mm) mit einem Fassungsvermögen von 16 l verwendet, die mit 13 l einer Nährlösung (Hoagland) gefüllt sind. Das Wasser wird durch kleine Kompressoren und einem Luftstein in der Mitte jedes Behälters ständig belüftet. Das Hypokotyl wird mit weichem Schaumstoff in 35 mm großen Löchern fixiert. Der Wasserstand wird in jedem Behälter ständig mit Leitungswasser ausgeglichen, um die Evapotranspiration zu kompensieren. Jeder Behälter enthält acht Pflanzen. Die Ergebnisse zeigen, dass unter hydroponischen Bedingungen große Mengen an Biomasse erzeugt werden können. Die Produktivität hängt jedoch vom Salzgehalt des Mediums und von der Pflanzenart ab. Die höchste Frischmasseproduktion von Tripolium betrug 45 t/ha in 5 Wochen nach dem Umpflanzen in Hydrokultur, während Crithmum 30 t/ha Frischmasse in 11 Wochen nach dem Umpflanzen lieferte. Salicornia erbrachte in 5 Wochen nach dem Einpflanzen bis zu 121 t/ha Frischmasse, allerdings bei einem Salzgehalt von 20 g/L NaCl im Kulturmedium. Daher haben Halophyten ein großes Potenzial für die Kultivierung in Hydrokulturen und liefern hohe Erträge.

Practice "abstract" 4:

Several practice abstracts may be needed for one project, depending on the size of the project and the number of outcomes/recommendations which are ready for practice.

Short title in English

Production of Salicornia spp. in a foil greenhouse using aquaculture efflue

Short summary for practitioners in english on the (final or expected) outcomes (1000-1500 characters, word count – no spaces). *Do not complete if the summary below is completed in English*

This summary should at least contain the following information:

- Main **results/outcomes** of the activity (expected or final)
- The **main practical recommendation(s)**: what would be the main added value/benefit/opportunities to the end-user if the generated knowledge is implemented? How can the practitioner make use of the results?

This summary should be as interesting as possible for farmers/end-users, using a direct and easy understandable language and pointing out entrepreneurial elements which are particularly relevant for practitioners (e.g. related to cost, productivity etc). Research oriented aspects which do not help the understanding of the practice itself should be avoided.

Marine animal aquaculture production effluents are characterized by high nutrient levels, that if not properly treated, are released into the environment. The use of these effluents for halophyte production, namely Salicornia spp., can constitute a sustainable solution for their treatment, potentially reducing aquaculture environmental impacts while increasing added value with coproduction. This has been shown, cultivating Salicornia ramosissima in greenhouse conditions, utilizing shrimp (Penaeus vannamei) and european seabass (Dicentrarchus labrax) production effluents for irrigation. Seeds were harvested from local plants in years prior to cultivation. In February, the seeds were sown in a 2 g/m2 density. Initially, freshwater was used to keep the soil moistened for two weeks, until plants germinated. During the growth phase (5-6 months duration) plants were irrigated two times a day utilizing a mixture of the effluents, with salinity around 18 ‰wt%, and freshwater in order to keep soil salinity around 12‰ wt%. Estimated biomass production was around 1.85 kg/m2 per year, before plants started to flower in August/September. An off-season cultivation (30 June 2020) was also tested utilizing the procedures previously described. Although seeds germinated, the growth phase lasted only 3 months and the plants did not develop as expected, which suggests that an off-season cultivation results in inferior yields. Data from this study suggests that aquaculture effluents can be successfully used for irrigation in S. ramosissima cultivation, if performed in natural season.

Short title in native language

Production d'halophytes sur des sols salins par irrigation à l'eau de mer,

Short summary for practitioners in <u>native language</u> (*can be the language of the coordinator / one of the partners - otherwise in English*) (1000-1500 characters, word count – no spaces). This summary should at least contain the following information: − Main **results/outcomes** of the activity (expected or final) − The **main practical recommendation(s)**: what would be the main added value/benefit/opportunities to the end-user if the generated knowledge is implemented? How can the practitioner make use of the results? This summary should be as interesting as possible for farmers/end-users, using <u>a direct and easy understandable language</u> and pointing out entrepreneurial elements which are particularly relevant for practitioners (e.g. related to cost, productivity etc). Research oriented aspects which do not help the understanding of the practice itself should be avoided.	Os efluentes de aquacultura de animais marinhos contêm níveis elevados de nutrientes que, caso não sejam adequadamente tratados, podem causar impactos negativos no meio ambiente. A utilização destes efluentes para a produção de plantas halófitas, nomeadamente Salicornia spp., pode constituir uma solução sustentável para o seu tratamento, reduzindo os potenciais impactos ambientais da aquacultura e aumentando o valor acrescentado em cenários de coprodução. A viabilidade deste método de produção foi demonstrada no cultivo de Salicornia ramosissima em estufas, utilizando efluentes de produção de camarão (Penaeus vannamei) e robalo (Dicentrarchus labrax) para irrigação. As sementes foram colhidas de plantas locais nos anos anteriores ao cultivo. Em fevereiro, as sementes foram semeadas numa densidade de 2 g/m2. Inicialmente, regou-se com água doce de forma a manter o solo húmido, durante duas semanas, até à germinação das plantas. Durante a fase de crescimento (5-6 meses de duração) as plantas foram irrigadas duas vezes por dia, utilizando uma mistura de efluentes (salinidade de 18) e água doce, a fim de manter a salinidade do solo em torno de 12. A produção estimada de biomassa foi de aproximadamente 1,85 kg/m2 por ano, antes do início da floração das plantas, que ocorreu no final de agosto/início de setembro. Testou-se também cultivo fora de estação (30 de junho de 2020), utilizando os procedimentos descritos anteriormente. Embora as sementes tenham germinado, a fase de crescimento durou apenas 3 meses e as plantas não se desenvolveram como esperado, o que sugere que um cultivo fora de época resulta em rendimentos inferiores. Os dados deste estudo sugerem que os efluentes de aquacultura podem ser utilizados com sucesso para irrigação no cultivo de S. ramosissima desde que este seja feito em época natural.

Practice "abstract" 5:

Several practice abstracts may be needed for one project, depending on the size of the project and the number of outcomes/recommendations which are ready for practice.

Short title in English

Production of halophytes on saline soils with seawater irrigation with a foc

Short summary for practitioners in english on the (final or expected) outcomes (1000-1500 characters, word count – no spaces). *Do not complete if the summary below is completed in English*

This summary should at least contain the following information:

- Main **results/outcomes** of the activity (expected or final)
- The **main practical recommendation(s)**: what would be the main added value/benefit/opportunities to the end-user if the generated knowledge is implemented? How can the practitioner make use of the results?

This summary should be as interesting as possible for farmers/end-users, using a direct and easy understandable language and pointing out entrepreneurial elements which are particularly relevant for practitioners (e.g. related to cost, productivity etc). Research oriented aspects which do not help the understanding of the practice itself should be avoided.

Halophytes can successfully be cultivated outdoors by several techniques. One option is to use natural seawater to irrigate halophytes. There exist systems that were used since centuries to accumulate salt from the seawater is a sophisticated way. Natural seawater flows into the system at each high tide. Salinity within different parts of the system and the water level itself can be controlled by simple pushers that opens or closes the water entry into the system or in parts of the system. One of these salinas is used to cultivate and irrigate Salicornia spp. according to regulations valid for organic agriculture. The sediment contains enough nutrients and with each high tide fresh seawater containing nutrients is floods the cultivated plants. The cultivation needs a lot of hand work because there are not yet machines developed and the sediment itself is very muddy. In addition, the salina has to be observed carefully and constantly, to be able react and modulate the water levels according to the tide. However, from an ecological point of view, the way of cultivation is very sustainable and supports well the idea of circular bioeconomy. Seeds from the naturally occurring plants are used, seedlings are sown in early spring and already in early summer fresh tips can be harvested for the local market. The plants are completely harvested when fully matured in October. The time of the different steps of the cultivation cycle depend very much on the weather conditions, as for all crop plants cultivated outdoor.

Short title in native language

Production of halophytes on saline soils with seawater irrigation with a

Short summary for practitioners in <u>native language</u> (*can be the language of the coordinator / one of the partners - otherwise in English*) (1000-1500 characters, word count – no spaces). This summary should at least contain the following information: − Main **results/outcomes** of the activity (expected or final) − The **main practical recommendation(s)**: what would be the main added value/benefit/opportunities to the end-user if the generated knowledge is implemented? How can the practitioner make use of the results? This summary should be as interesting as possible for farmers/end-users, using <u>a direct and easy understandable language</u> and pointing out entrepreneurial elements which are particularly relevant for practitioners (e.g. related to cost, productivity etc). Research oriented aspects which do not help the understanding of the practice itself should be avoided.	Les halophytes peuvent être cultivées avec succès en plein air grâce à plusieurs techniques. Une option consiste à utiliser l'eau de mer naturelle pour irriguer les halophytes. Il existe des systèmes qui sont utilisés depuis des siècles pour accumuler le sel de l'eau de mer d'une manière sophistiquée. L'eau de mer naturelle s'écoule dans le système à chaque marée haute. La salinité dans les différentes parties du système et le niveau de l'eau lui-même peuvent être contrôlés par de simples poussoirs qui ouvrent ou ferment l'entrée de l'eau dans le système ou dans certaines parties du système. L'une de ces salines est utilisée pour cultiver et irriguer des Salicornia spp. selon les réglementations valables pour l'agriculture biologique. Les sédiments contiennent suffisamment de nutriments et à chaque marée haute, de l'eau de mer fraîche contenant des nutriments inonde les plantes cultivées. La culture nécessite beaucoup de travail manuel car il n'y a pas encore de machines développées et le sédiment lui-même est très boueux. En outre, la saline doit être observée attentivement et constamment, afin de pouvoir réagir et moduler les niveaux d'eau en fonction de la marée. Cependant, d'un point de vue écologique, la méthode de culture est très durable et s'inscrit parfaitement dans l'idée de bioéconomie circulaire. Les semences des plantes naturelles sont utilisées, les jeunes plants sont semés au début du printemps et dès le début de l'été, les pointes fraîches peuvent être récoltées pour le marché local. Les plantes sont entièrement récoltées à maturité, en octobre. Comme pour toutes les plantes cultivées en plein air, la durée des différentes étapes du cycle de culture dépend beaucoup des conditions météorologiques.

