

**IN
RS**

Institut national
de la recherche
scientifique

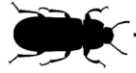


Ferme des Blés d'Or

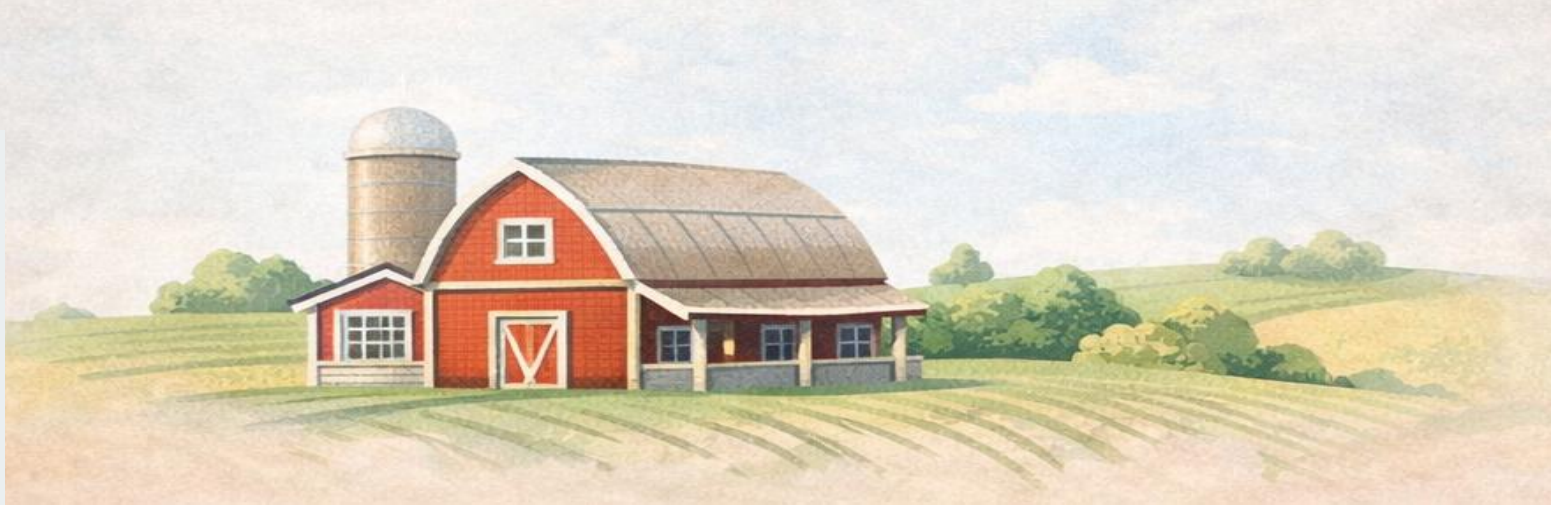
The Hidden Workforce in Insect Farming: How Microbes Shape Success

**Menail Sajid, PhD student INRS-AFSB
Antoine Ménard, V.P. D.G., Ferme des Blés d'Or
Entomo-culture Day**

Inside an insect farm



Ferme des Blés d'Or



Observed challenges in mealworm farming!

Some of the most common challenges faced by farmers at mealworm farms are:



Inconsistent growth performance



Mortality



Variable feed conversion efficiency



Season-dependent performance variability



Observed under real farming conditions

What is microbiome?

Microbial communities are the collection of microorganisms living together (Berg et al., 2020) and play their roles; good, bad, or neutral.



- Improve feed digestion
- Enhance nutrient absorption → better growth
- Support immune system
- Contribute to overall health & development



- Maintain microbial balance
- Stabilize gut environment
- Support consistent & stable performance



- Cause infections/ stress in larvae
- Reduce growth efficiency
- Disrupt digestion & nutrient use
- Increase mortality rates

Mealworm Microbiome

THE MICROBIOME

Trillions of microorganisms (bacteria, fungi, yeasts, viruses and others) living in and around mealworms.

KEY ROLES

-  Digest nutrients
-  Protect against pathogens
-  Influence growth and development
-  Support overall health and survival

INSIDE THE MEALWORM

The gut is the primary habitat for a rich and diverse microbiome.



