



| <b>General information</b>                      |  |
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| PPP number                                      | <b>AF14322</b>                                 |
| Title   | <b>Algae Linkages</b>                          |
| Roadmap/Umbrella                                | <b>TKI Agri &amp; Food kernthema CIRCULAIR</b> |
| Executive knowledge institution(s)              | <b>WFBR, WLR</b>                               |
| Research project leader (name + e-mail address) | <b>Lolke Sijtsma, lolke.sijtsma@wur.nl</b>     |
| Coordinator (on behalf of private parties)      | <b>Lolke Sijtsma</b>                           |
| Government contact person                       | <b>Patricia Wagenmakers</b>                    |
| Start date                                      | <b>01.03.2016</b>                              |
| End date  | <b>01.03.2020</b>                              |

| <b>Approval coordinator/consortium</b>                                      |   |
|---|---|
| The coordinator has assessed the annual report on behalf of the consortium: | X approved<br><input type="checkbox"/> rejected |
| Possible feedback on the annual report:                                     |   |

| <b>Short content description/aim PPS</b>   |
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| <p>Objective: In AlgaeLinkags a new, integrated and sustainable agrifood chain will be developed, using drain water from the Mexican greenhouse horticulture as a nutrient source for microalgae production. Next, his algal biomass will be studied as a healthy chicken feed to produce omega-3 enriched eggs. Future implementation of this agrifood chain will reduce the problems related to water quality in Mexico, and at the same time create a healthy and sustainable feed(ingredient) for enriched, healthy eggs, thereby using Dutch expertise and technology. Once proven successful and economically feasible the sustainable approach used in this project can be replicated in Mexico, the Netherlands and the rest of the world.</p> |

| <b>Planning and progress</b>                                       |   |
|--|---|
| Is the PPP going according to plan? <sup>1</sup>                   | No significant problems are encountered   |
| Have there been changes in the consortium/project partners?        | According to the project plan, Van Hall completed their activities in 2017.   |
| Is there a delay and/or deferred delivery date?                    | Due to some problems in producing relevant amounts of algal biomass, and availability in feeding slots, there is a delay in the start of WP3 (feed trials on chickens, start M6). We foresee, this work can start in Q3 2017.<br>Furthermore, Storage, processing and transport of algal biomass in relation to product stability and quality is a point of attention |
| Are there any substantive bottlenecks? Provide a brief description | No  |

<sup>1</sup> If applicable, use the explanation from the financial project report

|  |    |
|--|----|
| Are there any deviations from the projected budget?        | No |
| Do you expect a patent application to arise from this PPP? | No |

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| <p>Current summary of the project for the website Kennisonline</p> <p><b>AlgaeLinkages</b></p> <p>The overall goal of AlgaeLinkages is to develop a new, fully integrated and sustainable agrifood chain using drain water from the Mexican greenhouse industry as a source for microalgae production. This biomass will be used as poultry feed to generate omega-3 enriched eggs and improve animal health as well. In Mexico the greenhouse industry is expanding fast, giving rise to a huge amount of water that needs to be treated. Microalgae are able to reduce the amounts of nitrogen and phosphorus in the generated drain water from the greenhouse industry, using the remaining nutrients efficiently. Future implementation of this Agrifood chain will create sustainable feed and enriched, healthy eggs and, in the same process, decrease water scarcity problems, using Dutch knowledge and technology.</p> <p>Microalgae pilot plants will be tested using greenhouse drain water from a greenhouse near Queretaro in central Mexico. Upon storage and transport the produced microalgal biomass will be used in the Netherlands as poultry feed to study (i) in vitro and in vivo the digestibility and health of laying hens and (ii) the enrichment of the eggs with omega-3 fatty acids. The created additional value compared to existing poultry feed will be determined, for the current market and the possible future markets. Once proven successful and economically feasible the sustainable approach used in this project can be replicated in Mexico, the Netherlands and the rest of the world.</p> <p>July 2016 the kick-off of the project took place in the Agropark in Querétaro, Mexico.<br/> May 2017 a progress meeting including the Dutch and Mexican partners as well as an event to inform local industries, government and citizens about the project was organized by Finka/ Solar Gardens and Universidad Autónoma de Querétaro.</p> |
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**Highlights:**

## Highlights 2016

- Two *Nanochloropsis* species were selected as potential production strains.
- Three tubular photobioreactors of 750L and a laboratory have been installed closer to the greenhouses of Finka and a direct connection was made from the drain water leaving the greenhouse towards the microalgae production systems. First test trials in the tubular reactors have been done successfully using *Chlorella vulgaris*.
- Based on analyses of the greenhouse effluent from 2012 onwards, it can be concluded that sufficient nutrients, both macro and micro nutrients, are present in the greenhouse effluent to enable grow of microalgae. The greenhouse effluent has been mimicked to serve as feed water for the laboratory tests with *N. gaditana* and *N. limnetica*
- The greenhouse drain water as such appears not suitable for *N. gaditana* to grow on because of the effluents' low salinity compared to the normal salinity conditions of the species.