Several practice abstracts may be needed for one project, depending on the size of the project and the number of outcomes/recommendations which are ready for practice.

Practice "abstract" 6:

Short title in English	Hydroponics of Salicornia spp. in large scale
Short summary for practitioners in english on the (final or expected) outcomes (1000-1500 characters, word count – no spaces). *Do not complete if the summary below is completed in English* This summary should at least contain the following information: − Main **results/outcomes** of the activity (expected or final) − The **main practical recommendation(s)**: what would be the main added value/benefit/opportunities to the end-user if the generated knowledge is implemented? How can the practitioner make use of the results? This summary should be as interesting as possible for farmers/end-users, using a direct and easy understandable language and pointing out entrepreneurial elements which are particularly relevant for practitioners (e.g. related to cost, productivity etc). Research oriented aspects which do not help the understanding of the practice itself should be avoided.	The in-door vertical (2-storey) plant production of Salicornia europaea is based on a deep-water culture system (DWC), allowing for a 'traditional' growth season of 3-5 harvest times providing both fresh greens as well as dry stems for biorefinery purposes. The total growing area is 16 m2 and an all-year-round production supplied daily with 14 hours of artificial LED lighting providing 260-270 umol/m2/S (light particles hitting a m2 in one second). Data on PH-, Oxygen-, salinity- and temperature level is followed 24/7. Likewise, water consumption is measured and will be compared with the final yield output. Water input is a mix of sea water from the North Sea of 3.5 wt% salinity, pumped directly into the farm and diluted with fresh water reaching a level of 1.0 wt%, respectively 1.5 wt% salinity. Plants are provided a nutrient solution of 5-1-4 (NPK) and total nutrient input is compared with nutrient content in harvested biomass for information on optimal fertilization and harvest periods. Salicornia europaea has broad horizontal growth hence test on optimal planting space for optimal yields are on-going and are compared to lab-analysis on valuable product components with each harvest. Under investigation are details like Fresh Green Tips Yield (kg per m2), Dry Forage Biomass (kg per m2), optimal harvest periods per plant season, optimal plant spacing, optimal fertilization, optimal LED lighting. For the economic part, a contribution margin sheet is under construction, containing Turn Over (sales), Variable Costs (fertilizer, electricity, seed etc.), Fixed Costs (investment on production system), and expected profit.
Short title in native language	Dyrkning af Salicornia spp. i stor skala hydroponi

Short summary for practitioners in native language (*can be the language of the coordinator / one of the partners - otherwise in English*) (1000-1500 characters, word count – no spaces).

This summary should at least contain the following information:

- Main **results/outcomes** of the activity (expected or final)
- The **main practical recommendation(s)**: what would be the main added value/benefit/opportunities to the end-user if the generated knowledge is implemented? How can the practitioner make use of the results?

This summary should be as interesting as possible for farmers/end-users, using a direct and easy understandable language and pointing out entrepreneurial elements which are particularly relevant for practitioners (e.g. related to cost, productivity etc). Research oriented aspects which do not help the understanding of the practice itself should be avoided.

Den vertikale (2-etagers) indendørs planteproduktion af Salicornia europaea er baseret på et dybvandskultursystem, der giver plads til rødderne og mulighed for en "traditionel" vækstsæson på 3-5 høsttider. Det giver plads til både friske grønne skud såvel som tørre stilke til bioraffinaderiformål. Det samlede vækstareal er 16 m2 med en helårsproduktion, der forsynes dagligt med 14 timers kunstig LED-belysning på 260-270 umol/m2/S (lyspartikler som rammer en m2 per sekund).
Data om PH-, Ilt-, saltholdighed- og temperaturniveau følges 24/7. Ligeledes måles vandforbruget og vil blive sammenholdt med det endelige udbytte. Vandinput er en blanding af havvand fra Nordsøen med 3,5 % saltholdighed, pumpet direkte ind i til produktionen og fortyndet med ferskvand til et niveau på 1,0 % henholdsvis 1,5% saltholdighed.
Planterne får en næringsopløsning på 5-1-4 (NPK), og den samlede næringsstoftilførsel sammenlignes med næringsstofindholdet i høstet biomasse for at få oplysninger om optimal gødskning og høstperioder. Salicornia europaea har en bred horisontal vækst, derfor er test på optimal planteplads for optimalt udbytte i gang og sammenlignes med laboratorieanalyser af værdifulde produktkomponenter for hver høst. Samlet undersøges der for detaljer som udbytte af friske grønne skud (kg pr. m2) til føde, tørfoderbiomasse (kg pr. m2), optimale høstperioder pr. plantesæson, optimal planteafstand, optimal gødskning, optimal LED-belysning.
For den økonomiske del er et dækningsbidrag under opbygning, indeholdende Omsætning (salg), Variable Omkostninger (gødning, elektricitet, frø etc.), Faste Omkostninger (investering i produktionssystem) og forventet avance.

Practice "abstract" 7:	*Several practice abstracts may be needed for one project, depending on the size of the project and the number of outcomes/recommendations which are ready for practice.*
Short title in English	Cultivation of Salicornia spp. and fish production using seawater
Short summary for practitioners in english on the (final or expected) outcomes (1000-1500 characters, word count – no spaces). *Do not complete if the summary below is completed in English* This summary should at least contain the following information: − Main **results/outcomes** of the activity (expected or final) − The **main practical recommendation(s)**: what would be the main added value/benefit/opportunities to the end-user if the generated knowledge is implemented? How can the practitioner make use of the results? This summary should be as interesting as possible for farmers/end-users, using a direct and easy understandable language and pointing out entrepreneurial elements which are particularly relevant for practitioners (e.g. related to cost, productivity etc). Research oriented aspects which do not help the understanding of the practice itself should be avoided.	Based on an in-door aquaponic system producing all-year round steelhead with a biomass of 70 kg per m3 water. Cultivation of Salicornia europaea is based on a vertical (2-storey) deep-water culture system providing both fresh greens as well as dry stems for biofuel purposes. The total growing area is 16 m2 supplied daily with 14 hours of LED lighting providing 260-270 umol/m2/S (light particles hitting a m2 in one second). Data on PH-, Oxygen-, salinity- and temperature level is followed 24/7. Likewise, water consumption for the plant production is measured and compared with the final yield output. Water input to the fish is sea water from the North Sea of 3.5 wt% salinity pumped directly into the farm and diluted with fresh water reaching a level of 1.5 - 2.0 wt% salinity for the Salicornia. Nutrients for plants are based solely on fish effluent water targeting a limiting level of 75-80 mg of Nitrate per liter. Growth and content of desired plant components will show if a pure plant diet based on fish effluents and seawater are sufficient. Under investigation are Fresh Green Tips Yield (kg per m2), Dry Forage Biomass (kg per m2), optimal harvest periods per plant season, optimal plant spacing, optimal fertilization, optimal LED lighting. For the economic part, a contribution margin sheet is under construction, containing Turn Over (sales), Variable Costs (fertilizer, electricity, seed etc.), Fixed Costs (investment on production system), and expected profit.
Short title in native language	Dyrkning af Salicornia spp. sammen med saltvands fiskeproduktion

Short summary for practitioners in <u>native language</u> (*can be the language of the coordinator / one of the partners - otherwise in English*) (1000-1500 characters, word count – no spaces). This summary should at least contain the following information: − Main **results/outcomes** of the activity (expected or final) − The **main practical recommendation(s)**: what would be the main added value/benefit/opportunities to the end-user if the generated knowledge is implemented? How can the practitioner make use of the results? This summary should be as interesting as possible for farmers/end-users, using <u>a direct and easy understandable language</u> and pointing out entrepreneurial elements which are particularly relevant for practitioners (e.g. related to cost, productivity etc). Research oriented aspects which do not help the understanding of the practice itself should be avoided.	Baseret på et indendørs akvaponisk system, der producerer havørred året rundt med en biomasse på 70 kg pr. m3 vand. Dyrkning af Salicornia europaea er baseret på et vertikalt (2-etagers) hydroponisk system, der giver både friske grønne skud såvel som tørre stængler til biobrændstofformål. Det samlede vækstareal er på 16 m2, der forsynes dagligt med 14 timers LED-belysning med 260-270 umol/m2/S (lyspartikler som rammer en m2 per sekund). Data om PH-, Ilt-, saltholdigheds- og temperaturniveau følges 24/7. Ligeledes måles vandforbruget til planteproduktionen og sammenlignes med det endelige udbytte. Vandinput til fiskene er havvand fra Nordsøen med saltholdighed på 3,5% som fortyndes med ferskvand, til et niveau på 1,5 - 2,0% saltholdighed for Salicornia e. Næringsstoffer til planter er udelukkende baseret på udløbsvand fra fisk med et grænseniveau på 75-80 mg nitrat pr. liter. Vækst og indhold af ønskede plantekomponenter vil vise, om en plantediæt baseret på fiskeafløb og havvand er tilstrækkelig sammenlignet med planter tildelt en optimal næringsopløsning. Samlet undersøges der for detaljer som udbytte af friske grønne skud (kg pr. m2), tørfoderbiomasse (kg pr. m2), optimale høstperioder pr. plantesæson, optimal planteafstand, optimal gødskning, optimal LED-belysning. For den økonomiske del er et dækningsbidrag under opbygning, indeholdende Omsætning (salg), Variable Omkostninger (gødning, elektricitet, frø etc.), Faste Omkostninger (investering i produktionssystem) og forventet avance.