- ### Influenced by
- Diet
 - Environment(temp., moisture, hygiene)



Feed(diet)

Microbes come with ingredients and interact with feed.



Frass(excreta)

Contains microbes shed from the gut; a major source that shape the environment.



Rearing environment

Surfaces, air, bedding, and equipment host microbes that interact with mealworms.



Other mealworms

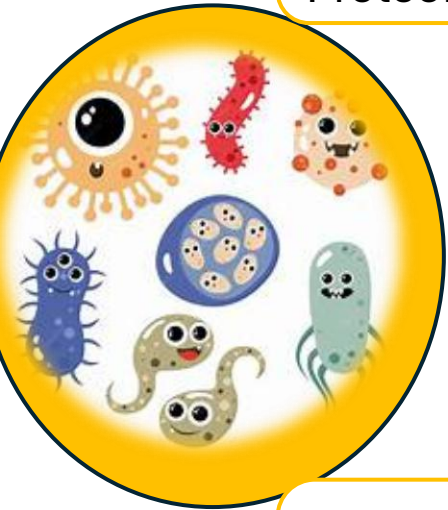
Microbes are shared between individuals through contact and social interactions

Mealworm microbiome is complex, dynamic, and interconnected which plays role in performance and health.

Gut microbiota of Mealworm larvae

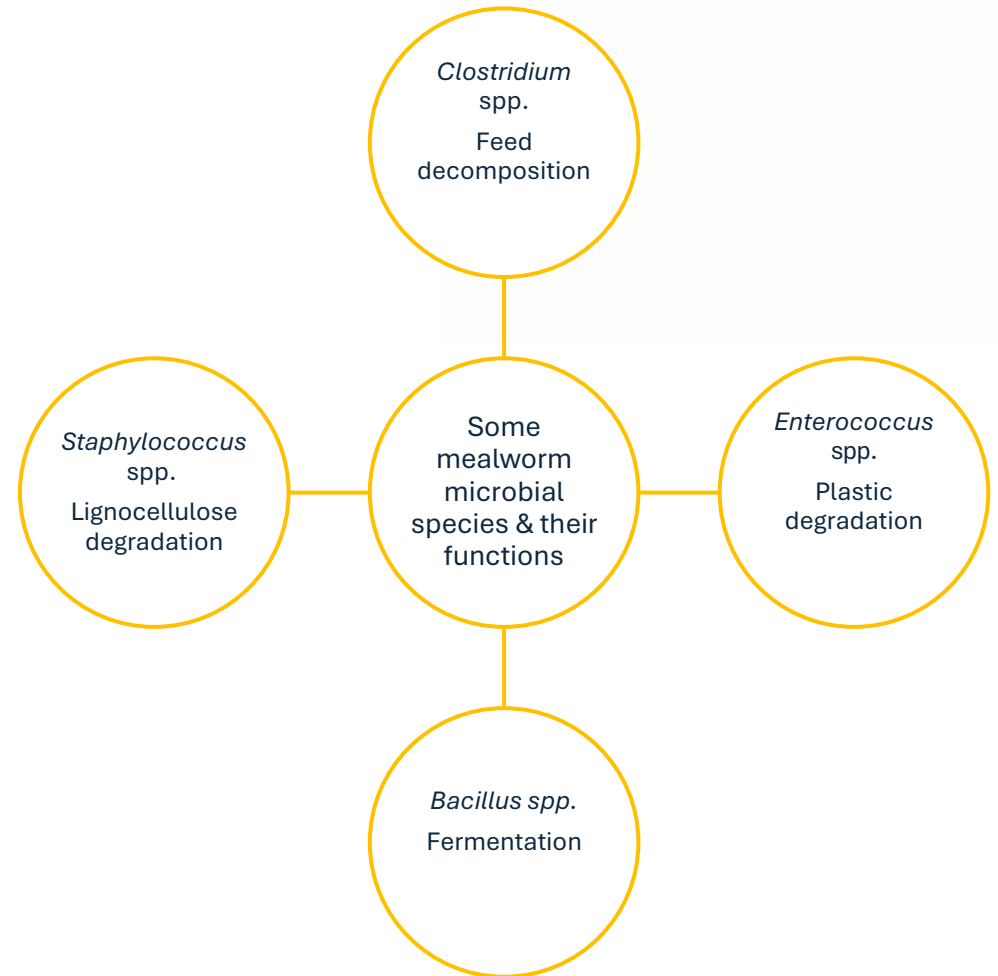
Composition:

Dominant phyla: Firmicutes, Actinobacteria, Proteobacteria, Tenericutes.



