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# 經濟動物保健市場趨勢及挑戰

## 動物健康意識興起，商機在哪裡？

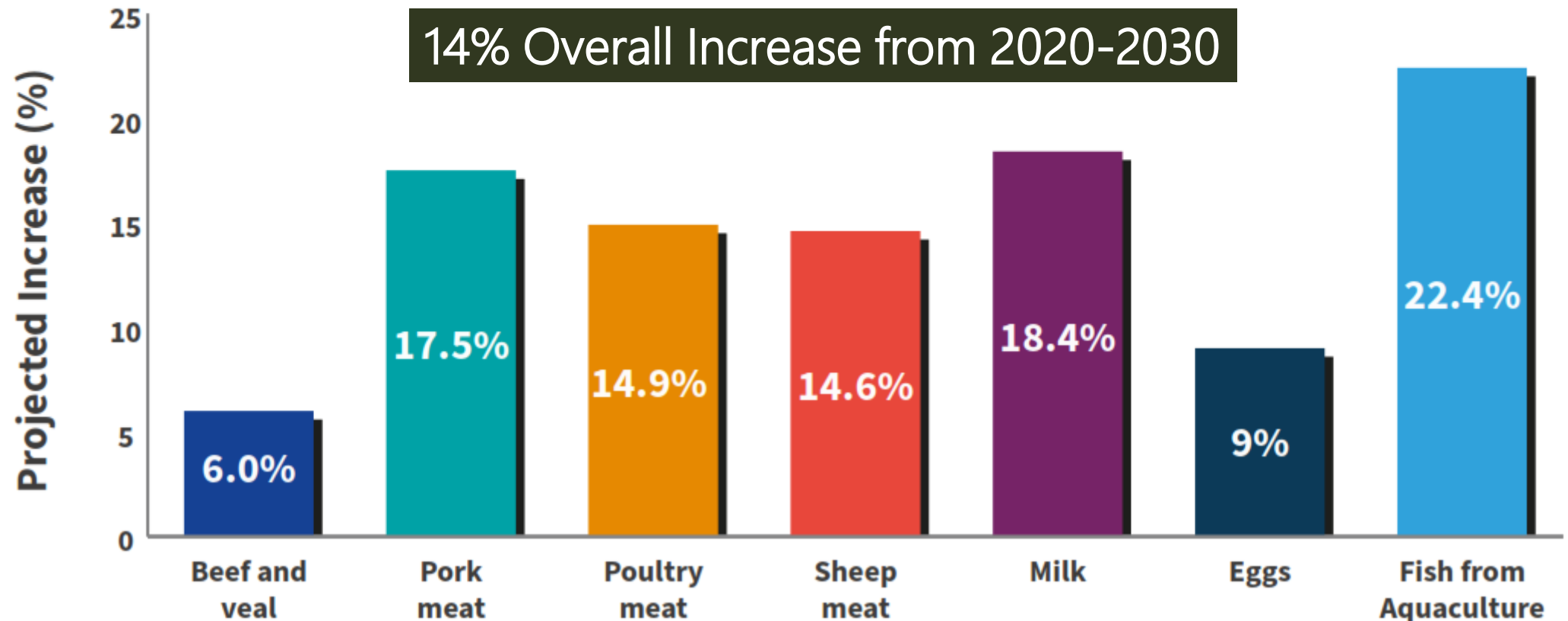
中興大學 榮譽特聘教授

余 碧

經濟合作暨發展組織(OECD)和聯合國糧食及農業組織(FAO) 估計，從2020年到2030年，畜牧業和漁業產量將增加14%。

為實現永續生產的目標，這很大一部分需要透過提高現有畜禽的生產力來實現。改善健康管理以減少畜禽損失，並提高生產效率，將是永續生產的重要組成。

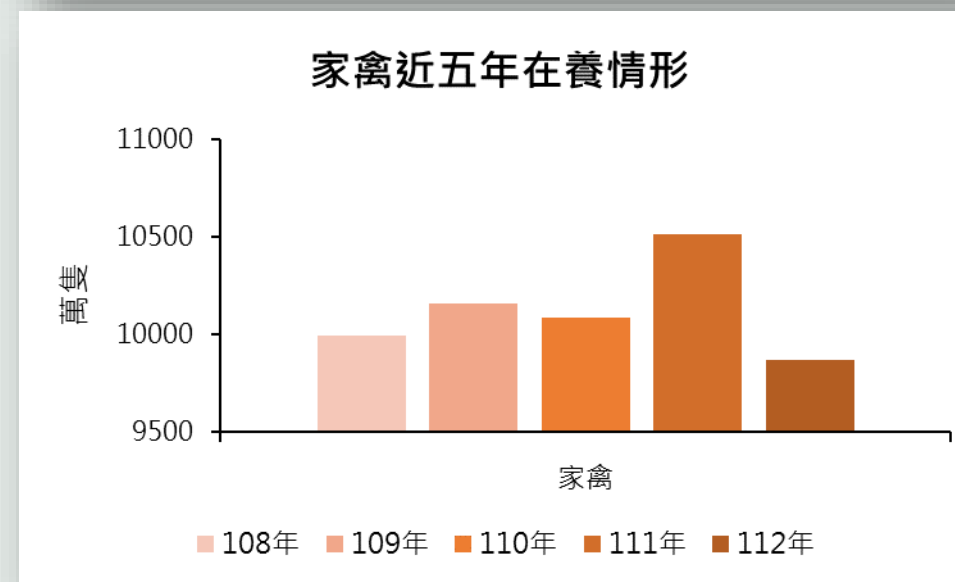
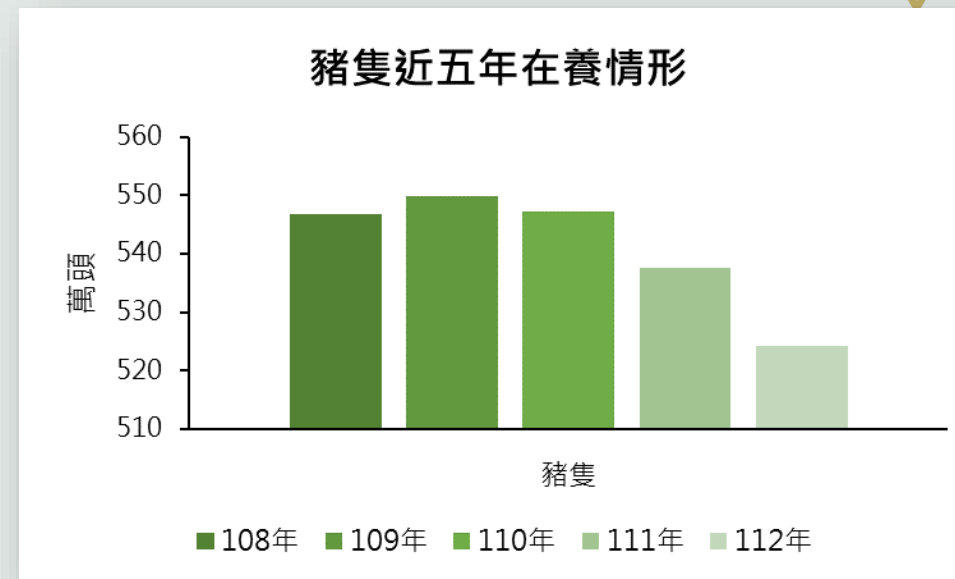
### Projected Increase in Livestock Commodity Production (2020-30)<sup>2</sup>



# 國內豬隻、家禽近五年在養頭數

	豬隻 ( 頭 )	家禽 ( 萬羽 )
108年	5,467,684	9,996
109年	5,499,413	10,161
110年	5,473,337	10,086
111年	5,375,109	10,515
112年	5,242,261	9,870

資料來源：中央畜產會，每年五月調查資料





Growth performance ↑

Prevention of diseases ↑

**Alternative to antibiotics , feed additives**



**動物保健**

- Enhancing immune response
- Reducing pathogen load in the gut.
- Stimulate establishment of beneficial gut microbes
- Stimulate digestive function

# Feed additives



## EFSA 分類：

- Nutritional feed additives
- Sensory feed additives
- **Zootechnical feed additives**
- **Coccidiostats**
- Technological feed additives



## 台灣飼料管理法 農業部飼料添加物分類：

- 微生物
- 酵素
- 保存劑和抗氧化劑
- 碘化酪蛋白
- 酸度調解劑
- 品質提升劑
- 技術添加物  
(天然植物和植物萃取物.....)