Practice "abstract" 8:	*Several practice abstracts may be needed for one project, depending on the size of the project and the number of outcomes/recommendations which are ready for practice.*
Short title in English	Low input extraction of bioactive phytochemicals from Salicornia residue s
Short summary for practitioners in english on the (final or expected) outcomes (1000-1500 characters, word count – no spaces). *Do not complete if the summary below is completed in English* This summary should at least contain the following information: − Main **results/outcomes** of the activity (expected or final) − The **main practical recommendation(s)**: what would be the main added value/benefit/opportunities to the end-user if the generated knowledge is implemented? How can the practitioner make use of the results? This summary should be as interesting as possible for farmers/end-users, using a direct and easy understandable language and pointing out entrepreneurial elements which are particularly relevant for practitioners (e.g. related to cost, productivity etc). Research oriented aspects which do not help the understanding of the practice itself should be avoided.	Bioactive plant-based compounds, here phenolics, can be extracted from the residual straw of Salicornia ramosissima (glasswort) for use in cosmetics, feed, or food supplements. As the species in the glasswort family are known to produce a high concentration of said bioactive compounds, a concentrated extractives fraction can yield a high profit for the producer with easily manageable methods. As the bioactive compounds of interest are bound in the cellular tissue of the biomass, these are targeted removed. Methods investigated were decoction, maceration, sub-critical water extraction, ultrasound-assisted extraction, alkaline hydrolysis, and conventional Soxhlet extraction. Of these individual methods, sub-critical water extraction showed the best extraction yields without the use of chemicals. An extraction at 140 °C and 2-3 cycles of 15 min is proposed for economical and practical reasons. Alkaline hydrolysis, already used in agriculture for some grains, showed to be an excellent extraction method to extract bound and conjugate phenolic compounds. Soxhlet extraction is a good extraction method if the use of chemicals or high pressure and temperature should be avoided. Alkaline hydrolysis extracts high amounts of phenolics after a first extraction, and could therefore be used in conjunction with a different primary extraction. Alkaline hydrolysis extracts more monophenolic compounds and isoquercitrin, e.g. caffeic acid (5.70 g/kg biomass at 4.08 $/g), isoquercitrin (1.84 g/kg biomass, 2472 $/g). Sub-critical water extraction targets more polyphenolic compounds, e.g. neochlorogenic acid (0.184 g/kg biomass at 10955 $/g), isoquercitrin (0.527 g/kg biomass at 2472 $/g) (prices source: https://www.sigmaaldrich.com).
Short title in native language	Lavenergi ekstraktion af bioaktive fytokemikalier fra Salicornia

Short summary for practitioners in <u>native language</u> (*can be the language of the coordinator / one of the partners - otherwise in English*) (1000-1500 characters, word count – no spaces).

This summary should at least contain the following information:
- Main **results/outcomes** of the activity (expected or final)
- The **main practical recommendation(s)**: what would be the main added value/benefit/opportunities to the end-user if the generated knowledge is implemented? How can the practitioner make use of the results?

This summary should be as interesting as possible for farmers/end-users, using <u>a direct and easy understandable language</u> and pointing out entrepreneurial elements which are particularly relevant for practitioners (e.g. related to cost, productivity etc). Research oriented aspects which do not help the understanding of the practice itself should be avoided.

Bioaktive plantebaserede stoffer, her kaldet fenoler, kan ekstraheres fra overskudsplantemateriale fra Salicornia ramosissima (salturt) til brug i kosmetik, foder eller fødevaresupplementer. Eftersom arterne i salturtplantefamilien er kendt for at producere høje koncentrationer af disse bioaktive stoffer, kan en koncentreret ekstraktfraktion give højt afkast for en producent med nemt tilgængelige metoder.
Da de bioaktive stoffer af interesse er bundet i det cellulære væv i biomassen, er disse forsøgt frigjort. Metoder brugt til dette var afkogning, maceration, sub-kritisk vand ekstraktion, ultralydsassisteret ekstraktion, base hydrolyse og konventionel Soxhlet ekstraktion. Af disse metoder viser sub-kritisk ekstraktion sig at have højest ekstraktionsudbytte uden brug af kemikalier. En ekstraktion ved 140 °C, 2-3 cyklusser af 15 min er forslået af økonomiske og praktiske årsager. Base hydrolyse, allerede brugt i landbruget til behandling af nogle typer af korn, viste fremragende egenskaber til at ekstrahere bundne og konjugerede fenoler. Soxhlet ekstraktion er en god ekstraktionsmetode hvis brugen af kemikalier eller højt tryk og høj temperatur skal undgås. Base hydrolyse ekstraherer større mængder af fenoler efter første ekstraktion, og kan derfor bruges i sammenhæng med en sekundær ekstraktion. Base hydrolyse ekstraherer flere monofenoler og isoquercitrin end andre ekstraktionsmetoder, f.eks. koffeinsyre (5,70 g/kg biomasse at 26,71 DKK/g), isoquercitrin (1,84 g/kg biomasse, 16.182 DKK/g). Sub-kritisk vand ekstraktion ekstraherer flere polyfenoler, f.eks. neoklorogensyre (0,184 g/kg biomasse, 71.714 DKK/g), isoquercitrin (0,527 g/kg biomasse, 16.182 DKK/g) (priskilde: https://www.sigmaaldrich.com).

Practice "abstract" 9:

Several practice abstracts may be needed for one project, depending on the size of the project and the number of outcomes/recommendations which are ready for practice.

Short title in English

Antioxidant and polyphenol content of Salicornia straw and their potential

Short summary for practitioners in english on the (final or expected) outcomes (1000-1500 characters, word count – no spaces). *Do not complete if the summary below is completed in English*

This summary should at least contain the following information:

- Main **results/outcomes** of the activity (expected or final)
- The **main practical recommendation(s)**: what would be the main added value/benefit/opportunities to the end-user if the generated knowledge is implemented? How can the practitioner make use of the results?

This summary should be as interesting as possible for farmers/end-users, using a direct and easy understandable language and pointing out entrepreneurial elements which are particularly relevant for practitioners (e.g. related to cost, productivity etc). Research oriented aspects which do not help the understanding of the practice itself should be avoided.

Bioactive plant-based compounds, phenolics, can be extracted from the residual straw of Salicornia ramosissima (glasswort) for use in cosmetics, feed, or food supplements. Analytical methods allow quantifying the antioxidant capacity and phenolic content of the extracts. The antioxidant capacity is analyzed by the DPPH antioxidant capacity assay. The concentration of phenolics, quantified as gallic acid equivalents (GAE), was determined by the Folin-Ciocalteu method. This resulted in a concentration of 4.5 g GAE/kg biomass, at subcritical water extraction, or similarly 4.6 g GAE/kg biomass for Soxhlet extraction, outperforming the known polyphenolic-rich Vaccinium corymbosium (blueberry) with reported values of 1.8-4.3 g GAE/kg biomass. Also the qualitative concentration of monophenolic and polyphenolic compounds was analyzed by chromatography for 15 bioactive compounds, including hydroxybenzoic acids, hydroxycinnamic acids, caffeoylquinic acids, and flavonoids. All mentioned molecule classes are proven antioxidant. Using different extraction methods, these compounds can be extracted. Polyphenolic antioxidants extensively degrade into smaller, less antioxidant monophenolic compounds in the digestive system of animals and humans. This emphasizes the necessity of stabilization of the molecules before the potential use in feed/food, as this will also increase the uptake of the polyphenolic compounds. The stabilization also tends to increase the digestibility of the polyphenolic compounds. Salicornia ramosissima has a high content of phenolic compounds, and can, if cleaned from salts, be introduced in a feed/food formula resulting in increased antioxidant and phenolic concentration of the product.

Short title in native language

Antioxidant og polyfenol indhold i Salicornia overskudsplantemateriale

Short summary for practitioners in <u>native language</u> (*can be the language of the coordinator / one of the partners - otherwise in English*) (1000-1500 characters, word count – no spaces).

This summary should at least contain the following information:

- Main **results/outcomes** of the activity (expected or final)
- The **main practical recommendation(s)**: what would be the main added value/benefit/opportunities to the end-user if the generated knowledge is implemented? How can the practitioner make use of the results?

This summary should be as interesting as possible for farmers/end-users, using <u>a direct and easy understandable language</u> and pointing out entrepreneurial elements which are particularly relevant for practitioners (e.g. related to cost, productivity etc). Research oriented aspects which do not help the understanding of the practice itself should be avoided.

Bioaktive plantebaserede stoffer, her kaldet fenoler, kan ekstraheres fra overskudsplantemateriale fra Salicornia ramosissima (salturt) til brug i kosmetik, foder eller fødevaresupplementer. Analytiske metoder muliggør kvantificeringen af antioxidant kapacitet og fenolindhold i ekstraktet.

Antioxidant kapaciteten er analyseret med DPPH antioxidant kapacitet metoden. Koncentrationen af fenoler, kvantificeret i gallussyre ækvivalenter (GAE), var besluttet ved Folin-Ciocalteu metoden. Dette resulterede i en koncentration på 4,5 g GAE/kg biomasse ved subkritisk vand ekstraktion, og ligeledes 4,6 g GAE/kg biomasse for Soxhlet ekstraktion, hvilket er et bedre resultat end den kendte polyfenolrige Vaccinium corymbosium (blåbær) med en reporteret værdi på 1,8-4,3 g GAE/kg biomasse. Den kvalitative koncentration af monofenoler og polyfenoler var også bestemt for 15 bioaktive stoffer, herunder hydrobenzoesyrer, hydrokanelsyrer, caffeoylquinicsyrer og flavonoider. Alle nævnte molekyleklasser er bevist antioxidante. Ved brug af forskellige ekstraktionsmetoder kan disse stoffer ekstraheres. Antioxidante polyfenoler degraderer ofte til de mindre monofenoler, som også er mindre antioxidante i fordøjelses systemet hos mennesker og dyr. Dette understreger nødvendigheden af stabilisering af molekylerne før potentiel brug i foder/fødevarer, da dette også vil forøge optagelsen af polyfenoler. Stabiliseringen har også tendens til at forøge fordøjeligheden af polyfenoler. Salicornia ramosissima har en høj koncentration af fenoler og kan, hvis renset for salte, introduceres i en foder-/fødevareformel som kan resultere i en forhøjet antioxidant kapacitet og fenolkoncentration i foder-/fødevareproduktet.

