



QUAL È IL
FUTURO DEI
FORAGGI FUORI
SUOLO IN
ALIMENTAZIONE
ANIMALE?

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Short biography

My path.....



Research interests

- ➔ Influence of feeds and feeding on quality of dairy products
- ➔ Alternative feed sources for ruminants
- ➔ Livestock environmental impact assessment and mitigation strategies
- ➔ Animal welfare and behaviour (Human-Animal Relationships)

What are sprouted grains?

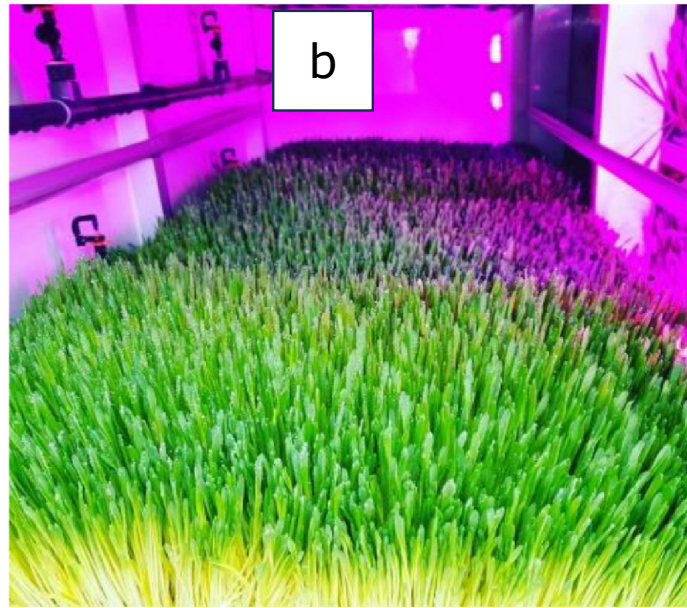
Feeds resulting from soilless germination and growth for a short period (6-8 d) of cereal seeds with high and rapid germination

- Barley is the commonly used seed
- Home grain sprouting is a common way to compensate for seasonal shortages of fresh forage in drought areas of Africa and Asia



Towards large-scale hydroponic feed production

Many start-up industries have developed around high-tech controlled environment feed production, especially in the United States, Australia, and Gulf countries



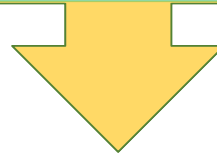
Fodder production in controlled environment settings: greenhouse (a), shipping container (b), vertical farm (c)

The large-scale hydroponic fodder plant

Fully automated process

Cut down the onset of molds and labour costs

Increase of production until 6000 kg/d as fed



Forage production claims

Soiless Forage production

Reduction of irrigation water

Year-round availability of green forage



Livestock farming context

Option for livestock farms with a shortage of arable land



The final product

Roots, seed kernels and the aerial green part of the seedlings, 12 - 14 cm in height, herein hydroponic fodder



Hydroponic feed for livestock

Searching for *fodder or hydroponic forages* yields enthusiastic sites showing cattle devouring sprouted grains 'like a vegetarian before a salad'.

What better feed for cattle than sprouted grains!



But what do we REALLY know?

- Anecdotal literature, mainly from Asian countries, evaluates the suitability of hydroponic forage as animal feed.
- Most studies are small scale and based on home-grown sprouts.
- The germination efficiency of different cereals is not well known.
- Lack of information on the quality of dairy products obtained by feeding animals with sprouted grains.

The open questions

What is the nutritional value of sprouted grains?

What is the yield and efficiency of the system?

May sprouted grains substitute traditional forages in ruminant feeding?

What are the effects on milk production?

Are reclaimed wastewater safe for producing hydroponic fodder?