## Highlights 2017

- The greenhouse drain water appeared suitable for cultivation of n-3 (eicosapentaenoic) producing *N. limnetica*.
- Currently the average nitrogen and phosphorus levels in the greenhouse effluent are approximately four times and two times higher, respectively, than the maximum levels allowed for discharge in open bodies as defined by the local legislation.
- Based on experimental data, it can be inferred that *N. gaditana* won't be able to sufficiently consume nitrogen from the drain water, in a very large period of the year, to provide final effluents with nitrogen levels low enough to comprise with the local legislation.
- Phosphorus removal, even at relatively high greenhouse effluent (Pt) concentrations, would probably comprise with the local legislation.
- Apart from a list of compound that are allowed to use in the greenhouse, no further legislation was found concerning the discharge of pesticides or fungicides. According to data received from the greenhouse group experts, only authorized compounds were applied.
- A 5000L tank was installed after the UV system to store the drain water. This will assure that there is sufficient supply of clean water with nutrients for the cultivation of the microalgae. An automatic pressure pump was also installed after the 5000L tank to facilitate filling of the 750L reactors
- Since the UV system is not always functioning, additional disinfection methods (filter) were considered to treat the greenhouse effluent before feeding it to the algae cultivation. Disinfection is needed to reduce bacterial contamination in the algae cultivation.
- Cultivation systems of *N. limnetica* at scale (kg's biomass) under different climatological conditions (high day temperatures, low night temperatures, high irradiation), and harvest systems were further improved.
- The ultrasonic treatments, within the tested laboratory configurations (30-55 kHz for different HRT), have not shown significant (statistical) effect on the growth of *N. gaditana*, it's total fatty acid content or the amount of omega 3 and 6 fatty acids.
- In vitro digestibility experiments have indicated that milling of algal biomass improves digestibility

**Number of delivered products in 2017**

| Academic articles | Reports | Articles in journals/newsitems | Introductions/workshops |
|-------------------|---------|--------------------------------|-------------------------|
|                   |         | 5                              | 3                       |

## **Appendix: Names of the products or a link to the products on a public website**

### **Scientific Presentations/ introductions:**

**Sijtsma, L** (2017) AlgaeLinkages: Production of microalgae on greenhouse drain water for the production of poultry feed. Wetsus Congress 2017, Synergy in Research and Innovation , October 9-10, Leeuwarden, The Netherlands (<https://www.wetsus.nl/home/wetsus-news/wetsus-congress-2017> )

**Wijers, T.** (2017) Lipid content in microalgae for treatment of wastewater in greenhouses. ECO innovations from biomass congress, 28-29 June 2017, Papenburg, Germany

**Agostino, L** (2017) Key note speaker. Tecnologias para aproveitamento de águas salinas: experiência Internacional. (Technology development in Water Technology. The Dutch System and Experiences) I CIESA, 26 Nov – 1 Dec 2017; Belem, Brazil. <http://www.funasa.gov.br/web/i-ciesa>

### **Newsitems:**

Presentatie voortgang Algae Linkages project (Landbouwrraad, ambassade)

Nieuwsbericht | 06-06-2017 | 16:27

<https://www.agroberichtenbuitenland.nl/actueel/nieuws/2017/06/06/presentatie-voortgang-algae-linkages-project>

Newspaper: <https://ingenieria.uaq.mx/facultad-de-ingenieria-desarrolla-produccion-de-microalgas-para-impulsar-la-sustentabilidad-alimenticia/>

Newspaper: <http://www.elfinanciero.com.mx/bajio/en-la-uaq-producen-microalgas-para-alimentar-gallinas.html>

VHL: <https://www.hvhl.nl/nieuws/items/2017/bezoek-aan-mexico-voor-algalinkages-project.html>

Website: <http://www.alfa-editores.com.mx/tecnologia-agricola-mexicana-para-enriquecer-huevos-con-omega-3/>

### **Link naar Kennisonline/TKI AF:**

<http://topsectoragrifood.nl/project/algaelinkages/>

[https://www.wur.nl/upload\\_mm/1/8/7/87679e63-8396-4887-8ae4-473d85be0d90\\_Onderzoeksprogramma%20Topsectoren%20Wageningen%20University%20%26%20Research-WR%202018.pdf](https://www.wur.nl/upload_mm/1/8/7/87679e63-8396-4887-8ae4-473d85be0d90_Onderzoeksprogramma%20Topsectoren%20Wageningen%20University%20%26%20Research-WR%202018.pdf) p53

<https://www.wur.nl/nl/project/Algaelinkages-1.htm>

Akkoord: Hans van der Kolk (Topsectorsecretaris)