Practice "abstract" 10:	*Several practice abstracts may be needed for one project, depending on the size of the project and the number of outcomes/recommendations which are ready for practice.*
Short title in English	Production of pre- and pro-biotic protein rich additive for functional feeds
Short summary for practitioners in english on the (final or expected) outcomes (1000-1500 characters, word count – no spaces). *Do not complete if the summary below is completed in English* This summary should at least contain the following information: − Main **results/outcomes** of the activity (expected or final) − The **main practical recommendation(s)**: what would be the main added value/benefit/opportunities to the end-user if the generated knowledge is implemented? How can the practitioner make use of the results? This summary should be as interesting as possible for farmers/end-users, using a direct and easy understandable language and pointing out entrepreneurial elements which are particularly relevant for practitioners (e.g. related to cost, productivity etc). Research oriented aspects which do not help the understanding of the practice itself should be avoided.	In this practice, the aim is to produce bio-active and protein-rich feed supplement for aquacultures and livestock from halophyte juice. This type of feed could not only improve the animal health, but could also provide a locally produced high-quality protein source. This decreases the dependency of protein imported from overseas, such as soybean. The protein is separated from green juice by acidification, which is done by fermenting the juice with lactic acid bacteria. During the fermentation, the produced lactic acid decreases the pH of the green juice, which makes protein insoluble in water and allows it to coagulate. Therefore, the protein-enriched concentrate can be easily separated, for example by centrifugation. As the produced cell mass is also present in the concentrate, it is desired to perform the fermentation using pre-biotic Lactobacillus strain. Considered halophyte species are relatively rich in protein, for example, the crude protein content of green juice dry matter from Tripolium pannonicum (sea aster) is up to 36.7 wt%, which is comparable to common legumes, such as lentil and chickpea. Tripolium pannonicum juice also has high concentration of available sugars, thus additive feeding of micro-organisms is not needed. Probiotic protein-enriched concentrate could also be a source of some other health beneficial compounds, such as phytochemicals and healthy fatty acids. The liquid fraction after separation can be utilized in biogas production. Overall, this method is cost-efficient and safe, and does not require high process temperatures or use of hazardous chemicals. Required fermentation time is also short, and processing requires only a few equipment.
Short title in native language	Produktion af præ- og probiotisk proteinrigt addetiv til funktionelt foder

Short summary for practitioners in <u>native language</u> (*can be the language of the coordinator / one of the partners - otherwise in English*) (1000-1500 characters, word count – no spaces). This summary should at least contain the following information: − Main **results/outcomes** of the activity (expected or final) − The **main practical recommendation(s)**: what would be the main added value/benefit/opportunities to the end-user if the generated knowledge is implemented? How can the practitioner make use of the results? This summary should be as interesting as possible for farmers/end-users, using <u>a direct and easy understandable language</u> and pointing out entrepreneurial elements which are particularly relevant for practitioners (e.g. related to cost, productivity etc). Research oriented aspects which do not help the understanding of the practice itself should be avoided.	I denne praktisering er formålet at producere bioaktive og proteinrigt fodersupplement til akvakulturer og til husdyr fra halofyt juice. Denne type foder kan ikke kun forbedre dyrs helbred, men kan også være et lokalt produceret højkvalitetsprotein. Dette mindsker afhængigheden af oversøisk importeret protein, for eksempel sojabønner. Proteinet er separeret fra den grønne juice ved forsuring, hvilket er gjort ved at fermentere juice med mælkesyrebakterier. Under fermenteringen vil den producerede mælkesyre sænke pH-værdien af den grønne juice, hvilket vil gøre proteinet uopløseligt i vand, og derved tillader det at koagulere. Derfor kan det proteinrige koncentrat nemt separeres, for eksempel ved centrifugering. Eftersom den producerede cellemasse også er i koncentratet er det ønsket at lave fermenteringen med den pro-biotiske Lactobacillus stamme. De anvendte halofytter er relativt proteinrige, for eksempel er råproteinen i tørstoffet fra den grønne juice af Tripolium pannonicum op til 36,7 m%, hvilket er sammenligneligt med gængse bælgfrugter som linser og kikærter. Tripolium pannonicum juice har også en høj koncentration af frie sukre, så derved er tilføjelse af føde for mikroorganismerne ikke nødvendig. Probiotisk proteinberiget koncentrat kan også være en kilde til andre sundhedsgavnlige stoffer, som fytokemikalier og sunde fedtsyrer. Den flydende fraktion efter separation kan blive brugt i biogasproduktion. Samlet set er denne metode omkostningseffektiv og sikker, og har ikke behov for høj procestemperaturer eller brug af farlige kemikalier. Fermenteringstiden er kort, og processeringen kræver kun få nemt tilgængelige stykker udstyr.

Practice "abstract" 11:

Several practice abstracts may be needed for one project, depending on the size of the project and the number of outcomes/recommendations which are ready for practice.

Short title in English

Green fractionation and protein production from non-food succulent bioma

Short summary for practitioners in english on the (final or expected) outcomes (1000-1500 characters, word count – no spaces). *Do not complete if the summary below is completed in English*

This summary should at least contain the following information:

- Main **results/outcomes** of the activity (expected or final)
- The **main practical recommendation(s)**: what would be the main added value/benefit/opportunities to the end-user if the generated knowledge is implemented? How can the practitioner make use of the results?

This summary should be as interesting as possible for farmers/end-users, using a direct and easy understandable language and pointing out entrepreneurial elements which are particularly relevant for practitioners (e.g. related to cost, productivity etc). Research oriented aspects which do not help the understanding of the practice itself should be avoided.

Growing Salicornia for food production in un- or underutilized land flooded with seawater can be very rewarding. As a farmer, growing Salicornia means you are future proof, ready for an everchanging climate and rising sea levels.
However only about 30 wt% of the Salicornia plant is suitable to eat and the remaining plant cannot be used in traditional means because of the high amounts of salt in the plant. Nonetheless it is crucial that one finds a way to use these leftovers to improve the economic viability.
As discovered in this project, the leftover plant mass still has a lot of interesting possibilities as it contains proteins, sugars and other components that are easily extracted and could provide additional revenue after the harvest. A simple but effective method for the extraction of a protein-enriched fraction has been developed.
Practically we start by extracting juice from Salicornia. This juice contains many nutrients but still has a lot of salt. The best way to concentrate the nutrients and reduce salt is by centrifugation. This is a process where we exert a force on a liquid by spinning it. This causes chunks full of proteins to separate from the liquid and sink to the bottom. After spinning the liquid is removed together with the salt. The solid chunk on the bottom can then be dried.
Using this method we have already processed more than 300 kg of Salicornia. Currently feeding trials are on their way to investigate the health effects of this Salicornia fraction when it is included in the regular diet of fish. We have reasons to believe that it might not only feed the farmed fish, but also provide them with protection against certain diseases, potentially reducing the need for antibiotics during their cultivation

Short title in native language

Fractionnement vert et production de protéines à partir de la biomasse

Short summary for practitioners in <u>native language</u> (*can be the language of the coordinator / one of the partners - otherwise in English*) (1000-1500 characters, word count – no spaces). This summary should at least contain the following information: − Main **results/outcomes** of the activity (expected or final) − The **main practical recommendation(s)**: what would be the main added value/benefit/opportunities to the end-user if the generated knowledge is implemented? How can the practitioner make use of the results? This summary should be as interesting as possible for farmers/end-users, using <u>a direct and easy understandable language</u> and pointing out entrepreneurial elements which are particularly relevant for practitioners (e.g. related to cost, productivity etc). Research oriented aspects which do not help the understanding of the practice itself should be avoided.	La culture de la salicorne sur des terres inondées par l'eau de mer peut être très rentable. Cultiver la salicorne signifie que vous, agriculteurs, êtes à l'épreuve du temps, prêts pour un climat en constante évolution et une élévation du niveau de la mer. Cependant, seulement 30% du poids de la plante est consommé. Les 70% restants ne peuvent pas être utilisés de manière traditionnelle en raison des quantités élevées de sel retrouvées dans la salicorne. Néanmoins, pour augmenter la viabilité économique de cette culture, il est crucial de trouver un moyen d'utiliser l'entièreté de la plante. Dans ce projet, on a découvert que la masse végétale restante (les 70% restants) a des propriétés intéressantes. Elle contient des protéines, des sucres et d'autres composants qui sont faciles à extraire et pourraient fournir des revenus supplémentaires après la récolte. Or, le projet apporte une méthode simple mais efficace pour l'extraction d'une fraction enrichie en protéines. En pratique, on commence par l'extraction du jus de salicorne qui contient de nombreux nutriments mais encore beaucoup de sel. La meilleure façon de concentrer les nutriments et de réduire le sel est la centrifugation. Ce processus permet de séparer des particules d'une solution selon leur densité grâce à une force centrifuge. Les protéines se séparent alors du reste du jus et forme un amas dans le fond du contenant, appelé le culot. Après essorage, le liquide qui contient le sel est éliminé et le culot est séché. En utilisant cette méthode, nous avons déjà traité plus de 300 kg de salicorne. Actuellement, les effets sur la santé des poissons sont étudiés en ajoutant des fractions de salicorne dans leur régime alimentaire. Nous avons des raisons de croire que les protéines de salicorne pourraient non seulement nourrir les poissons d'élevage, mais aussi leur fournir une protection contre certaines maladies, réduisant potentiellement le besoin d'antibiotiques pendant leur élevage.

Practice "abstract" 12:

Several practice abstracts may be needed for one project, depending on the size of the project and the number of outcomes/recommendations which are ready for practice.

Short title in English

Chemical variation in halophyte biomass cultivated at different salinities

Short summary for practitioners in english on the (final or expected) outcomes (1000-1500 characters, word count – no spaces). *Do not complete if the summary below is completed in English*

This summary should at least contain the following information:

- Main **results/outcomes** of the activity (expected or final)
- The **main practical recommendation(s)**: what would be the main added value/benefit/opportunities to the end-user if the generated knowledge is implemented? How can the practitioner make use of the results?

This summary should be as interesting as possible for farmers/end-users, using a direct and easy understandable language and pointing out entrepreneurial elements which are particularly relevant for practitioners (e.g. related to cost, productivity etc). Research oriented aspects which do not help the understanding of the practice itself should be avoided.

An increase in cultivation salinity causes oxidative stress in plants and can affect the chemical composition of biomass. Therefore, the effect of cultivation salinity on the yield and composition of Salicornia europaea, Tripolium pannonicum and Crithmum maritimum was analysed in a characterisation study. S. europaea and T. pannonicum were cultivated in a hydroponic system under 0, 10, 20, 30, and 40 g/l NaCl salinities. C. maritimum could not survive under the highest salinity conditions; therefore, it was cultivated under 0, 5, 10, 15 and 20 g/l salinities. Biomass was harvested green, but not-food grade, and fractionated to green juice and fibre residue using a single-auger screw press. The composition of these fractions were analysed separately for the contents of carbohydrates, Klason lignin, protein, lipids, organic acids and minerals. By knowing the effect of salinity on the biomass composition, the cultivation could be optimised to enhance the production of desired compounds. The highest S. europaea yield was obtained in 20 g/l NaCl salinity, and these plants also had the highest lignocellulose content, 26.1 wt%, and the lowest crude protein content, 14.4 wt%. C. maritimum yielded the highest amount of biomass in 0 g/l NaCl, and for T. pannonicum, no significant change was observed in yield from batches grown in 0 g/l NaCl and 10 g/l NaCl. Salinity affected mainly the biomass yield instead of the composition, and only a few significant changes were observed. T. pannonicum dry matter was high in protein (29.9 wt%) and content is comparable to common legumes. Lipid content was low (< 4 wt%) in all species. C. maritimum exhibited the lowest salt accumulation. Halophyte species can be seen as a potential feedstock for green biorefinery.