Our activity



Cerase
Azienda
Agricola



Grains sprouting trial

In vivo feeding trial

Use of reclaimed
wastewater

The hydroponic system

- EA-38*2, Eleusis International, Spain
- Insulated panels shed (8 m x 100 m x 7 m)
- Two parallel production lines with 7 conveyor belts

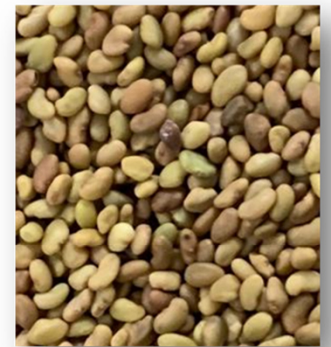
- Seeds germinate for 7 d
- Full automatized system

Daily fodder production capacity: 6000 kg



Step 1. Grains sprouting trial

Evaluate the biomass yield, the nutritional profile, and the in vitro digestibility of sprouted grains from different seeds



Hordeum vulgare

Avena sativa

Triticum durum

Triticum aestivum

Medicago sativa

Remarkable results

In 7 days of growth cycle, seedlings lose dry matter
- 0,8 Kg of fodder DM from 1 kg of seeds DM

True protein and non-fiber carbohydrate decreased in
sprouted grains compared with the raw seeds

**Barley shows the best yields and sprouted
barley has a similar nutritional profile to corn
silage**



Implications

Yield efficiency



Improvements

- cycle length (exploit photosynthesis)
- environmental conditions (nutrient in water, treated wastewater)
- seed varieties for soilless cultivation

Collaboration, prof. Rouphael group

In vivo feeding trial

Dairy buffalo farming

- Livestock and intensive horticulture competing for arable land
- Maize silage-based forage production systems

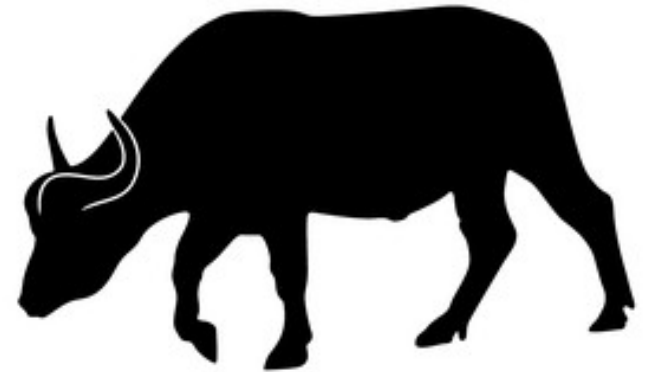
Questions

Can hydroponic
fodders replace
maize silage

?

Effects on the
production

?