# Many products for 1 purpose

## ENZYMES

- Xylanase, beta-glucanase
- Protease
- Beta-mannanase

## PROBIOTICS

- E. faecium, B. subtilis,
- L. plantarum, etc.
- Single strain
- Multi-strain

## PREBIOTICS

- Inulin
- FOS

## YEAST/YEAST DERIVATES

- Live yeast
- Inactivated yeast
- MOS
- Beta-glucans
- Yeast fermentates

## PFAs

- Nature-identical products
- Ess. oil products
- Herbal extract products
- Complex products

## ACIDIFIERS

- Formic, propionic, lactic, sorbic, etc.
- Acid belnds
- Ca-/K-salt

## MCFAs

- C6, C8, C10, C12

## COMBINED PRODUCTS

- Acids + EOCs
- MCTs, SCFAs, EOs
- Org. Acids + EOs
- EOs + prebiotics

**Gut health**

A central diagram of a cross-section of the gut wall, showing the mucosal lining with various colored segments (pink, green, blue, red) representing different components. Arrows from surrounding boxes point towards this central diagram.



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# 依要訴求主功能分類

## 加強免疫反應

- immunoglobulin
- $\omega$ - fatty acids
- $\beta$ -glucan

## 減少腸道病原菌

- Organic & inorganic acids
- essential oils
- herbs and spices
- prebiotics
- anti-microbial peptides

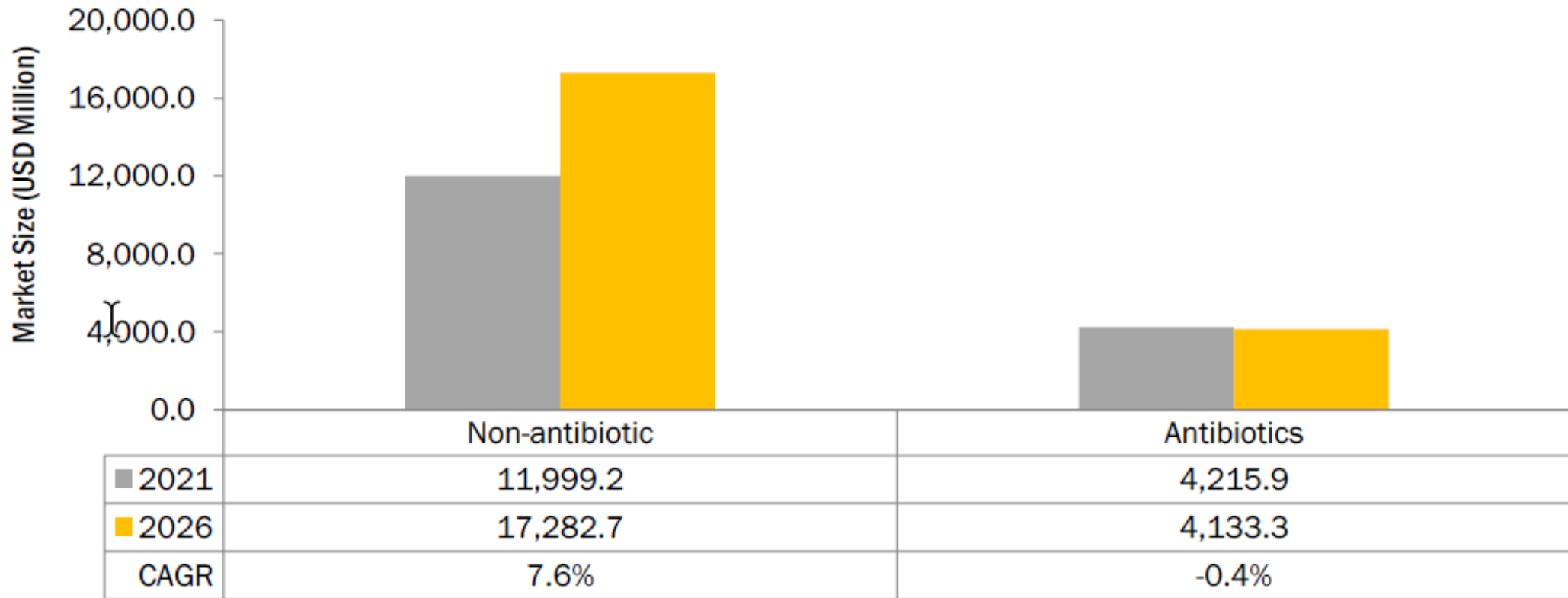
## 建立腸道有益菌相

- probiotics
- prebiotics

## 優化腸道消化功能

- enzymes

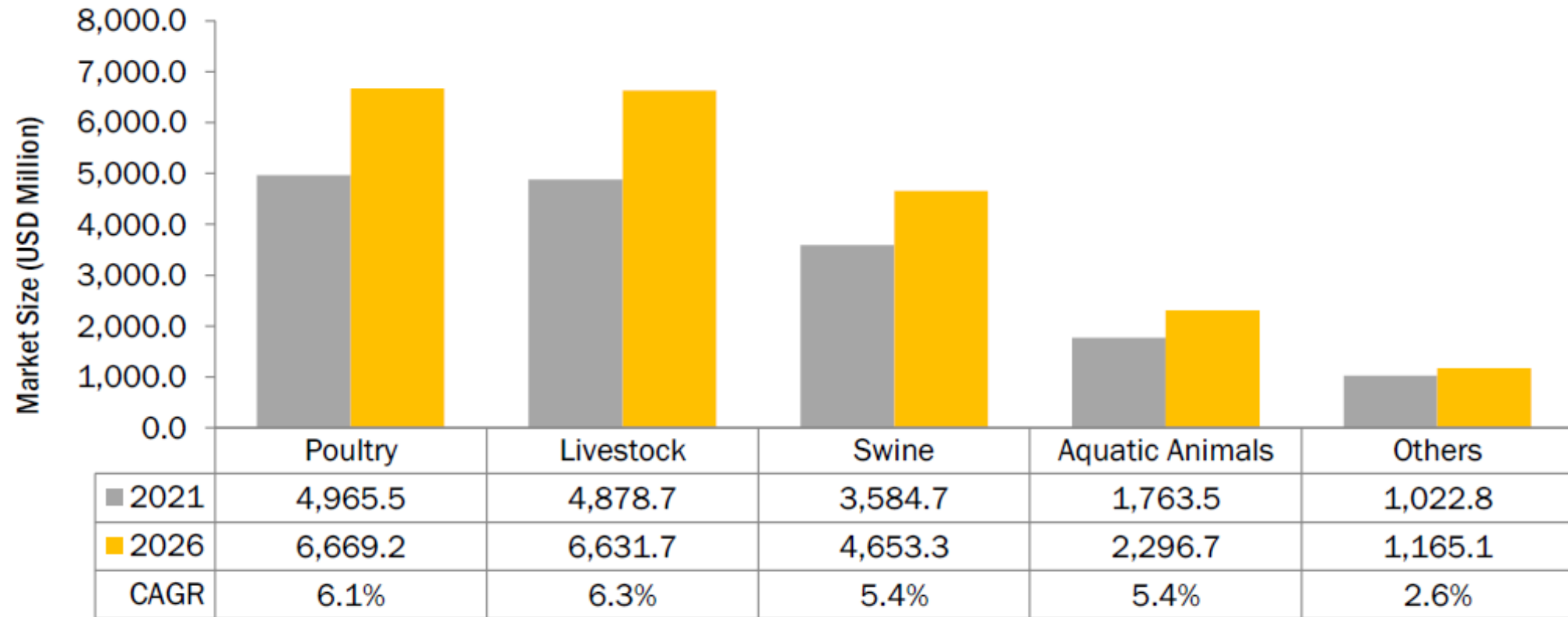
**FIGURE 14** ANIMAL GROWTH PROMOTERS AND PERFORMANCE ENHANCERS MARKET, BY TYPE, 2021 VS. 2026 (USD MILLION)