Short title in native language

Kemisk variation i halofytbiomasse kultiveret ved forskellige

Short summary for practitioners in <u>native language</u> (*can be the language of the coordinator / one of the partners - otherwise in English*) (1000-1500 characters, word count – no spaces). This summary should at least contain the following information: − Main **results/outcomes** of the activity (expected or final) − The **main practical recommendation(s)**: what would be the main added value/benefit/opportunities to the end-user if the generated knowledge is implemented? How can the practitioner make use of the results? This summary should be as interesting as possible for farmers/end-users, using <u>a direct and easy understandable language</u> and pointing out entrepreneurial elements which are particularly relevant for practitioners (e.g. related to cost, productivity etc). Research oriented aspects which do not help the understanding of the practice itself should be avoided.	En øgning i dyrkningssaltholdighed forsager oxidativ stress i planter og kan påvirke den kemiske komposition af biomasse. Derfor er effekten af dyrkningssaltholdighed på udbyttet og kompositionen af Salicornia europaea, Tripolium pannonicum og Crithmum maritimum analyseret i en karakteriseringsundersøgelse. S. europaea og T. pannonicum var kultiveret i et hydroponisk system ved 0, 10, 20, 30 og 40 g/l NaCl saltholdigheder. Biomassen var høstet grønt, dog ikke fødevare-kvalitet, og fraktioneret til en grøn juice og en fiberrest ved brug af en sneglskruepresse. Kompositionen af disse to fraktioner var analyseret separat for kulhydrater, Klason lignin, protein, lipider, organiske syrer og mineraler. Ved at kende effekten af saltholdighed på biomassens komposition kan kultiveringen optimeres for at øge produktionen af de ønskede forbindelser. Det højeste udbytte for S. europaea var fundet ved 20 g/l NaCl saltholdighed, og disse planter havde også det højeste lignocelluloseindhold, 26,1 m%, og det laveste råproteinindhold, 14,4 m%. C. maritimum gav det højeste udbytte af biomasse ved 0 g/l NaCl, og ved T. pannonicum var der ikke observeret nogen signifikant forskel mellem kultivering ved 0 g/l NaCl og 10 g/l NaCl. Saltinholdet havde primært en indvirkning på biomasse udbyttet, og kun få signifikante forskelle blev observeret. T. pannonicum tørstof var højt i protein (29,9 m%) og kompositionen er sammenlignelig med gængse bælgfrugter. Lipidindholdet var lavt (<4 m%) i alle arter. C. maritimum udviste laveste saltakkumulering. Halofytarter kan ses som potentielt råmateriale til grøn bioraffinaderi.

Practice "abstract" 13:

Several practice abstracts may be needed for one project, depending on the size of the project and the number of outcomes/recommendations which are ready for practice.

Short title in English

Pharmacological Insights into Halophyte Bioactive Extract Action on Anti-I

Short summary for practitioners in english on the (final or expected) outcomes (1000-1500 characters, word count – no spaces). *Do not complete if the summary below is completed in English*

This summary should at least contain the following information:

- Main **results/outcomes** of the activity (expected or final)
- The **main practical recommendation(s)**: what would be the main added value/benefit/opportunities to the end-user if the generated knowledge is implemented? How can the practitioner make use of the results?

This summary should be as interesting as possible for farmers/end-users, using a direct and easy understandable language and pointing out entrepreneurial elements which are particularly relevant for practitioners (e.g. related to cost, productivity etc). Research oriented aspects which do not help the understanding of the practice itself should be avoided.

The pharmacological activities in bioactive plant extracts play an increasing role in sustainable resources for valorization and biomedical applications. Bioactive phytochemicals, including natural compounds, secondary metabolites and their derivatives, have attracted significant attention for use in both medicinal products and cosmetic products. High salinity during growth and development also increases the level of free radicals in plants. Such potential beneficial dietary factors in small doses and complex combinations (e.g., polyphenols, fibers, polyunsaturated fatty acids, etc.) for lifestyle changes can lead to reduced inflammation and improved health; however, metabolic disturbances are key contributors to disease progression. Screening and testing of extracts from medicinal plants species, including halophytes, against a variety of pharmacological targets and disease conditions in order to benefit from the immense natural chemical diversity is a research focus in many laboratories and companies worldwide. Halophytic plants are an obvious resource because several studies have proved their antimicrobial effectiveness. Due to the multiple positive effects on health aspects such as antibiotic resistance, regulation of the inflammatory response, and pain analgesia, it increases the need to further investigate the mechanisms and pathways in which these plant species and their secondary metabolites are involved.
Our review highlights the pharmacological mode-of-action and current biomedical applications of key bioactive compounds applied as anti-inflammatory, bactericidal with antibiotics effects, and pain relief purposes in controlled clinical studies or preclinical studies. In this systematic review, the availability of bioactive compounds from several salt-tolerant plant species, mainly focusing on the three promising

Short title in native language

Farmakologisk indsigt i bioaktive halofyt planteekstrakters virkning

Short summary for practitioners in <u>native language</u> (*can be the language of the coordinator / one of the partners - otherwise in English*) (1000-1500 characters, word count – no spaces). This summary should at least contain the following information: − Main **results/outcomes** of the activity (expected or final) − The **main practical recommendation(s)**: what would be the main added value/benefit/opportunities to the end-user if the generated knowledge is implemented? How can the practitioner make use of the results? This summary should be as interesting as possible for farmers/end-users, using <u>a direct and easy understandable language</u> and pointing out entrepreneurial elements which are particularly relevant for practitioners (e.g. related to cost, productivity etc). Research oriented aspects which do not help the understanding of the practice itself should be avoided.	De farmakologiske komponenter i bioaktive planteekstrakter spiller en stigende rolle som bæredygtige ressourcer til valorisering af materialer og til biomedicinske anvendelser. Bioaktive fytokemikalier, herunder naturlige forbindelser, sekundære metabolitter og deres derivater, har tiltrukket sig betydelig opmærksomhed til brug i både lægemidler og kosmetiske produkter. Højt saltindhold under udvikling øger også niveauet af frie radikaler i salturt. Sådanne potentielle gavnlige kostfaktorer i små doser og komplekse kombinationer (f.eks. polyfenoler, fibre, flerumættede fedtsyrer osv.) til livsstilsændringer kan føre til reduceret inflammation og forbedret helbred; metaboliske forstyrrelser er imidlertid vigtige bidragydere til sygdomsprogression. Screening og test af ekstrakter fra lægeplantearter, herunder halofytter, mod en række farmakologiske mål og sygdomstilstande for at drage fordel af den enorme naturlige kemiske mangfoldighed er et forskningsfokus i mange laboratorier og virksomheder verden over. Halofytiske planter er en oplagt ressource, fordi flere undersøgelser har bevist deres antimikrobielle effektivitet. På grund af de mange positive effekter på sundhedsaspekter som antibiotikaresistens, regulering af den inflammatoriske respons og smerteanalgesi, øger det behovet for yderligere at undersøge de mekanismer og veje, hvori disse plantearter og deres sekundære metabolitter er involveret. Vores gennemgang fremhæver den farmakologiske virkemåde og aktuelle biomedicinske anvendelser af vigtige bioaktive forbindelser anvendt som antiinflammatoriske, bakteriedræbende med antibiotikaeffekter og smertelindrende formål i kontrollerede kliniske undersøgelser eller prækliniske undersøgelser. I denne systematiske gennemgang opsummeres og diskuteres tilgængeligheden af bioaktive forbindelser fra flere salt-tolerante plantearter, hovedsageligt med fokus på de tre lovende arter Aster tripolium, Crithmum maritimum og Salicornia europaea.

Practice "abstract" 14:	*Several practice abstracts may be needed for one project, depending on the size of the project and the number of outcomes/recommendations which are ready for practice.*
Short title in English	Anti-inflammatory and regenerative effects of Halophyte Bioactive Extracts
Short summary for practitioners in english on the (final or expected) outcomes (1000-1500 characters, word count – no spaces). *Do not complete if the summary below is completed in English* This summary should at least contain the following information: − Main **results/outcomes** of the activity (expected or final) − The **main practical recommendation(s)**: what would be the main added value/benefit/opportunities to the end-user if the generated knowledge is implemented? How can the practitioner make use of the results? This summary should be as interesting as possible for farmers/end-users, using a direct and easy understandable language and pointing out entrepreneurial elements which are particularly relevant for practitioners (e.g. related to cost, productivity etc). Research oriented aspects which do not help the understanding of the practice itself should be avoided.	Halophyte plants are salt-tolerant and are acclimated for growth in saline soils such as along coastal areas. Among the halophytes the Salicornia species have been used as both folk medicine and functional feed for multiple years due to high levels of bioactive compounds including anti-inflammatory and antioxidative effects. Halophyte farming in synergy with aquaculture may be used to create high value-added products in the cosmetic and pharmaceutical industry through the implements of continual use of resources and waste through prevention, reduction, and recycling. The properties of Salicornia bioactive extracts, for modulation of pain and itch sensation, remain still unclear. Prior to clinical assessment of such salicornia extract on skin conditions the effect of the prolonged application of aqueous extracts have to be addressed using healty subjects. In an exploratory study we obtained ethical approval to test 30 healthy volunteers for treatment with 10% Salicornia cream or inert vehicle cream for 24 or 48 hours. On day 0, and 24 or 48 hours post cream application thermal detection and pain thresholds, mechanical pain thresholds and sensitivity, and micro-vascular reactivity were assessed to evaluate the effects of cream containing Salicornia. Our data indicate an overall effect of the bioactive cream to reduce histamine induced itch although the study design and time-frame selected also show need for further assessment of the long-term effect after prolonged use. Future use of green technologies and renewable ingredients, as the S. ramosissima infused skin cream, as a putative primary treatment to reduce symptoms like itch and pain in different skin diseases, such as psoriasis and atopic dermatitis, could be favorable.
Short title in native language	Anti-inflammatoriske og regenererende virkninger af bioaktive Halophyte