33 lactating buffaloes



Animal performances

- Intake of DM
- Body weight
- Body condition score
- Milk production

Milk quality

- Composition
- Clotting ability
- Mozzarella cheese yield

Mozzarella cheese quality

- Sensory properties

D0

Maize silage based diet

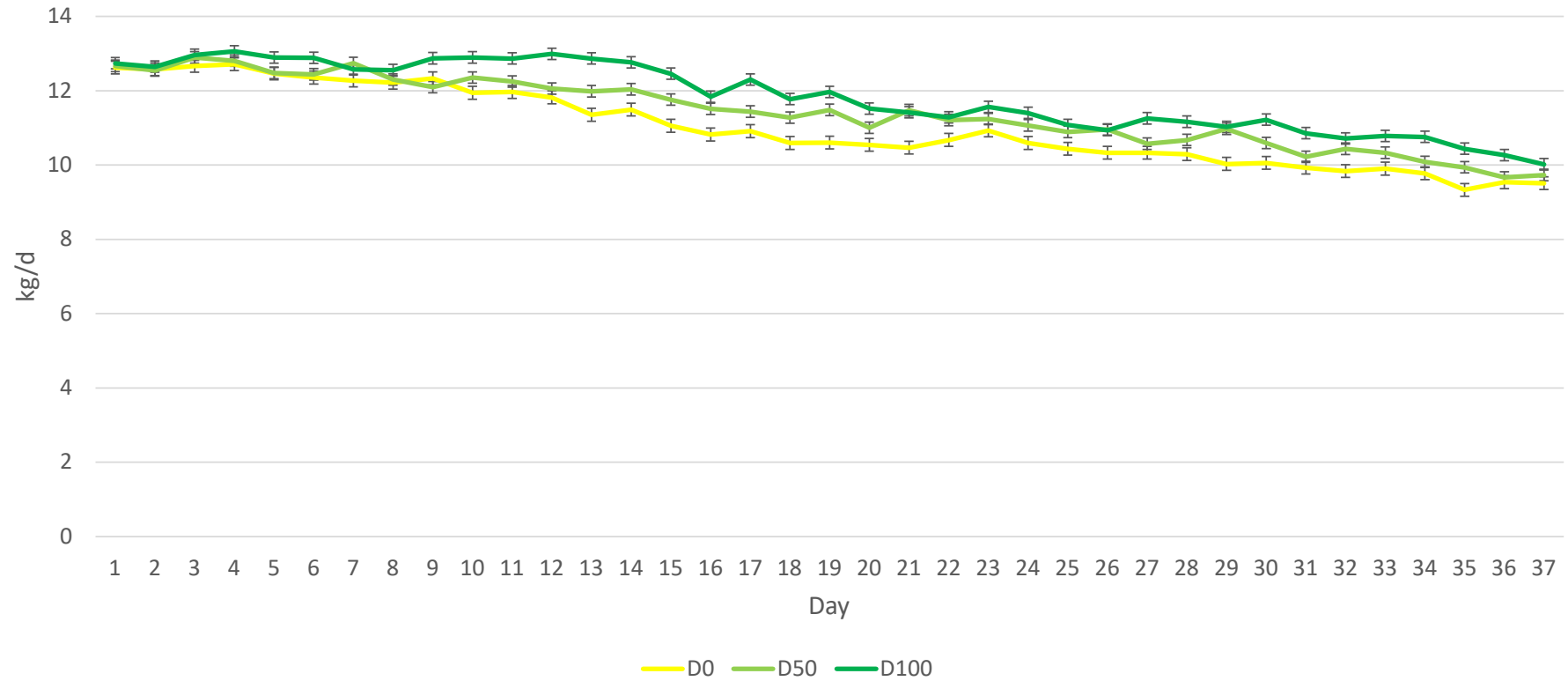
D50

- 50% maize silage
- 50% sprouted barley

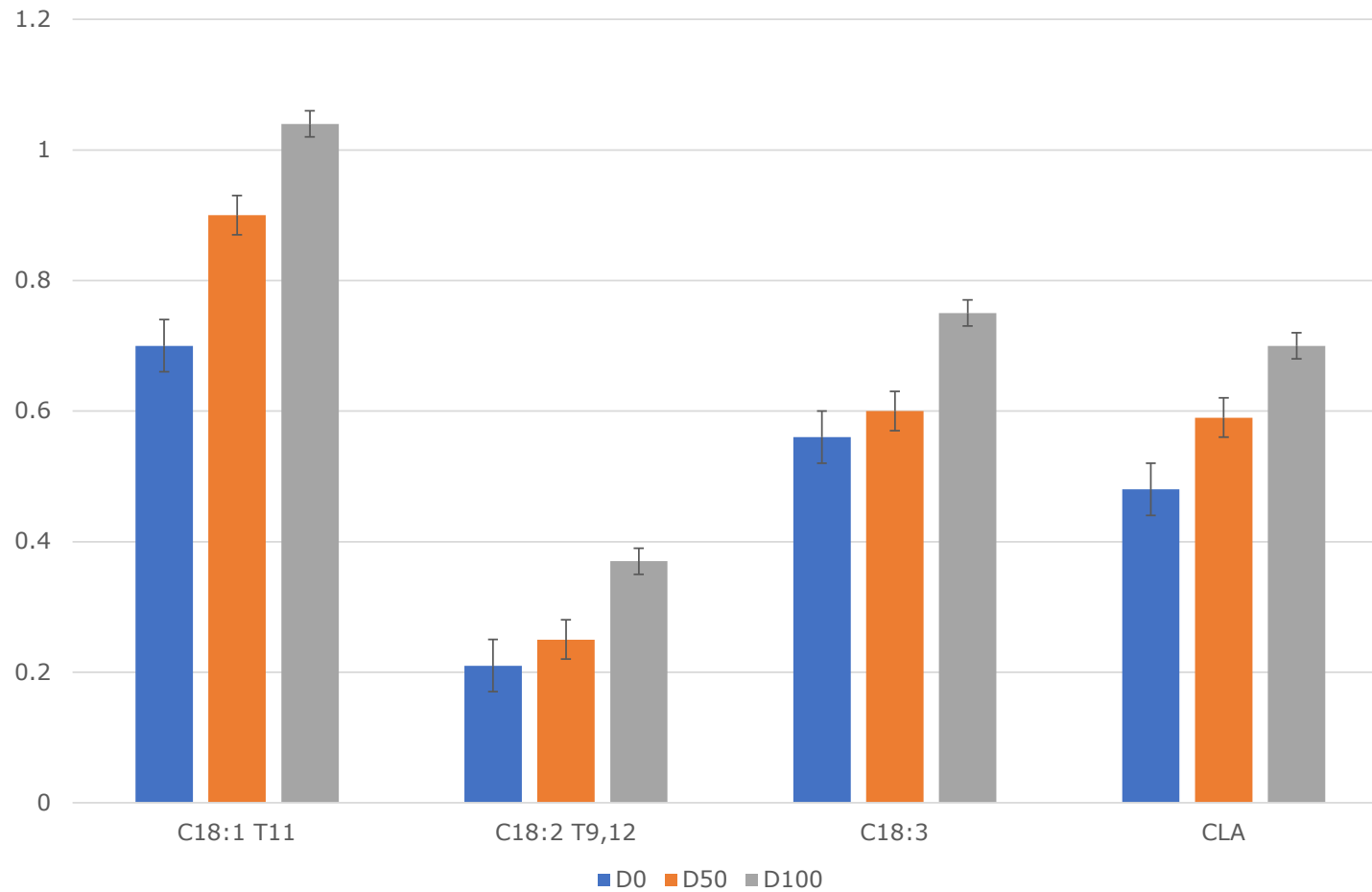
D100

100% sprouted barley

Remarkable results



Total replacement of maize silage improve MUFA and PUFA content



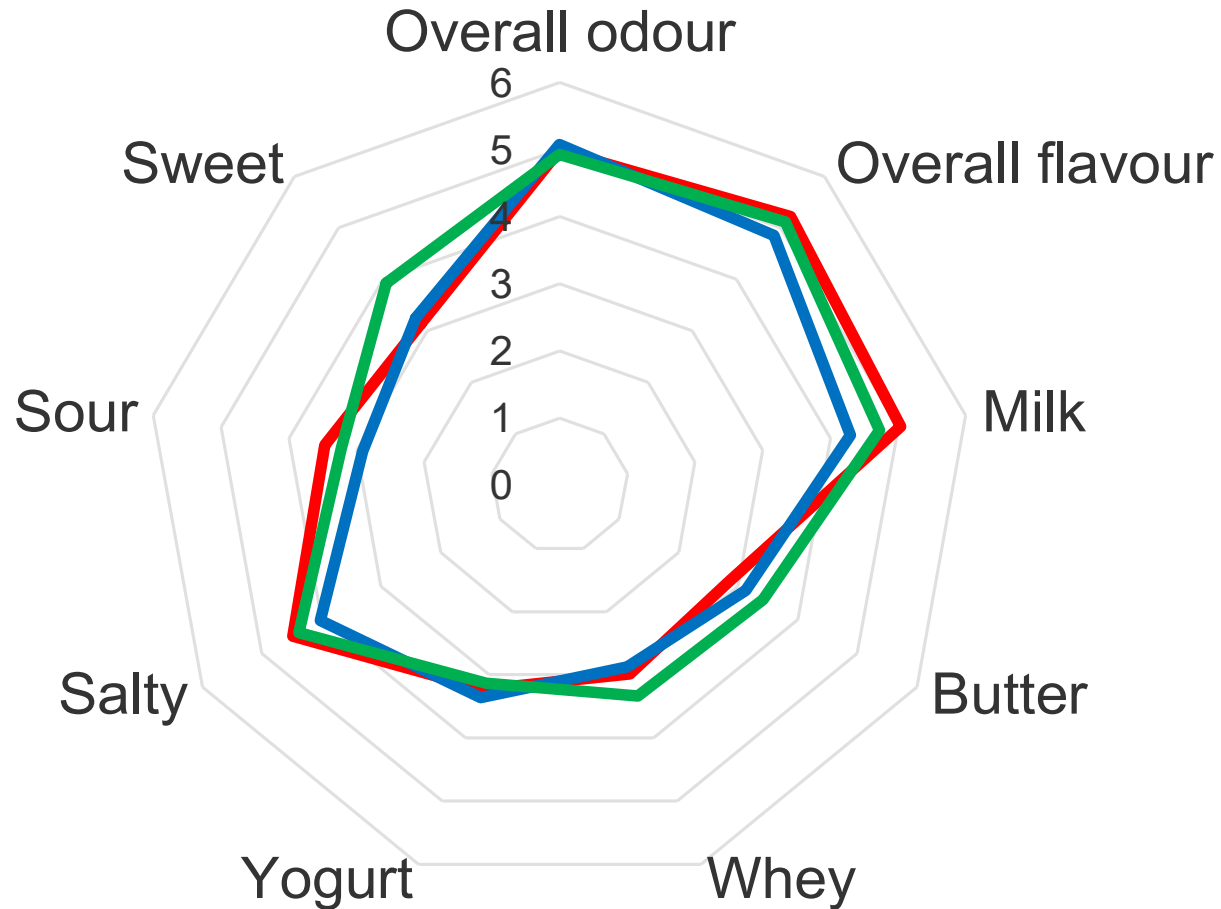
Mozzarella cheese quality



Collaboration, prof. Genovese group and PhD thesis dr. Andrea Balivo

— D0 — D50 — D100

Mozzarella cheese quality



— D0 — D50 — D100

Step 3. Reclaimed wastewater for Hydroponic forages

With



Where

Dairy cattle farm in Gioia del Colle (BA)