Source: World Health Organization (WHO), Center for Veterinary Medicine (CVM), Food and Drug Administration (FDA), U.S. Department of Agriculture (USDA), Centers for Disease Control and Prevention (CDC), Food and Agriculture Organization of the United Nations (FAO), USDA Foreign Agriculture Service (FAS), Food Safety and Inspection Service (FSIS), Global Advisory on Antibiotic Resistance Data (GAARD), Reservoirs of Antibiotic Resistance (ROAR), Annual Reports, Expert Interviews, Investor Presentations, and MarketsandMarkets Analysis

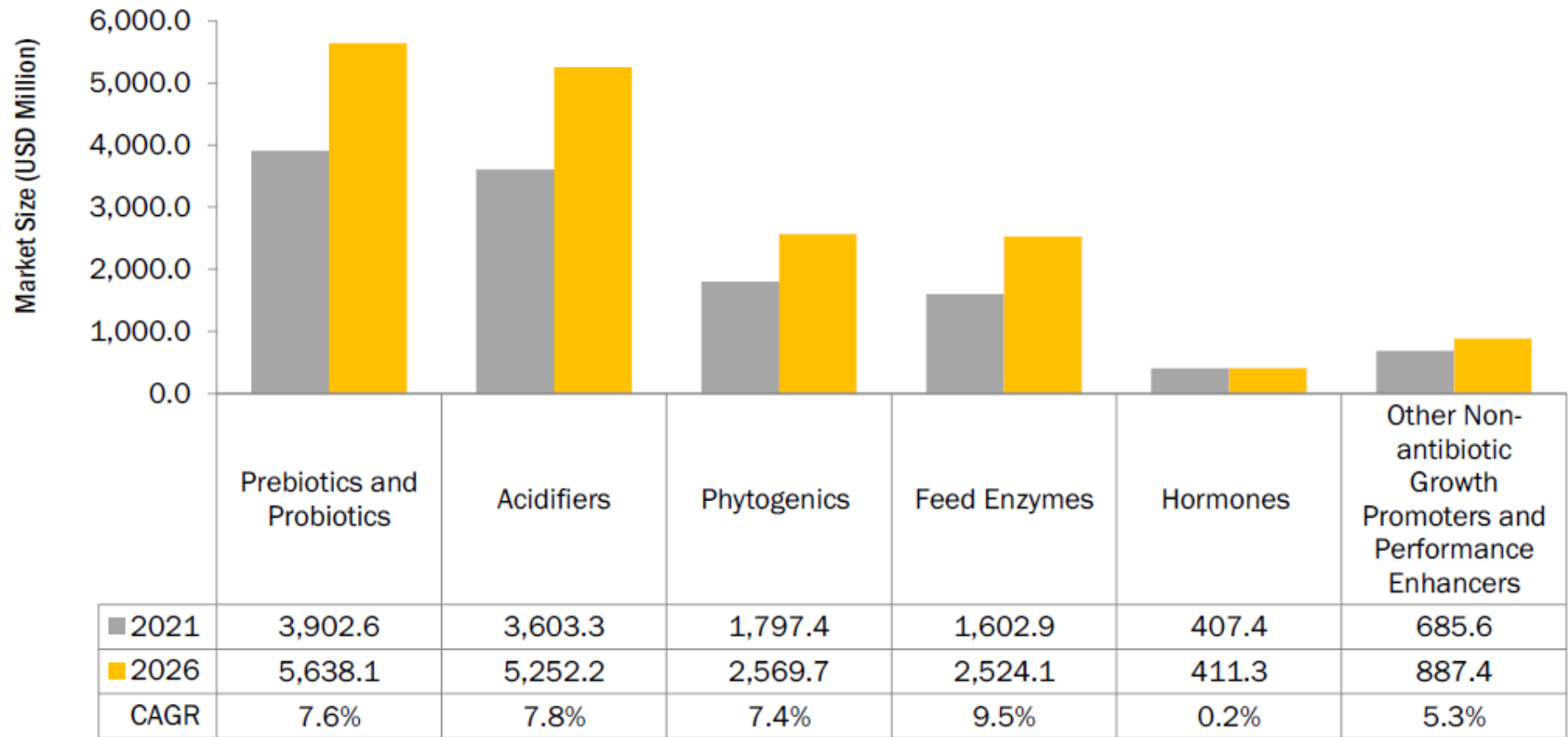


**FIGURE 16** ANIMAL GROWTH PROMOTERS AND PERFORMANCE ENHANCERS MARKET, BY ANIMAL TYPE, 2021 VS. 2026 (USD MILLION)



Source: World Health Organization (WHO), Center for Veterinary Medicine (CVM), Food and Drug Administration (FDA), U.S. Department of Agriculture (USDA), Centers for Disease Control and Prevention (CDC), Food and Agriculture Organization of the United Nations (FAO), USDA Foreign Agriculture Service (FAS), Food Safety and Inspection Service (FSIS), Global Advisory on Antibiotic Resistance Data (GAARD), Reservoirs of Antibiotic Resistance (ROAR), Annual Reports, Expert Interviews, Investor Presentations, and MarketsandMarkets Analysis

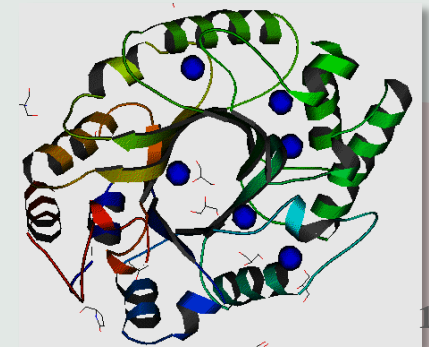
**FIGURE 15** NON-ANTIBIOTIC GROWTH PROMOTERS AND PERFORMANCE ENHANCERS MARKET, BY TYPE, 2021 VS. 2026 (USD MILLION)



Source: World Health Organization (WHO), Center for Veterinary Medicine (CVM), Food and Drug Administration (FDA), U.S. Department of Agriculture (USDA), Centers for Disease Control and Prevention (CDC), Food and Agriculture Organization of the United Nations (FAO), USDA Foreign Agriculture Service (FAS), Food Safety and Inspection Service (FSIS), Global Advisory on Antibiotic Resistance Data (GAARD), Reservoirs of Antibiotic Resistance (ROAR), Annual Reports, Expert Interviews, Investor Presentations, and MarketsandMarkets Analysis

# Enzymes 酵素

- Xylanase,  $\beta$ -glucanase,  $\beta$ -mannanase, protease, amylase, phytase  
木聚糖酶、 $\beta$ -葡聚糖酶、 $\beta$ -甘露聚糖酶、蛋白酶、澱粉酶、植酸酶
- Increase in digestibility of energy, nutrients & minerals through breakdown of particular substrates 通過分解特定基質提高能量、營養素和礦物質的消化率
- NSP enzymes: reducing viscosity 降低腸內容物粘度
- Phytase and NSP enzymes standard in broiler diets, increasing use in pig diets 植酸酶和 NSP 酶廣泛添加至肉雞日糧，豬日糧逐漸使用
- **Issues: Thermostability 問題**





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# Acidifiers 酸化劑

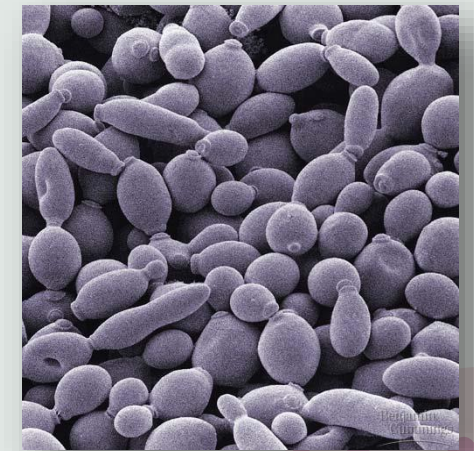
- Organic and inorganic acids and salts

Acetic, benzoic, butyric, propionic, citric, formic, propionic, lactic, malic, sorbic, Ca formate, K diformate 乙酸、苯甲酸、丁酸、丙酸、檸檬酸、甲酸、丙酸、乳酸、蘋果酸、山梨酸、甲酸鈣、二甲酸鉀