Short summary for practitioners in <u>native language</u> (*can be the language of the coordinator / one of the partners - otherwise in English*) (1000-1500 characters, word count – no spaces). This summary should at least contain the following information: − Main **results/outcomes** of the activity (expected or final) − The **main practical recommendation(s)**: what would be the main added value/benefit/opportunities to the end-user if the generated knowledge is implemented? How can the practitioner make use of the results? This summary should be as interesting as possible for farmers/end-users, using <u>a direct and easy understandable language</u> and pointing out entrepreneurial elements which are particularly relevant for practitioners (e.g. related to cost, productivity etc). Research oriented aspects which do not help the understanding of the practice itself should be avoided.	Halofytter er salttolerante og er akklimatiseret til vækst i saltholdige jorder såsom langs kystområder. Blandt halofytterne er Salicornia-arterne blevet brugt som både folkemedicin og funktionelt foder i flere år på grund af høje niveauer af bioaktive forbindelser, herunder anti-inflammatoriske og antioxidative virkninger. Halofytopdræt i synergi med akvakultur kan bruges til at skabe produkter med høj værditilvækst i den kosmetiske og farmaceutiske industri gennem implementeringer af kontinuerlig brug af ressourcer og affald gennem forebyggelse, reduktion og genanvendelse. Egenskaberne af Salicornia bioaktive ekstrakter til modulering af smerte og kløefornemmelse er stadig uklare. Forud for klinisk vurdering af sådan salicornia-ekstrakt på hudsygdomme skal virkningen af den langvarige påføring af vandige ekstrakter behandles ved hjælp af raske forsøgspersoner. I en eksplorativ undersøgelse opnåede vi etisk godkendelse til at teste 30 raske frivillige til behandling med 10 % Salicornia-creme eller inert vehikelcreme i 24 eller 48 timer. På dag 0 og 24 eller 48 timer efter påføring af creme blev termisk detektion og smertetærskler, mekaniske smertetærskler og følsomhed og mikrovaskulær reaktivitet vurderet for at evaluere virkningerne af creme indeholdende Salicornia. Vores data indikerer en overordnet effekt af den bioaktive creme til at reducere histamin-induceret kløe, selvom undersøgelsesdesignet og den valgte tidsramme også viser behov for yderligere vurdering af den langsigtede effekt efter længere tids brug. Fremtidig brug af grønne teknologier og vedvarende ingredienser, som S. ramosissima-infunderet hudcreme, som en formodet primær behandling for at reducere symptomer som kløe og smerter i forskellige hudsygdomme, såsom psoriasis og atopisk dermatitis, kunne være gunstig.

Practice "abstract" 15:	*Several practice abstracts may be needed for one project, depending on the size of the project and the number of outcomes/recommendations which are ready for practice.*
Short title in English	Bactericidal and potential impact on multi-resistance bacterial by Halophyt
Short summary for practitioners in english on the (final or expected) outcomes (1000-1500 characters, word count – no spaces). *Do not complete if the summary below is completed in English* This summary should at least contain the following information: − Main **results/outcomes** of the activity (expected or final) − The **main practical recommendation(s)**: what would be the main added value/benefit/opportunities to the end-user if the generated knowledge is implemented? How can the practitioner make use of the results? This summary should be as interesting as possible for farmers/end-users, using a direct and easy understandable language and pointing out entrepreneurial elements which are particularly relevant for practitioners (e.g. related to cost, productivity etc). Research oriented aspects which do not help the understanding of the practice itself should be avoided.	Bioactive compounds for medical applications such as novel natural antibiotics and anti-inflammatory agents could be of rising value in green circular economics in order to solve future world health challenges. The increasing bacterial resistance to antibiotics has developed due to different factors such as overconsumption of antibiotics against bacterial and nonbacterial infections and unregulated use hereof. The AQUA-COMBINE project is a new business model endeavoring the implementation of continual use of resources and elimination of waste through prevention, reduction, and recycling. Halophyte extracts are known to have an antimicrobial effect on different bacterial strains. To investigate the putative antimicrobial effect of plant extract from Salicornia Europaea the proliferation rates of multiple clinical important bacteria including Klebsiella Pneumoniae species, Escherichia Coli, and Staphylococcus Aureus strains were investigated in relation to discover alternative treatment options in order to control rising antibiotic resistance. Klebsiella Pneumoniae species, Escherichia Coli, and Staphylococcus Aureus strains were exposed to diluted extract from Salicornia Europaea and the effect was measured using both time dependent test and agar well diffusion method. A sensitivity test using gentamicin and kanamycin was performed as a positive control to the agar well diffusion method. Preliminary results indicate a growth inhibitory effect and experiments are pending for investigating antibiotic resistance relevant parameters.
Short title in native language	Baktericid og potentiel indvirkning på multiresistente bakterier af

Short summary for practitioners in <u>native language</u> (*can be the language of the coordinator / one of the partners - otherwise in English*) (1000-1500 characters, word count – no spaces). This summary should at least contain the following information: − Main **results/outcomes** of the activity (expected or final) − The **main practical recommendation(s)**: what would be the main added value/benefit/opportunities to the end-user if the generated knowledge is implemented? How can the practitioner make use of the results? This summary should be as interesting as possible for farmers/end-users, using <u>a direct and easy understandable language</u> and pointing out entrepreneurial elements which are particularly relevant for practitioners (e.g. related to cost, productivity etc). Research oriented aspects which do not help the understanding of the practice itself should be avoided.	Bioaktive forbindelser til medicinske anvendelser såsom nye naturlige antibiotika og antiinflammatoriske midler kan være af stigende værdi i grøn cirkulær økonomi for at løse fremtidige sundhedsudfordringer i verden. Den stigende bakterielle resistens over for antibiotika er udviklet på grund af forskellige faktorer, såsom overforbrug af antibiotika mod bakterielle og ikke-bakterielle infektioner og ureguleret brug heraf. AQUA-COMBINE-projektet er en ny forretningsmodel, der bestræber sig på at implementere kontinuerlig brug af ressourcer og eliminering af affald gennem forebyggelse, reduktion og genanvendelse. Halofytekstrakter er kendt for at have en antimikrobiel virkning på forskellige bakteriestammer. For at undersøge den formodede antimikrobielle virkning af planteekstrakt fra Salicornia Europaea blev spredningsraterne for flere klinisk vigtige bakterier, herunder Klebsiella Pneumoniae-arter, Escherichia Coli og Staphylococcus Aureus-stammer, undersøgt i forhold til at opdage alternative behandlingsmuligheder for at kontrollere stigende antibiotikaresistens. Klebsiella Pneumoniae-arter, Escherichia Coli og Staphylococcus Aureus-stammer blev udsat for fortyndet ekstrakt fra Salicornia Europaea, og effekten blev målt ved hjælp af både tidsafhængig test og agarbrøndsdiffusionsmetode. En følsomhedstest under anvendelse af gentamicin og kanamycin blev udført som en positiv kontrol til agarbrøndsdiffusionsmetoden. Foreløbige resultater indikerer en vksthæmmende effekt, og der afventes eksperimenter til undersøgelse af relevante parametre for antibiotikaresistens.

Practice "abstract" 17:	*Several practice abstracts may be needed for one project, depending on the size of the project and the number of outcomes/recommendations which are ready for practice.*
Short title in English	Salicornia inedible residues can be used to replace cereals in aquafeeds f
Short summary for practitioners in english on the (final or expected) outcomes (1000-1500 characters, word count – no spaces). *Do not complete if the summary below is completed in English* This summary should at least contain the following information: − Main **results/outcomes** of the activity (expected or final) − The **main practical recommendation(s)**: what would be the main added value/benefit/opportunities to the end-user if the generated knowledge is implemented? How can the practitioner make use of the results? This summary should be as interesting as possible for farmers/end-users, using a direct and easy understandable language and pointing out entrepreneurial elements which are particularly relevant for practitioners (e.g. related to cost, productivity etc). Research oriented aspects which do not help the understanding of the practice itself should be avoided.	The whiteleg shrimp (Penaeus vannamei) is the most produced crustacean species worldwide. However, feed associated costs are substantial. In fact, cereal prices have been increasing over the years, making the creation of more economical and sustainable formulations essential for the success of shrimp farming. Therefore, the potential of incorporating a co-product, the non-edible biomass of Salicornia ramosissima, replacing wheat meal in diets for juvenile P. vannamei was evaluated. Two diets containing S. ramosissima stems and two containing leaves and seeds, both in 5% and 10% inclusion levels, were tested versus a commercial diet. After 55 days of feeding, shrimp growth performance and survival were similar among all diets. Nevertheless, shrimp fed diets containing Salicornia needed to eat more to achieve the same weight as those fed the commercial diet, especially those containing leaves and seeds at 10%. These results can be explained by the lower digestibility of dry matter, lipids and energy observed for this diet. Salicornia incorporation also seemed to provide some antioxidant supplementation to shrimp and improve immune response as well as disease resistance against Vibrio parahaemolyticus. Data from this study indicates that S. ramosissima biomass can be included in diets for juvenile P. vannamei with no detrimental effects on growth performance or survival, while providing some beneficial effects to their antioxidant and immune response. Additionally, shrimp were able to utilize Salicornia stem biomasses more successfully than leaves and seeds. This is the ideal scenario for adding value to halophyte production and potentially improve aquafeeds sustainability by replacing wheat meal.
Short title in native language	Resíduos não comestíveis de salicórnia podem substituir cereais em