Equipment for hydroponic fodder

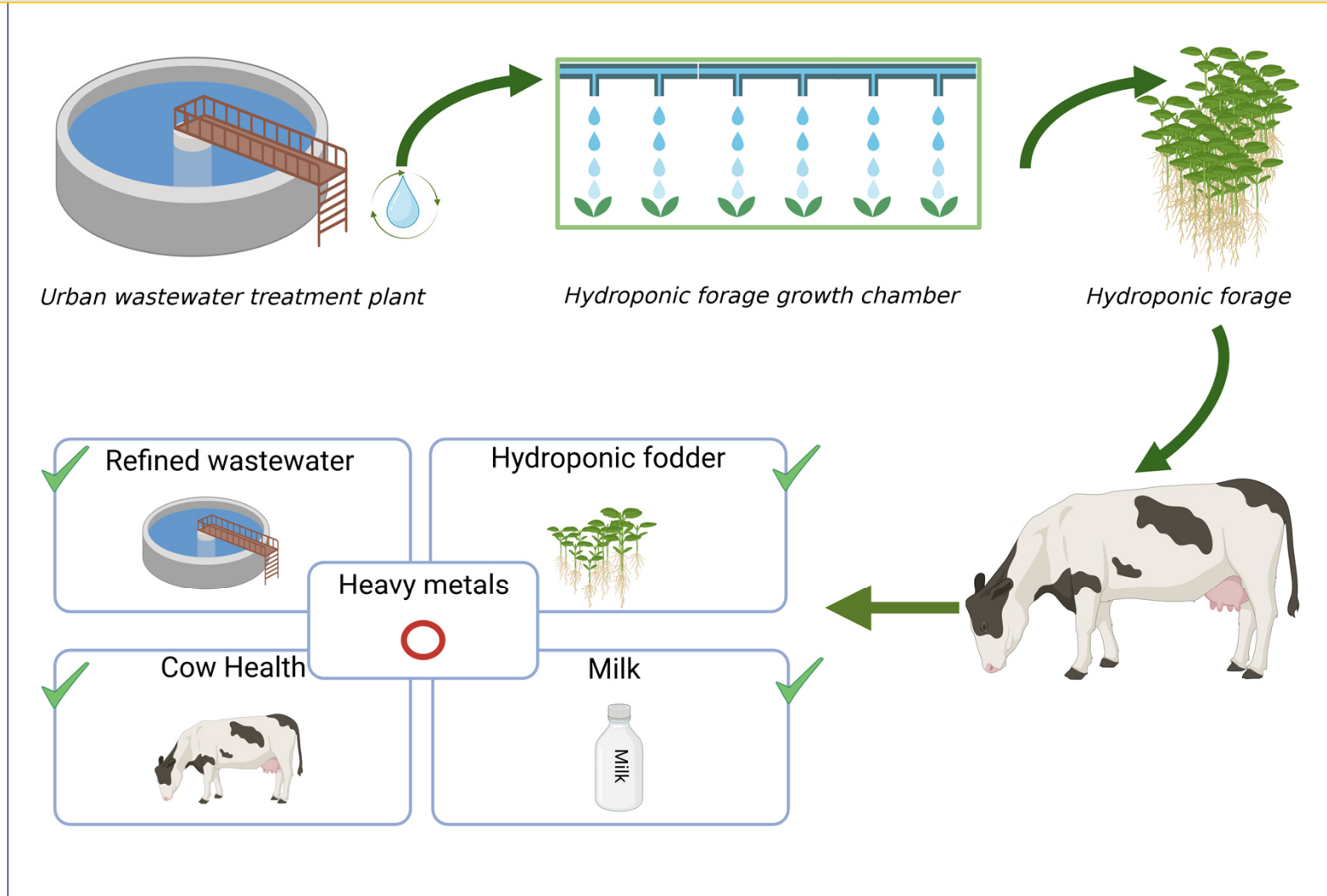
ELEUSIS



Refined Wastewater

Apulian Acqueduct

Ceci, L., Cavalera, M. A., Serrapica, F., Di Francia, A., Masucci, F., Carelli, G. *Use of reclaimed urban wastewater for the production of hydroponic barley forage: water characteristics, feed quality and effects on health status and production of lactating cows.* doi.org/10.3389/fvets.2023.1274466.



..and then

High level of hydroponic barley forage allows slight improvement in milk yield and quality of mozzarella in terms of fatty acid profile

Are Hydroponic forages

**Sustainable?
Profitable?**

Direct and indirect production costs

Low biomass yield per unit of water or energy used



Teams



Dipartimento
Medicina Veterinaria
Produzioni Animali



FRA 2020-UNINA

Utilizzo di foraggi idroponici nell'alimentazione dei ruminanti da latte - FORIDRO

- Felicia Masucci
- Alessandro Genovese
- Monica Isabella Cutrignelli
- Antonio Di Francia
- Alessandro Vastolo
- Andrea Balivo
- Antonio Ambrosino
- Grazia Scalera
- Gianluca Melone

FE5R 2014/2020

Utilizzo delle acque reflue affinate per la produzione di foraggio idroponico per l'alimentazione del bestiame - Hydrofodderpuglia

- Luigi Ceci, UNIBA
- Grazia Carelli, UNIBA
- Alfonsa M. Cavalera, UNIBA
- Felicia Masucci, UNINA
- Antonio Di Francia, UNINA
- Mariano Pucella



UNIVERSITÀ
DEGLI STUDI DI BARI
ALDO MORO



References

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doi.org/10.1016/j.atech.2022.100080

Pastorelli G., Serra V., Turin L., Attard E. (2023). Hydroponic fodders for livestock production—a review
doi.org/10.2478/aoas-2023-0075

Ceci L., Cavalera M.A., Serrapica F., Di Francia A., Masucci F., Carelli G. (2023). Use of reclaimed urban wastewater for the production of hydroponic barley forage: water characteristics, feed quality and effects on health status and production of lactating cows. doi.org/10.3389/fvets.2023.1274466



13 Dicembre 2023

Antonio Caporale

*Il sistema suolo-pianta in
ambienti terrestri ed
extraterrestri e le interazioni con
l'uomo*