- Reduction in pH & buffering capacity in feed and GIT 降低胃腸道 pH 和增加飼料緩衝能力
- Direct anti-microbial effect against Gram-/+ bacteria 對革蘭氏-/+菌直接抗菌作用
- Standard in most piglet diets 大多數仔豬日糧已普遍添加

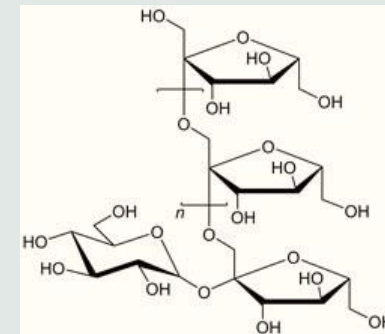
# Probiotics & Yeast 益生菌&酵母

- Viable microorganisms to establish a beneficial gut microbiota, particularly in young animals 活微生物建立有益的腸道微生物群，特別是在幼年動物中
- *Bacillus*, *Bifidobacterium*, *Enterococcus*, *Lactobacillus*, *Pediococcus*, *Saccharomyces* 芽孢桿菌屬、雙歧桿菌屬、腸球菌屬、乳酸桿菌屬、片球菌屬、酵母菌屬
- Competitive exclusion 競爭排斥
- Bacterial antagonism (bacteriocins) 細菌拮抗作用 ( 細菌素 )
- Immune modulation 免疫調節
- **Issues: Thermo-stability 問題**



# Prebiotics 益生質

- Non-digestible oligosaccharides selectively stimulating the beneficial microbiota. 不易被消化的寡糖，選擇性被有益微生物群利用。
- Fructo-oligosaccharides (FOS), inulin, trans-galactosyl-oligosaccharides (TOS), 4'-galactosyllactose (GLL), isomalto-oligosaccharides (IMO), raffinose, lactulose, lactitol. 低聚果糖、菊糖、反式低聚半乳糖、4'-半乳糖基乳糖、低聚異麥芽糖、棉子糖、乳果糖、乳糖醇。
- Effective concentrations required usually exceed commercial use levels in feed. 有效濃度通常超過飼料中的商業推薦用量。



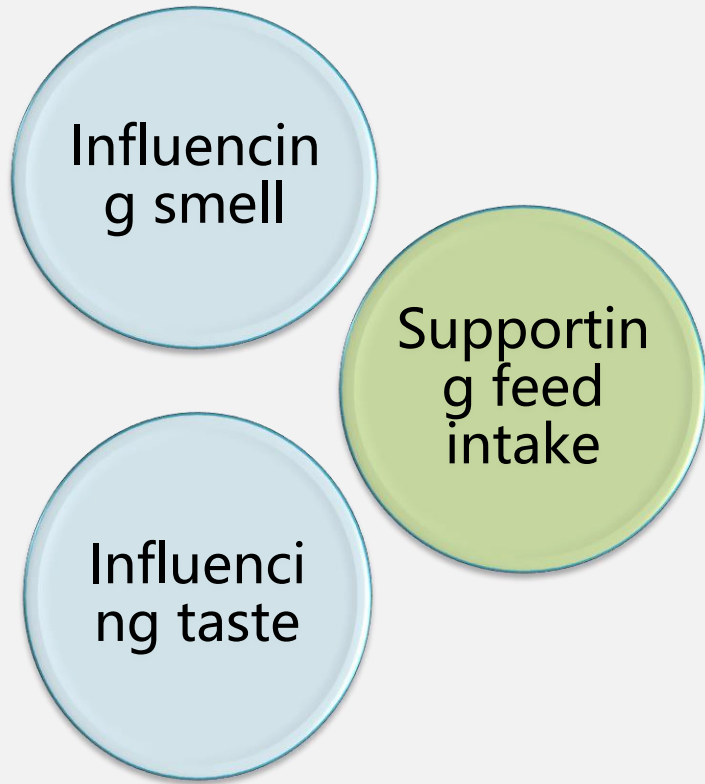


# Phytogenic Feed Additives (PFA) 植源劑

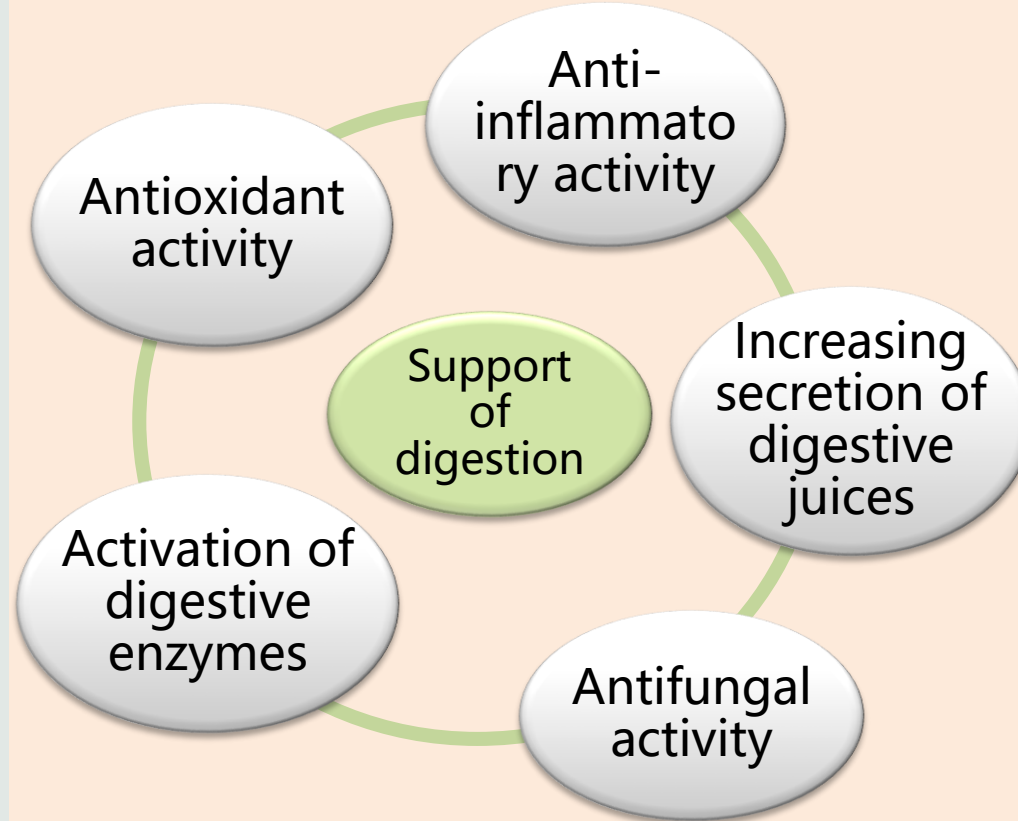


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## Sensory properties 感官特性



## Biological properties 生物特性



+

=

**Optimizing Performance**  
優化表現

# Composition of Phytogenic Feed Additives



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## Complex products

- Products are usually made of **one or more compounds** originating from herbs & spices, volatile extracts (essential oils), non-volatile extracts or pure substances. 多種原料混搭使用。
- Many commercial Phytogenic feed additives are powdered, others are granulated or encapsulated using fat or wax. 以粉末、顆粒或包覆劑型提供。
- Rule of thumb: The more compounds, the more chemical ingredients (= higher **number of active principles** and lower level of **standardization**). 有效成分多，難標準化。





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# Yeast Derivates 酵母衍生物

- Cell wall fragments of yeasts 酵母細胞壁碎片
- Mannan-oligosaccharides (MOS),  $\beta$ -glucans 甘露寡糖 (MOS)、 $\beta$ -葡聚糖
- Binding of Gram- bacteria 結合革蘭氏陰性菌
- Immune modulation 免疫調節

# *Reasons for Variable Results of Feed Additives*

- Differences in composition
- Dosage
- Batch-to-batch variation of raw materials
- Variation in finished products
- Volatility of active principles (stability!)
- Undefined mode of action



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# Feed Additives for Gut Health

## ✓ Targets: 目標

Support gut function & overall animal health → stabilize animal performance  
and prevent secondary infections  
支持腸道功能和動物整體健康，穩定動物性能並預防繼發感染

## ✓ Prerequisites: 先決條件

1. Defined composition 確定的成分 
2. Safe for animals, workers & consumers 對動物、員工和消費者安全
3. Stability 穩定性
4. Standardization of correct dosage regime for a particular function 精準之劑量
5. Defined mode of action 定義作用模式 
6. 動物試驗

# 以科學證據提供腸道健康保健產品研發之建議策略：

## 1. 建立抗菌之in vivo 模式之必要性 (Lange et al., 2010)

Experimental approaches to explore gut health evaluating substitute products for antibiotics **in vivo** is to use an appropriate **disease model**. A challenge model per os of post-weaning diarrhea (PWD) using specific pathogenic strains of enterotoxigenic *Escherichia coli* (ETEC).