Short summary for practitioners in <u>native language</u> (*can be the language of the coordinator / one of the partners - otherwise in English*) (1000-1500 characters, word count – no spaces). This summary should at least contain the following information: − Main **results/outcomes** of the activity (expected or final) − The **main practical recommendation(s)**: what would be the main added value/benefit/opportunities to the end-user if the generated knowledge is implemented? How can the practitioner make use of the results? This summary should be as interesting as possible for farmers/end-users, using <u>a direct and easy understandable language</u> and pointing out entrepreneurial elements which are particularly relevant for practitioners (e.g. related to cost, productivity etc). Research oriented aspects which do not help the understanding of the practice itself should be avoided.	O camarão Penaeus vannamei é a espécie de crustáceo mais produzida mundialmente. No entanto, os custos associados à ração são substanciais. O preço dos cereais tem aumentado gradualmente, tornando o desenvolvimento de rações mais económicas e sustentáveis essencial para a viabilidade da aquacultura. Assim, avaliou-se o potencial de incorporação de um coproduto, a biomassa não comestível de Salicornia ramosissima, em substituição da farinha de trigo, em dietas para juvenis de P. vannamei. Duas dietas contendo caules e duas com folhas e sementes de S. ramosíssima, ambas em níveis de inclusão de 5% e 10%, foram testadas contra uma dieta comercial. Após 55 dias de alimentação, o crescimento e sobrevivência dos camarões foi similar entre todas as dietas. No entanto, os camarões alimentados com as dietas experimentais, especialmente a que continha folhas e sementes a 10%, necessitaram de comer mais para atingir o mesmo peso daqueles alimentados com a dieta comercial. Estes resultados podem ser explicados pelos valores mais baixos de digestibilidade de matéria seca, lípidos e energia observados para as dietas experimentais. A inclusão de salicórnia parece fornecer alguma suplementação antioxidante e melhorar a resposta imune dos camarões, bem como a sua resistência contra Vibrio parahaemolyticus. Estes dados indicam que a biomassa de salicórnia pode ser incluída em dietas para camarões juvenis, sem efeitos prejudiciais no crescimento e sobrevivência, concedendo alguns efeitos benéficos de resposta antioxidante e imune. Os camarões utilizaram melhor a biomassa de caules de salicórnia do que a de folhas e sementes, sendo este o cenário ideal para adicionar valor à produção destas halófitas e, potencialmente melhorar a sustentabilidade de rações para aquacultura.

Several practice abstracts may be needed for one project, depending on the size of the project and the number of outcomes/recommendations which are ready for practice.

Practice "abstract" 18:

Short title in English

Incorporation of Salicornia in feeds for European seabass grow-out

Short summary for practitioners in english on the (final or expected) outcomes (1000-1500 characters, word count – no spaces). *Do not complete if the summary below is completed in English*

This summary should at least contain the following information:

- Main **results/outcomes** of the activity (expected or final)
- The **main practical recommendation(s)**: what would be the main added value/benefit/opportunities to the end-user if the generated knowledge is implemented? How can the practitioner make use of the results?

This summary should be as interesting as possible for farmers/end-users, using a direct and easy understandable language and pointing out entrepreneurial elements which are particularly relevant for practitioners (e.g. related to cost, productivity etc). Research oriented aspects which do not help the understanding of the practice itself should be avoided.

The tenderest stems of Salicornia are directed for human consumption, while the remaining parts of the plant considered a residue have great potential for animal nutrition. Although low in protein (9-10%), this Salicornia co-product may potentially serve as a source of carbohydrates in fish feeds, allowing for a reduction on the use of cereal eatable crops like wheat. The European seabass (Dicentrarchus labrax) is one of the most representative species from the aquaculture industry in the Mediterranean Sea, and therefore, the potential of incorporating Salicornia ramosissima biomass replacing wheat meal in diets for juvenile seabass was evaluated. Three diets containing S. ramosissima biomass at 2.5%, 5%, and 10% inclusion levels were tested versus a commercial diet.

After 62 days of feeding, fish growth performance, survival and feed digestibility were similar among all diets. Additionally, Salicornia incorporation seemed to provide some antioxidant supplementation to fish and improve their response to an inflammatory insult when compared to the commercial diet. Data from this study suggests that S. ramosissima biomass can be included in diets for juvenile seabass up to 10% of their composition with no detrimental effects on growth performance or survival, while providing some beneficial effects to their antioxidant and innate immune response and promoting DNA integrity. This is the ideal scenario for adding value to halophyte production and potentially improve aquafeeds sustainability by replacing wheat meal, which is a valuable resource for human consumption.

Short title in native language

Incorporação de Salicórnia em rações para juvenis de robalo europeu

Short summary for practitioners in <u>native language</u> (*can be the language of the coordinator / one of the partners - otherwise in English*) (1000-1500 characters, word count – no spaces). This summary should at least contain the following information: − Main **results/outcomes** of the activity (expected or final) − The **main practical recommendation(s)**: what would be the main added value/benefit/opportunities to the end-user if the generated knowledge is implemented? How can the practitioner make use of the results? This summary should be as interesting as possible for farmers/end-users, using <u>a direct and easy understandable language</u> and pointing out entrepreneurial elements which are particularly relevant for practitioners (e.g. related to cost, productivity etc). Research oriented aspects which do not help the understanding of the practice itself should be avoided.	As partes mais tenras da salicórnia destinam-se ao consumo humano, sendo as restantes partes da planta consideradas um resíduo, que pode ter, no entanto, um grande potencial para a nutrição animal. Apesar de ter baixos níveis de proteína (9-10%), este coproduto pode potencialmente servir como uma fonte de carboidratos em rações para peixes, permitindo uma redução no uso de cereais comestíveis, como o trigo. O robalo europeu (Dicentrarchus labrax) é uma das espécies mais representativas da aquacultura mediterrânea, e, por isso, a incorporação de biomassa de Salicornia ramosíssima, em substituição de farinha de trigo, foi avaliada em dietas para juvenis de robalo. Testaram-se três níveis de inclusão de biomassa de S. ramosissima (2.5%, 5% e 10%), em comparação com uma dieta comercial. Depois de 62 dias de alimentação, a performance de crescimento dos peixes, sobrevivência e digestibilidade das rações foi similar entre todas as dietas. Adicionalmente, as dietas com incorporação de salicórnia parecem ter conferido aos peixes alguma suplementação antioxidante e melhorado a sua resposta a um insulto inflamatório, quando comparadas com a dieta comercial. Os dados deste estudo sugerem que a biomassa de S. ramosissima pode ser incluída em dietas para juvenis de robalo, em níveis de inclusão até 10%, sem efeitos prejudiciais na performance de crescimento e sobrevivência dos peixes, e com efeitos benéficos na sua resposta imune inata e antioxidante, promovendo também uma proteção à integridade do ADN. Assim, este cenário parece ser ideal para adicionar valor à produção de halófitas e potencialmente melhorar a sustentabilidade de rações para aquacultura, substituindo a farinha de trigo, que é um recurso valioso para a alimentação humana.

Practice "abstract" 19:

Several practice abstracts may be needed for one project, depending on the size of the project and the number of outcomes/recommendations which are ready for practice.

Short title in English

Halophytes and their residues after biorefining for biogas production

Short summary for practitioners in english on the (final or expected) outcomes (1000-1500 characters, word count – no spaces). *Do not complete if the summary below is completed in English*

This summary should at least contain the following information:
- Main **results/outcomes** of the activity (expected or final)
- The **main practical recommendation(s)**: what would be the main added value/benefit/opportunities to the end-user if the generated knowledge is implemented? How can the practitioner make use of the results?

This summary should be as interesting as possible for farmers/end-users, using a direct and easy understandable language and pointing out entrepreneurial elements which are particularly relevant for practitioners (e.g. related to cost, productivity etc). Research oriented aspects which do not help the understanding of the practice itself should be avoided.

The EU project AQUACOMBINE investigates the full valorization of halophyte plants in a biorefinery concept to produce food, feed, bioactive compounds, bioenergy, and biochar. The investigations of cultivation and use of halophyte plants are especially important for extending the agricultural use of saline land areas that have increased globally in recent years.
Thus, more biomass can be grown on saline areas that can also be used for biogas production. The halophyte plants can either directly be used as biogas substrate or their residues after using the green tips as food and extraction of bioactive compounds, proteins, and fatty acids. The biogas yield of halophyte plants is similar to green grasses. However, the salt content of halophyte plants may cause inhibition of the biogas process if the biomass, especially its liquid fraction, is directly used as sole substrate in biogas plants.
Consequently, co-digestion of fresh halophyte plants with other substrates with lower salt content is recommended. Residual halophyte plant material after extraction of valuable compounds may, on the other hand, contain less salt thus having less or no inhibitory effects on the biogas process. This means that residues after biorefining of halophyte plant material can be preferably used as substrate for biogas plants, also in higher concentration. Furthermore, fiber residues that are treated in the biorefinery to remove lignin for biochar production, are easier degradable in the anaerobic digestion process, thus leading to a higher biogas yield than non-treated fibers.

Short title in native language

Biogaserzeugung aus Salzpflanzen und ihren Reststoffen nach

Short summary for practitioners in <u>native language</u> (*can be the language of the coordinator / one of the partners - otherwise in English*) (1000-1500 characters, word count – no spaces). This summary should at least contain the following information: − Main **results/outcomes** of the activity (expected or final) − The **main practical recommendation(s)**: what would be the main added value/benefit/opportunities to the end-user if the generated knowledge is implemented? How can the practitioner make use of the results? This summary should be as interesting as possible for farmers/end-users, using <u>a direct and easy understandable language</u> and pointing out entrepreneurial elements which are particularly relevant for practitioners (e.g. related to cost, productivity etc). Research oriented aspects which do not help the understanding of the practice itself should be avoided.	Das EU-Projekt AQUACOMBINE untersucht die Nutzbarmachung von Salzpflanzen (Halophyten) in einem Bioraffineriekonzept zur Erzeugung von Nahrungs- und Nahrungsergänzungsmitteln, Futtermitteln, Arzneimitteln sowie Biogas und Biokohle. Die Untersuchungen zu Anbau und Verwertung von Halophyten-Pflanzen ist besonders wichtig für den Ausbau der landwirtschaftlichen Nutzung von salzhaltigen Landflächen, die in den letzten Jahren weltweit zugenommen haben. So können auf salzhaltigen Flächen vermehrt Pflanzen auch für die Biogasproduktion angebaut werden. Diese können entweder direkt als Biogassubstrat eingesetzt werden oder deren Rückstände nach Verwendung der grünen Spitzen als Salat und nach Extraktion von bioaktiven Inhaltsstoffen, Proteinen und Fettsäuren. Die Biogasausbeute von Halophyten-Pflanzen ist ähnlich wie die von grünen Gräsern. Der Salzgehalt von Halophyten kann jedoch zur Hemmung des Biogasprozesses führen, wenn das Pflanzenmaterial, insbesondere die Flüssigphase, direkt als Monosubstrat in Biogasanlagen verwendet wird. Daher wird für die Biogaserzeugung aus frischen Halophyten-Pflanzen die Co-Vergärung mit anderen Substraten mit niedrigerem Salzgehalt empfohlen. Andererseits beinhalten die Pflanzenreststoffe nach den verschiedenen Extraktionsprozessen deutlich geringere Mengen an Salz und rufen daher weniger eine Hemmung des Biogasprozesses hervor. Dies bedeutet, dass die Reststoffe nach der Bioraffination von Halophytenpflanzen vorzugsweise und in höherer Konzentration als Substrat für Biogasanlagen verwendet werden können. Außerdem sind Faserrückstände, aus denen in der Bioraffinerie das Lignin für die Biokohleproduktion abgetrennt wurde, im anaeroben Vergärungsprozess leichter abbaubar als unbehandelte Fasern, was zu einer höheren Biogasausbeute führt.