Key genera:

Lactobacillus, *Enterococcus*, *Bacillus*, *Clostridium*, *Pseudomonas*, *Spiroplasma*, *Serratia*.



Feedstock variability shapes microbiota & performance

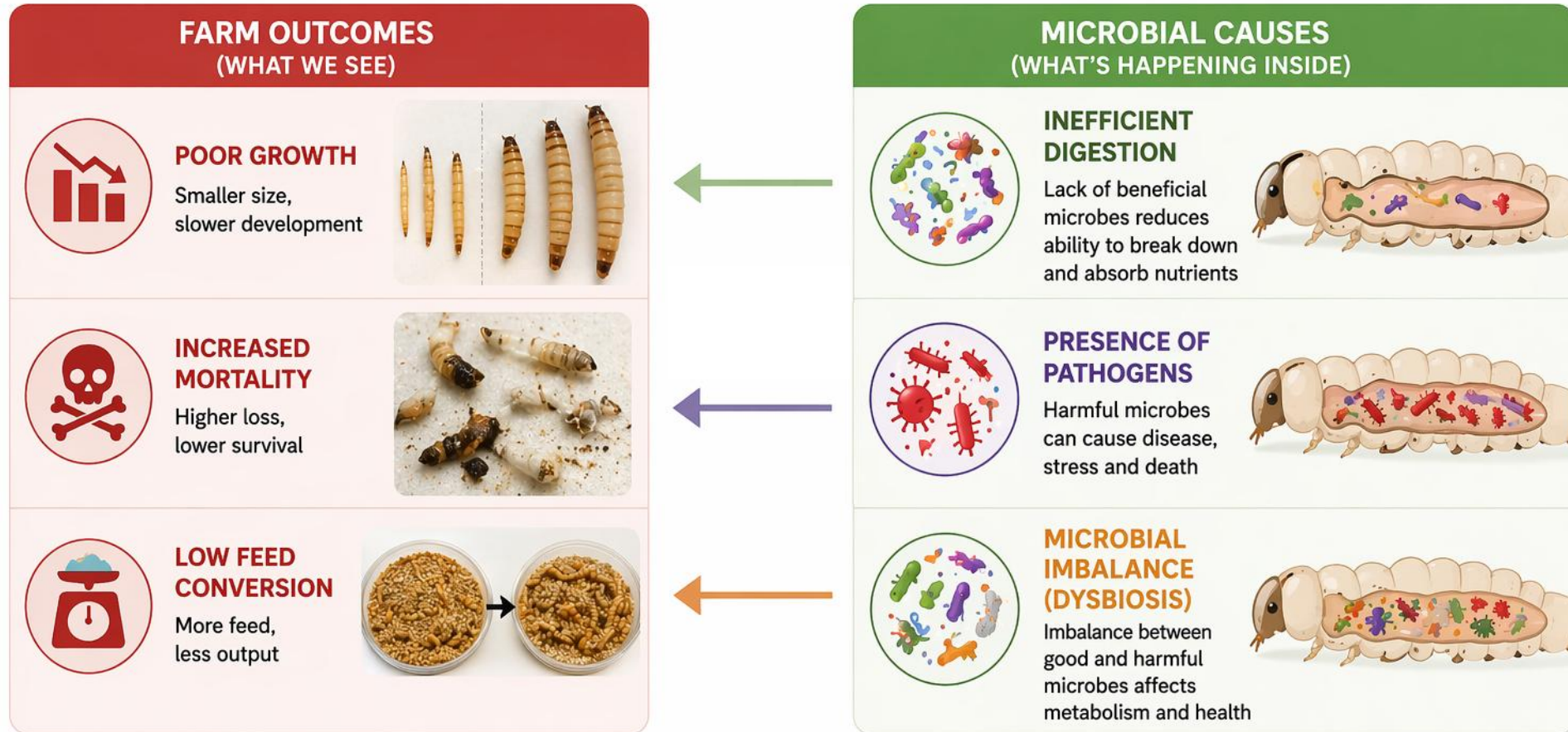
Feedstock affects larval protein

| Substrate | Protein(%DM) | Reference |
|------------------|--------------|----------------------------|
| Range | 40-75% | (Janssen et al., 2017) |
| Wheat bran | 63.3% | (Syahrulawal et al., 2023) |
| Barley meal | 52.7% | (Syahrulawal et al., 2023) |
| Agro-by-products | 46% | (Khanal et al., 2023) |
| Oat meal | 44% | (Khanal et al., 2023) |