★ 註：*In vitro* 之抑菌試驗，於動物體內因與飼料之吸附作用而影響效果。

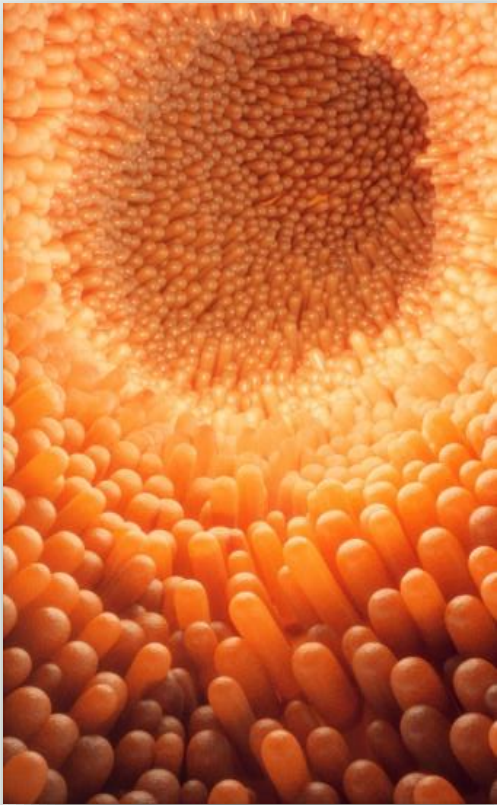
## 2. 針對腸道健康，以動物腸道**生理指標**與**生物指標**系統性提出證據 (Celi et al., 2019)

## 3. 利用 **micro RNAs** 評估腸道健康之生物指標

MicroRNAs Regulate Intestinal Immunity and Gut Microbiota for Gastrointestinal Health: A Comprehensive Review . (Kefan et al. 2020. *Genes* 2020.11,1075.)



# 腸道健康與黏膜組織之生理指標



- 胃、腸道內容物pH：低pH (抑菌、提高胃蛋白酶活性、降低尿素酶活性)
- 消化液與酵素分泌
- 腸道黏膜組織：絨毛發育
- 腸道黏膜緊密連結蛋白：Claudin 1, Mucin-1, Zo-1, Occluding
- 腸道黏膜完整性相關因子：diamine oxidase (DAO), trefoil factor family (TFF) and transforming growth factor- $\alpha$  (TGF- $\alpha$ )
- 腸道吸收能力指標：協同轉運蛋白Na-glucose cotransporter, Peptide transporter
- 腸淋巴組織免疫反應與抗發炎細胞激素

# 腸道健康之生物指標(Biomarker)



Contents lists available at ScienceDirect

Animal Feed Science and Technology

journal homepage: [www.elsevier.com/locate/anifeedsci](http://www.elsevier.com/locate/anifeedsci)

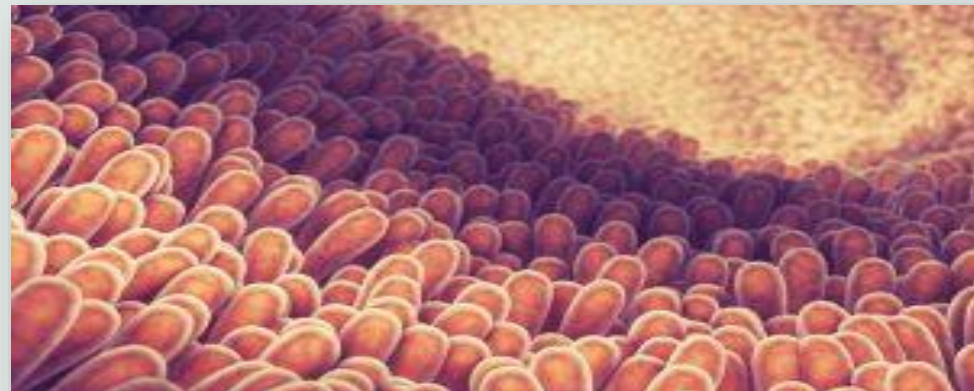


## Biomarkers of gastrointestinal functionality in animal nutrition and health



Celi Pietro<sup>a,d,\*</sup>, Verlhac Viviane<sup>b</sup>, Pérez Calvo Estefania<sup>b</sup>, Schmeisser Jerome<sup>b</sup>, Klunter Anna-Maria<sup>c</sup>

- 一、消化、吸收
- 二、菌相
- 三、腸道障蔽完整性





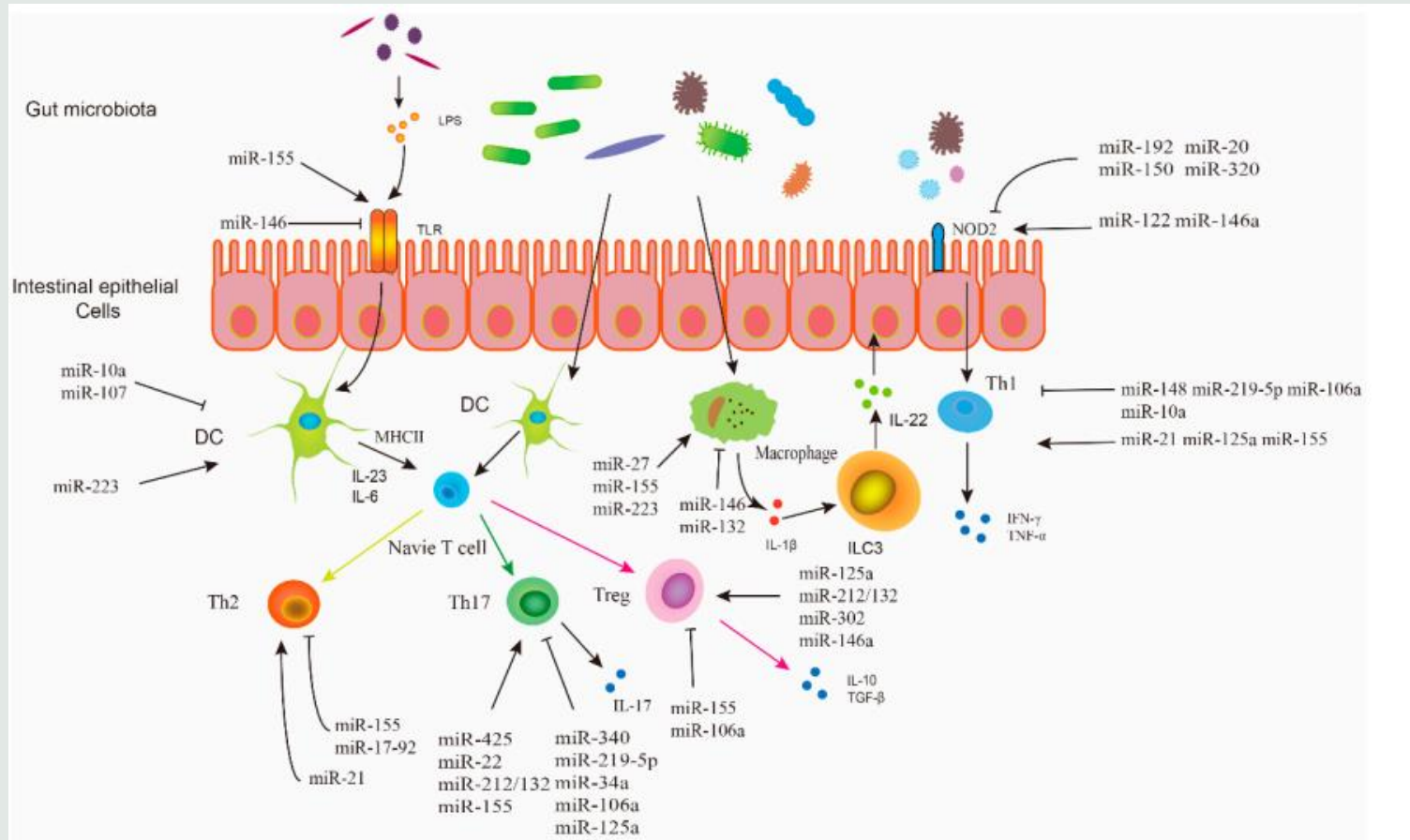
# MicroRNAs Regulate Intestinal Immunity and Gut Microbiota for Gastrointestinal Health: A Comprehensive Review .