Several practice abstracts may be needed for one project, depending on the size of the project and the number of outcomes/recommendations which are ready for practice.

Practice "abstract" 20:

Short title in English

Halophytes and their residues after biorefining for biochar production

Short summary for practitioners in english on the (final or expected) outcomes (1000-1500 characters, word count – no spaces). *Do not complete if the summary below is completed in English*

This summary should at least contain the following information:

- Main **results/outcomes** of the activity (expected or final)
- The **main practical recommendation(s)**: what would be the main added value/benefit/opportunities to the end-user if the generated knowledge is implemented? How can the practitioner make use of the results?

This summary should be as interesting as possible for farmers/end-users, using a direct and easy understandable language and pointing out entrepreneurial elements which are particularly relevant for practitioners (e.g. related to cost, productivity etc). Research oriented aspects which do not help the understanding of the practice itself should be avoided.

The AQUACOMBINE project investigates the full valorisation of halophyte plants to produce food, bioactive compounds, bioenergy, and biochar.
An integral use of the halophyte plant is of key importance for the overall profitability of this innovative crop and enables reaching a close to zero waste-balance. One important barrier to reach this goal is to deal with the most recalcitrant components of the plant.
Lignin is, by weight, the major recalcitrant fraction of the halophyte plant that cannot be transformed into biogas. In the AQUACOMBINE's biorefining scheme, the solution is to separate lignin from the woody parts of the plant via a selective process named 'organosolv'. This process leaves most of the non-recalcitrant components (mainly cellulose) in the main stream ready for biogas production. Then a separate process of treatment at high temperature (i.e. pyrolysis) under carefully selected conditions is used to transform the lignin granulates into a porous carbon material known as activated biochar. This product finds commercial application as filtering media for purification of water and air streams. As such, it can be used as filler media in filters for the purification of water streams generated in the hydroponic systems that are used for the cultivation of the halophyte plants. This approach not only provides a circular economy approach to the halophyte crop, but it also contributes to develop a commercially viable product obtained out of the main recalcitrant component of the plant.

Short title in native language

Gewinnung von Biokohle aus Salzpflanzen und ihren Reststoffen nach

Short summary for practitioners in <u>native language</u> (*can be the language of the coordinator / one of the partners - otherwise in English*) (1000-1500 characters, word count – no spaces). This summary should at least contain the following information: − Main **results/outcomes** of the activity (expected or final) − The **main practical recommendation(s)**: what would be the main added value/benefit/opportunities to the end-user if the generated knowledge is implemented? How can the practitioner make use of the results? This summary should be as interesting as possible for farmers/end-users, using <u>a direct and easy understandable language</u> and pointing out entrepreneurial elements which are particularly relevant for practitioners (e.g. related to cost, productivity etc). Research oriented aspects which do not help the understanding of the practice itself should be avoided.	Das EU-Projekt AQUACOMBINE untersucht die Nutzbarmachung von Salzpflanzen (Halophyten) in einem Bioraffineriekonzept zur Erzeugung von Nahrungs- und Nahrungsergänzungsmitteln, Futtermitteln, Arzneimitteln sowie Biogas und Biokohle. Für die wirtschaftliche Nutzung von Halophyten-Pflanzen als neuartige Nutzpflanze ist die vollständige Umsetzung der Pflanzen ohne Bildung von Abfallströmen von entscheidender Bedeutung. Hierzu gehört insbesondere auch die Wertschöpfung der schwer-abbaubaren Bestandteile der Pflanze. Lignin ist gewichtsmäßig der größte Bestandteil der Halophyten-Pflanze, der nur schwer biologisch abbaubar ist und nicht in Biogas umgewandelt werden kann. Im Bioraffineriesystem von AQUACOMBINE besteht die Lösung in der Abtrennung des Lignins aus den holzigen Pflanzenteilen durch das sogenannte "Organosolv" Verfahren. Bei diesem Verfahren wird das Lignin in der Flüssigphase gelöst, während die meisten abbaubaren Bestandteile (hauptsächlich Zellulose) als Faserstoffe zurückbleiben, die für die Biogaserzeugung sehr gut geeignet sind. Das Lignin wird anschließend als Ligningranulat in einem separaten Verfahren bei hoher Temperatur (Pyrolyse) unter sorgfältig ausgewählten Bedingungen in ein poröses Kohlenstoffmaterial, die so genannte Aktivkohle, umgewandelt. Aktivkohle findet kommerzielle Anwendung als Filtermedium für die Wasser- und Luftreinigung. So kann es ebenfalls als Füllmaterial in Filtern zur Wasseraufbereitung in Hydrokulturanlagen verwendet werden, in denen Halophyten-Pflanzen angebaut werden. Diese Anwendung bietet nicht nur einen kreislaufwirtschaftlichen Ansatz für den Halophytenanbau, sondern trägt auch zur Wirtschaftlichkeit des Gesamtsystems bei, indem auch der schwer abbaubare Bestandteil der Pflanze in ein kommerziell nutzbares Produkt umgewandelt wird.

Practice "abstract" 21:	*Several practice abstracts may be needed for one project, depending on the size of the project and the number of outcomes/recommendations which are ready for practice.*
Short title in English	Demonstration of combine aquaculture and Salicornia cultivation
Short summary for practitioners in english on the (final or expected) outcomes (1000-1500 characters, word count – no spaces). *Do not complete if the summary below is completed in English* This summary should at least contain the following information: − Main **results/outcomes** of the activity (expected or final) − The **main practical recommendation(s)**: what would be the main added value/benefit/opportunities to the end-user if the generated knowledge is implemented? How can the practitioner make use of the results? This summary should be as interesting as possible for farmers/end-users, using a direct and easy understandable language and pointing out entrepreneurial elements which are particularly relevant for practitioners (e.g. related to cost, productivity etc). Research oriented aspects which do not help the understanding of the practice itself should be avoided.	Production at demonstration scale is based on a decoupled aquaponic system, placed in-door and producing all-year round of steelhead. The cultivation of Salicornia europaea takes place on a vertical (2-storey) deep-water culture system (DWC), providing both fresh greens as well as dry stems for biorefinery purposes. The total growing area is 16 m2 supplied daily with 14 hours of LED lighting providing 260-270 umol/m2/S (light particles hitting a m2 in one second). Data on PH-, Oxygen-, salinity- and temperature level is monitored 24/7. Likewise, water consumption for the plant production is measured and will be compared with the final yield output. Water input to the fish is sea water from the North Sea of 3.5 wt% salinity pumped directly into the farm and diluted with fresh water reaching a level of 1.5 - 2.0 wt% salinity for the Salicornia. Nutrients for plants will be analyzed for growing solely on fish effluent targeting a limiting level of 75-80 mg of Nitrate per liter. Growth and content of desired plant components will show if a pure plant diet based on fish effluents and seawater will be sufficient. Any nutrient accumulation will be analyzed to conclude if the loop between fish and plant production can be closed completely, or additional filtering needs to take place. A contribution margin sheet will be provided as a valuable instrument for the end-user, containing turnover (sales), variable costs (fertilizer, electricity, seed etc.), fixed costs (investment on production system), and expected profit.
Short title in native language	Demonstration af akvakultur kombineret med en Salicornia produktion

Short summary for practitioners in <u>native language</u> (*can be the language of the coordinator / one of the partners - otherwise in English*) (1000-1500 characters, word count – no spaces). This summary should at least contain the following information: − Main **results/outcomes** of the activity (expected or final) − The **main practical recommendation(s)**: what would be the main added value/benefit/opportunities to the end-user if the generated knowledge is implemented? How can the practitioner make use of the results? This summary should be as interesting as possible for farmers/end-users, using <u>a direct and easy understandable language</u> and pointing out entrepreneurial elements which are particularly relevant for practitioners (e.g. related to cost, productivity etc). Research oriented aspects which do not help the understanding of the practice itself should be avoided.	Produktion i demonstrationsskala er baseret på et afkoblet akvaponisk system, som er placeret indendørs og producerer havørred hele året rundt. Dyrkningen af Salicornia europaea foregår på i et vertikalt (2-etagers) hydroponisk system, der giver både friske grønne skud til føde såvel som tørre stængler til bioraffinaderiformål. Det samlede vækstareal er 16 m2, der forsynes dagligt med 14 timers LED-belysning med 260-270 umol/m2/S (Lys partikler som rammer en m2 per sekund). Data om PH-, Ilt-, saltholdigheds- og temperaturniveau overvåges 24/7. Ligeledes måles vandforbruget til planteproduktionen og vil blive sammenlignet med det endelige udbytte. Vandinput til fisken er havvand fra Nordsøen med 3,5% saltholdighed pumpet direkte ind til produktionen og fortyndet med ferskvand til et niveau på 1,5 - 2,0% saltholdighed for Salicornia e. Næringsstoffer til planter dyrket på fiskespildevand tilført et grænseniveau på 75-80 mg nitrat pr. liter. Vækst og analyser for indhold af ønskede plantekomponenter vil vise, om en ren plantediæt baseret på fiskeafløb og havvand vil være tilstrækkelig sammenlignet med planter tilført en optimal næringsopløsning. En eventuel ophobning af næringsstoffer vil blive analyseret for at konkludere, om kredsløbet mellem fisk og planteproduktion kan lukkes fuldstændigt, eller om der skal foretages yderligere filtrering. Et dækningsbidrag vil blive leveret som et værdifuldt instrument for slutbrugeren, indeholdende omsætning (salg), variable omkostninger (gødning, elektricitet, frø etc.), faste omkostninger (investering i produktionssystemet) og forventet fortjeneste.