Feedstock reshapes gut microbiota

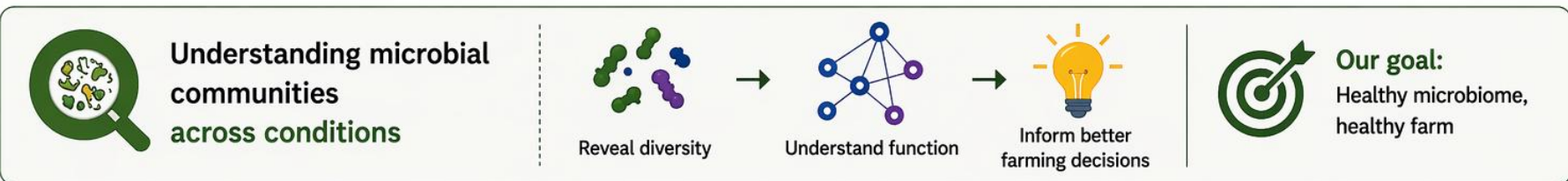
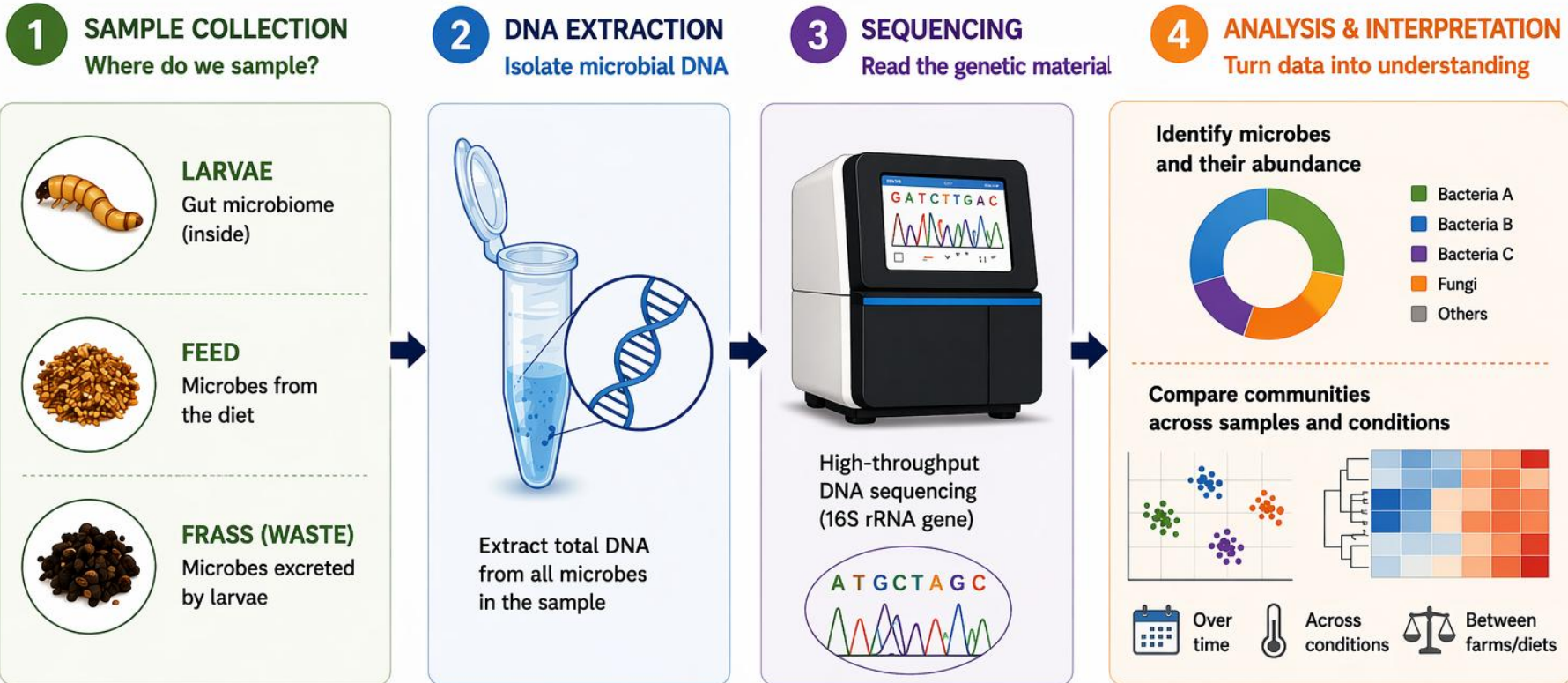
| Feeding substrate | Gut microbiota | Reference |
|----------------------------|--|-----------------------|
| Starvation | ↑ Firmicutes, Proteobacteria | (Khanal et al., 2023) |
| Wheat bran feeding | Dominance of Clostridium. ↑ Spiroplasma taceae and Enterococcaceae | (Khanal et al., 2023) |
| Cardboard | ↑ nitrifying bacteria | (Yu et al., 2024) |
| Plastic-enriched bran diet | ↑ Lactobacillus, Mucispirillum | (Khanal et al., 2023) |