**Table 1.** Representative microRNAs and their functions in gut intestine.

MicroRNA	Target	Function
miR-21	Rho-associated protein kinase 1	Regulates tight junction proteins; Protects intestinal barrier from dysfunction
miR-21	PTEN/PI3K/Akt signaling pathway	Regulates intestinal tight junction permeability; Preserves intestinal barrier
miR-31	Wnt/Hippo signaling pathway; GP130; IL7R; IL16R	Promotes intestinal epithelial cell proliferation
miR156	Wnt/ $\beta$ -catenin signaling pathway	Inhibits intestinal cell proliferation
miR-181c	TNF- $\alpha$	Regulates TNF- $\alpha$ ; Reduces intestinal barrier injury
miR-191a	Zonula occludens-1	Regulates tight junction proteins; Reduces TNF- $\alpha$ -induced injury
miR-200b	Myosin light chain kinase	Inhibits TNF- $\alpha$ -induced IL-8 secretion; Suppresses tight junction disruption
miR-212	Zonula occludens-1	Regulates tight junction proteins; Reduces gut leakiness
miR-301a	BTG anti-proliferation factor 1	Stimulates NF- $\kappa$ B activation; Promotes mucosal inflammation and tumorigenesis

(Kefan et al. 2020. Genes 2020.11,1075.)

# Micro RNA 與腸道免疫系統調控作用



**Figure 1.** Effect of microRNA on the regulation of immune cells in the intestine.

(Kefan et al. 2020. Genes 2020.11,1075.)



# 動物保健產品之研發挑戰

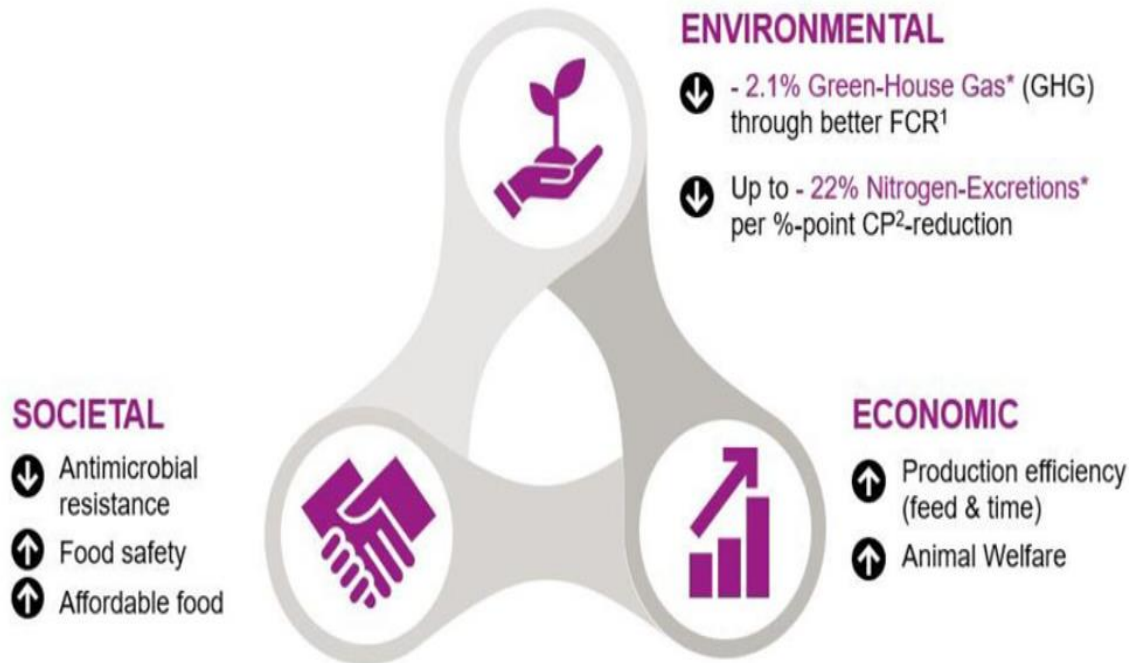
## 尋求永續性產業



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### Benefits for sustainability



### 提升經濟效益與動物福祉

Balance the intestinal ecosystem and ensure animal health and welfare, end-product quality and save costs.

# 飼料添加物 未來趨勢與挑戰

## 環境永續

低碳永續

減少碳排  
降低溫室氣體排放

資源再利用

農資材·剩餘  
品應用

## 經濟效益

降低疾病發生

疾病檢測

新的蛋白質來源

昆蟲蛋白 ✓

藻類/真菌 ✓

減抗

提升生產效率

## 人文環保

動物福利

舒緩/鎮定 ✓

降低環保負擔

管理措施

食品安全與量

# 國內豬場主要生產技術指標(2023-Q2)



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	後10%	平均	前10%	國外 後10%	國外 平均
母豬年產離乳仔豬數 ( PSY )	16.5	21.07	25.5	17.9	26.6
窩均總仔數	11.9	13.51	15.5	13.8	15.4
窩均活仔數	10.8	12.13	13.7	-	-
離乳前死亡率(%)	25.5	16.04	8.39	24.9	15.8
母豬平均離乳仔豬數	8.82	10.22	11.9	9.14	11.63
分娩率(%)	59	74.78	86.8	77.4	85.5
母豬非生產天數	87.2	60.17	38.7	-	-
母豬年產胎數	1.95	2.14	2.29	-	-
母豬年產活仔數	18.8	25.69	30.8	-	-

資料來源：來自美國、加拿大、澳洲共400個母豬場的數據  
MetaFarms, Inc.

資料來源：P P M T生產醫學管理團隊

# 豬隻飼養獲利更高的策略



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✓ 提高哺乳期表現，提高母豬**泌乳能力**與福祉

+0.50kg 離乳體重

✓ 縮短母豬離乳至配種間距



✓ 改善保育期表現：**腸道健康**

+0.50kg 保育期終重 = +1.1kg 上市體重



✓ 配合肥育期營養策略 與降低**成本**

減少蛋白質與能量浪費，強化飼料效率與**屠體品質**

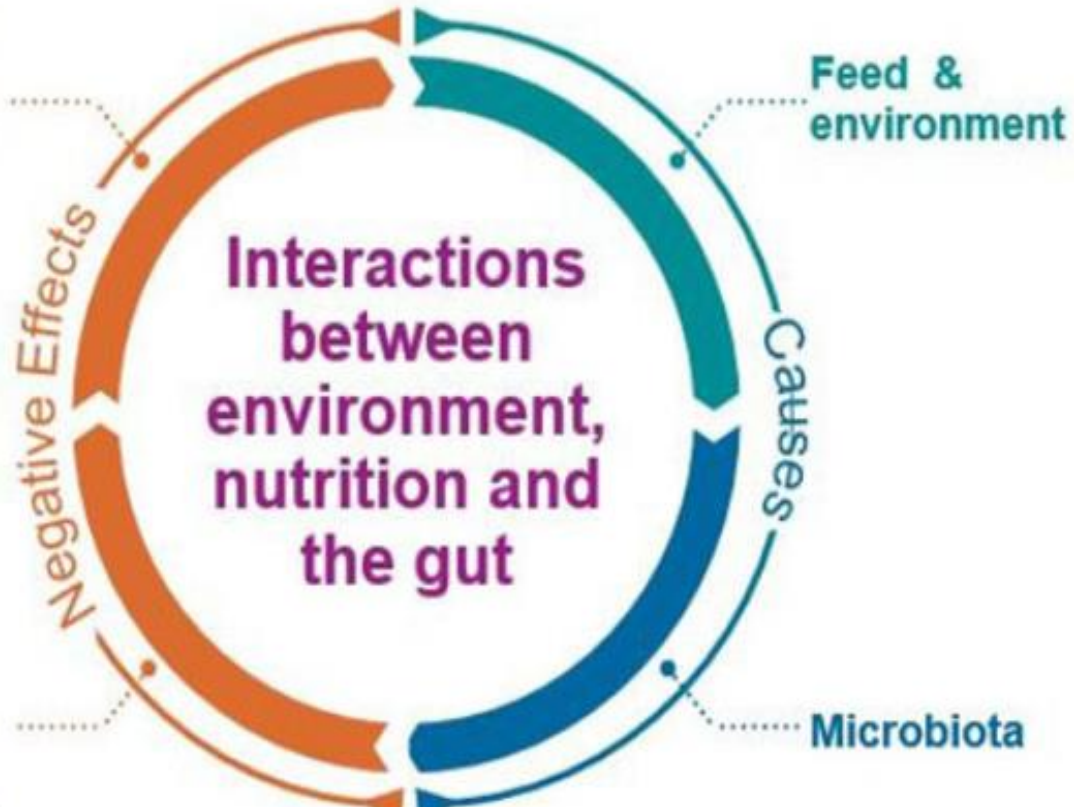
# Addressing the key challenges in broiler farming



- Growth performance ↓
- Flock uniformity ↓
- Mortality ↑
- Litter and air quality ↓
- Food pad lesions ↑
- Pathogen load in the GIT ↑
- Intestinal lesions score ↑

Poor digestion & nutrient absorption

Morphological and functional alteration of the GIT



- ✓ 產蛋雞延長產蛋期
- ✓ 減少腸道梭菌感染
- ✓ 替代抗球蟲藥劑之天然物處理劑

- Heat stress
- Unbalanced diet
- Antinutritional factors
- Feed contaminants
- Coccidiosis
- AGP
- Pathogenic bacteria



# 永續農業的研發挑戰

- 減緩甲烷氣的排放
- 農業資源再利用

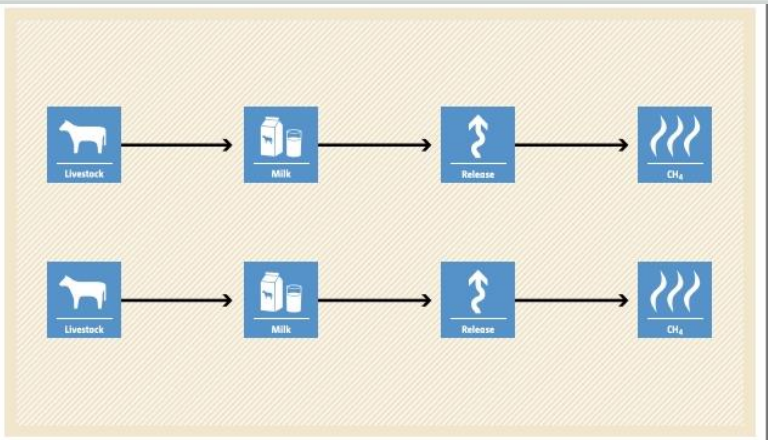


# 一、提升牛隻的生產效率 → 增加經濟效益 → 降低單位產乳量的甲烷排放量。

## AMS-III.BK. Strategic feed supplementation in smallholder dairy sector to increase productivity

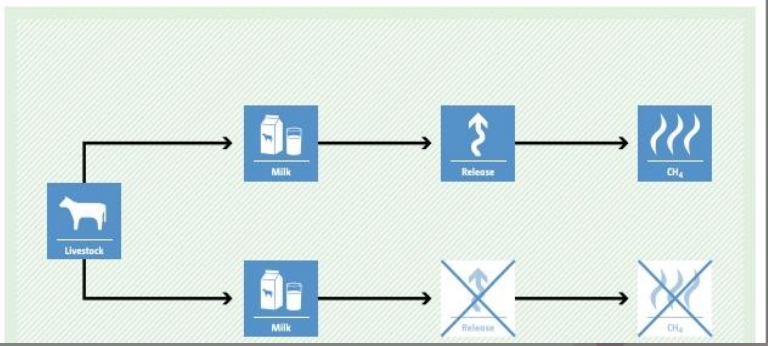
<b>Typical project(s)</b>	Provision of strategic supplementation to large ruminants (e.g. cows), which reduces the level of methane emissions per unit of milk produced.
<b>Type of GHG emissions mitigation action</b>	<ul style="list-style-type: none"> <li>Methane avoidance and displacement of a more-GHG-intensive output.</li> <li>Methane emission avoidance from large ruminants due to improved productivity by using strategic supplementation to improve digestibility.</li> </ul>
<b>Important conditions under which the methodology is applicable</b>	<ul style="list-style-type: none"> <li>The population of lactating animals maintained in the participating smallholders shall be equal or less than 100;</li> <li>The gross energy (GE) content of the supplement consumed does not exceed 10% of the total GE of the basal ration.</li> </ul>
<b>Important parameters</b>	<p>At validation:</p> <ul style="list-style-type: none"> <li>Number of lactating animals in the farm and their milk production.</li> </ul> <p>Monitored:</p> <ul style="list-style-type: none"> <li>Number of lactating animals in the farm and their milk production;</li> <li>Dry matter intake of feedstuff.</li> </ul>

**BASELINE SCENARIO**  
High specific methane emission per unit of milk production due to the poor nutritional conditions of lactating animals in the baseline.



**PROJECT SCENARIO**  
Reduced specific methane emission per unit of milk production due to improved nutritional conditions of lactating animals in the project.

降低單位產乳量的甲烷排放量



## 二、開發減少甲烷排放之添加物

- Recent advances in feed additives with the potential to **mitigate enteric methane** emissions from ruminant livestock.

L. Kelly and E. Kebreab. *J. Soil and water conservation*. 2023 78;111

- Feed additives as a strategic approach to **reduce enteric methane** production in cattle: modes of action, effectiveness and safety

M. Honan <sup>A</sup>, X. Feng <sup>A</sup>, J.M. Tricarico <sup>B</sup> and E. Kebreab <sup>A C+</sup> Author Affiliations

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- Feed additives as a strategic approach to **reduce enteric methane production** in cattle: modes of action, effectiveness and safety

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- Feed additives that **inhibit methanogenesis** or compete with substrate for methanogens include 3-nitroxypropanol (3NOP), nitrates, and halogenated compounds containing organisms such as macroalgae. Although 3NOP and macroalgae affect methyl-coenzyme M reductase enzyme that is necessary in CH<sub>4</sub> biosynthesis, the former is more specific to methanogens



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## 三、降低甲烷排放之添加物

### \*\*\* Plant secondary compounds 植物次級代謝物質

- 1) **Essential oils (精油)** : with lipophilic character , high affinity for lipid of bacteria cell membrane. Decrease the abundance of methanogens and protozoal.
- 2) **Condensed Tannins (單寧)** : (Grape marc.) direct effect on methanogenic srchaea.
- 3) **Gallic acid (沒食子酸)** : Garlic and citrus flavonoid compounds
- 4) **Probiotic 、Yeast 、Fungi (increase C3 production , decrease C2 、 C4 、 H2)**
- 5) ***Moringa oleifera* (辣木)** : the natural capacity of the species to inhibit methanogenesis.
- 6) **Seaweed** as an enteric methane mitigant.
- 7) **Flavonoid (類黃酮)**
- 8) ***Leucaena leucocephala*(銀合歡)**: high condensed Tannin
- 9) **3-Nitroxypropanol (3NOP) (3-硝基氧丙醇)** and macroalgae affect methyl-coenzyme M reductase enzyme that is necessary in CH<sub>4</sub> biosynthesis



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# 農業資源再利用與降低碳足跡

1. 纖維性原料與副產物: Use of **fibrous alternative (local) feed ingredient** and co-products supports sustainability and circularity in its ability to reduce the carbon impact of poultry feed and farming practices.
2. 加工廠剩餘物:
3. 海藻類之應用: **Seaweed** has a positive influence on the gut microbiome of swine.
4. 檢討飼養與營養標準: the overall carbon impact of **the low AME** diets was reduced by 9% compared with the high AME control diets. This will empower nutritionists with more ingredient flexibility to design diets and optimise for poultry performance, farm profitability and sustainability
5. 應用發酵技術
6. 善用飼料添加物，降低氮，磷與CO2排出



## Enzyme Efficiency

HiPhorius™ activity is optimized, making it stable over a wide pH range in the gastrointestinal tract. The superior stability of HiPhorius™ enables rapid and efficient phytate degradation and mitigation of anti-nutritional effects of dietary phytate.