How does microbiome influence farm outcomes?



Mapping mealworm microbiome

— Who is there, where, and when?? —



Microbiome management & improved insect farming



Black soldier fly larvae: Real research evidence

Kooienga et al. (2020) tested bacterial supplement in SBFL diet at bench & industrial scale

Arthrobacter AK19

Positive effects



- Larvae 94% heavier
- Significant higher weight
- Better feed conversion
- More genes for digestion and metabolism.

Rhodococcus

Positive effects



- Larvae 22% heavier than control
- Improved early growth performance

Bifidobacterium

Negative effects



- Weak, lighter, slow, & discolored larvae
- Poor waste conversion, survival, & overall performance

How beneficial microbes help?

Feed + Helpful microbes



Better digestion & gut balance

Better nutrient use

Faster growth & better yield



For mealworm larvae!

Diet studies in mealworms are still limited, but studies from BSFL suggest similar approaches may help in:

- Better growth
- Better feed conversion efficiency
- Reduced mortality and stress
- Faster development and pupation
- Alternative feed
- More stable and productive farming systems

Can we control microbiome?



1. PROBIOTICS

Add beneficial microbes



Probiotic



- ✓ Introduce beneficial bacteria
- ✓ Compete with harmful microbes
- ✓ Support digestion and immunity



2. FEED MODIFICATION

Shape the microbiome through diet



- ✓ Prebiotics and functional ingredients
- ✓ Improve nutrient availability
- ✓ Promote beneficial microbes



3. ENVIRONMENTAL CONTROL

Create a favorable environment for good microbes



Hygiene
Reduce harmful microbes



Temperature
Maintain optimal conditions



Moisture & Airflow
Ensure proper humidity and ventilation

- ✓ Limit pathogens and stress
- ✓ Support a stable microbial community



1. MAP

Understand the microbial communities



2. MANIPULATE

Apply strategies to influence the microbiome

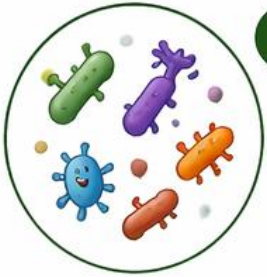


3. IMPROVE OUTCOMES

Better growth, survival and feed efficiency

Take home message

Key points to remember



1 Microbiome plays a critical role in mealworm performance



2 Farm variability can often be explained by microbial differences



3 Understanding the microbiome enables better control and optimization



**CONTROL THE MICROBIOME →
CONTROL THE OUTCOME**



Better microbiome. Better mealworms. Better future. | Thank you!