## Minimized Environmental Footprint

HiPhorius™ increases profits while reducing livestock emissions. It goes beyond feed efficiency, delivering enhanced value by helping manage emerging challenges related to environmental sustainability (Phosphorus and GHG emissions). HiPhorius™ enables animals to utilize better the naturally occurring Phosphorus in feed and reduces the need for inorganic Phosphorus supplementation.

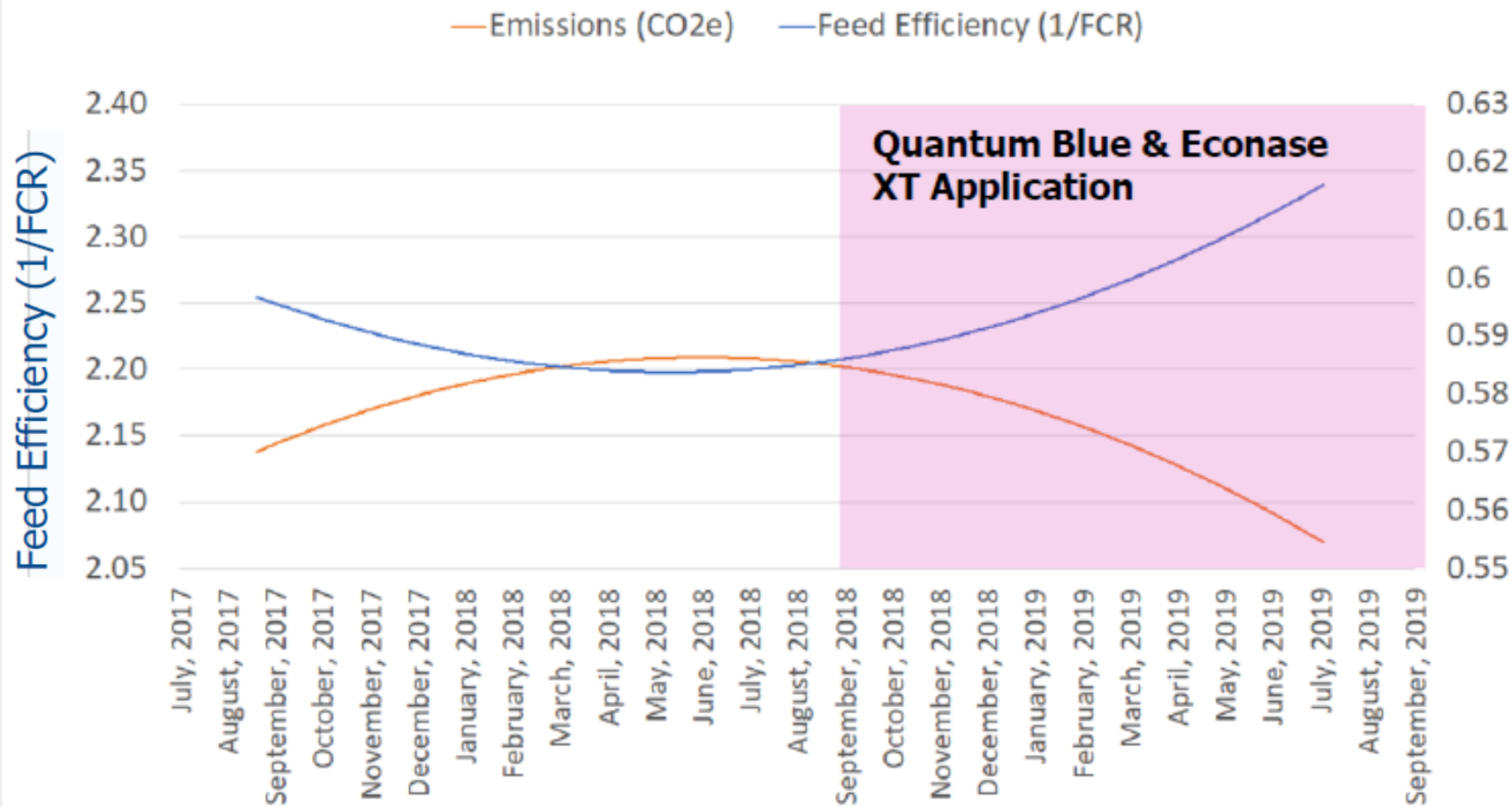
If 25g HiPhorius™40 is included in each MT of feed for 10mil broiler chicken, the Phosphorus emissions are reduced by 30MT of PO<sub>4</sub> equivalents, while the GreenHouse Gas emissions (CH<sub>4</sub>, N<sub>2</sub>O, CO<sub>2</sub>) are reduced by 850MT of CO<sub>2</sub> equivalents.



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## Commercial Evaluation looking at targeted enzyme application



Kg CO<sub>2</sub>e/Kg Chicken Meat



# *Animal Welfare*

**Helping to reach full animal productivity potential  
by meeting welfare expectations**



## Welfare Plus

### A growing concern ...

94%

of European citizens believe that it is important to protect animal welfare on farms

59%

of Europeans are willing to pay more for products from animal welfare friendly systems

- Strategies and solutions to deal with behavioral problems in swine

*Management approaches*

*Common nutritional solutions*



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# Dietary interventions to reduce stress



## Overview of common nutritional solutions

### *Tryptophan*

- Role in Serotonin production (anxiolyticum, calming) → lowers cortisol level

### *Fiber*

- Structure
- Satiety
- Gut health

### *Magnesium (oxide/acetate/phosphate)*

- Calming effect

### *Crude protein (level & source)*

- Digestibility and dose depending
- Low CP (digestibility) induces aggressiveness

### *Fat & Fatty acids*

- Digestibility
- Anti-inflammatory effect (omega 3, MCFA's)

### *Salt/Sodium*

- Low sodium/ salt levels tend to increase biting

### *Zinc / Copper / Vitamins B*

- Wound healing & immunity
- Deficit > necrosis
- Wound healing & immunity

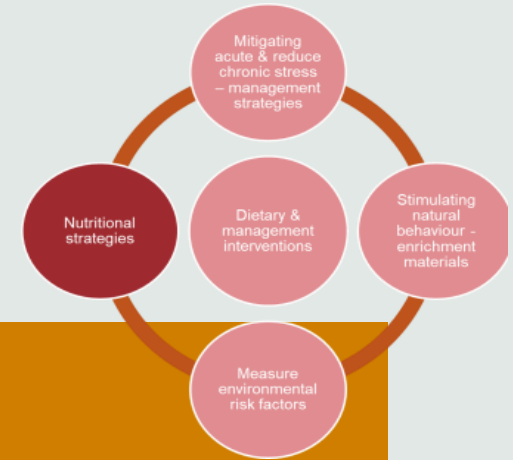
### *High level of anti-oxidants*

- Prevent tissue damage
- anti-inflammatory effect
- boost immunity

### *Mycotoxin binder*

- Mycotoxins have dermonecrotic effect (T2, alkaloids, DON)
- Endotoxins predispose for aggressiveness

# Role of plants



**Specially selected herbs**

*Main effects*

- ❖ **Brain activity**
  - Opening or closing of different pathways
  - Stimulating or inhibiting synthesis of different hormones
- ❖ **Inflammation** —

*Side effects linked to improved behavior*

- ❖ **Oxidation** —
- Depression —
- Sleeping time +

**LEADING TO:**

- ✓ **Less stress**
- ✓ **More serenity**
- ✓ **Less anxiety**





# 結論

1.目標: 在地化研發提高功效、安全性和環境友善的新型飼料添加物。

2.策略:

- 應用基因工程、生物技術和奈米技術等尖端技術來提高飼料添加物的功效。
- 產品研發需有科學證據，動物確效，具有試量產能力與經濟效益。
- 提升產品端之生產技術，增加產品穩定性與適時之腸道作用位置。



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敬請指教

Thank you !