

Nutri Forum 23

**El matrimonio sanidad-nutrición,
en la salud y en la enfermedad**

Edgar Garcia Manzanilla, Teagasc



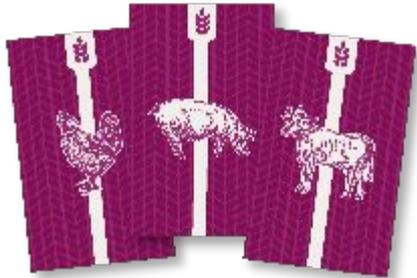
Sanidad



Nutrición

En la salud: Como afecta la nutrición a la respuesta inmune del animal? Inmunomodulación

En la enfermedad: Como modifica una enfermedad los requerimientos nutricionales del animal?



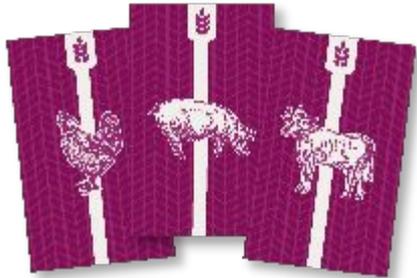
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Como evaluamos el efecto de un nutriente?

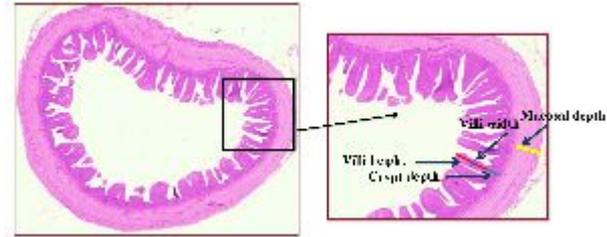


Como evaluamos el efecto de un nutriente?

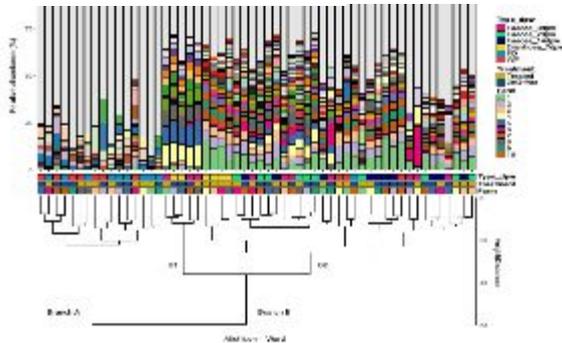
Digestibilidad



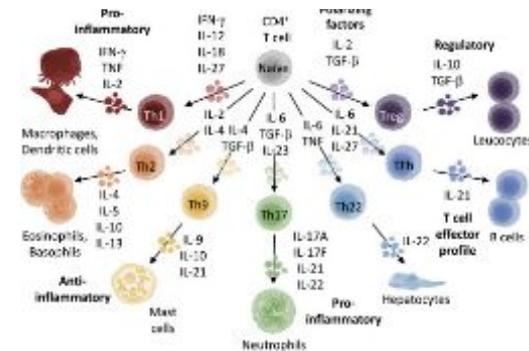
Estructura del intestino



Microbiota



Respuesta inmune???



Ejemplos de experimento

Effects of spray-dried porcine plasma and plant extracts on intestinal morphology and on leukocyte cell subsets of weaned pigs¹

M. Nofrarías,^{*2} E. G. Manzanilla,[†] J. Pujols,[‡] X. Gibert,[‡] N. Majó,^{*} J. Segalés,^{*} and J. Gasa[†]

^{*}Centre de Recerca en Sanitat Animal (CRESA)—Departament de Sanitat i d'Anatomia Animals, Universitat Autònoma de Barcelona, 08193, Bellaterra, Barcelona, Spain;

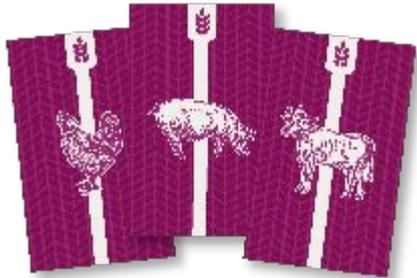
[†]Departament de Ciència Animal i dels Aliments, Universitat Autònoma de Barcelona, 08193, Bellaterra, Barcelona, Spain; [‡]CRESA—Institut de Re

Effects of butyrate, avilamycin, and a plant extract combination on the intestinal equilibrium of early-weaned pigs¹

E. G. Manzanilla,^{*2} M. Nofrarías,[†] M. Anguita,^{*} M. Castillo,^{*} J. F. Perez,^{*} S. M. Martín-Orúe,^{*} C. Kamel,[‡] and J. Gasa^{*}

^{*}Departament de Ciència Animal i dels Aliments; [†]Departament de Sanitat i Anatomia Animals, CRESA (Centre de Recerca en Sanitat Animal), Universitat Autònoma de Barcelona, 08193, Bellaterra, Spain;

[‡]Pancosma, 01200 Bellegarde-sur-Valserine Cedex, France



Ejemplos de índices inmunes

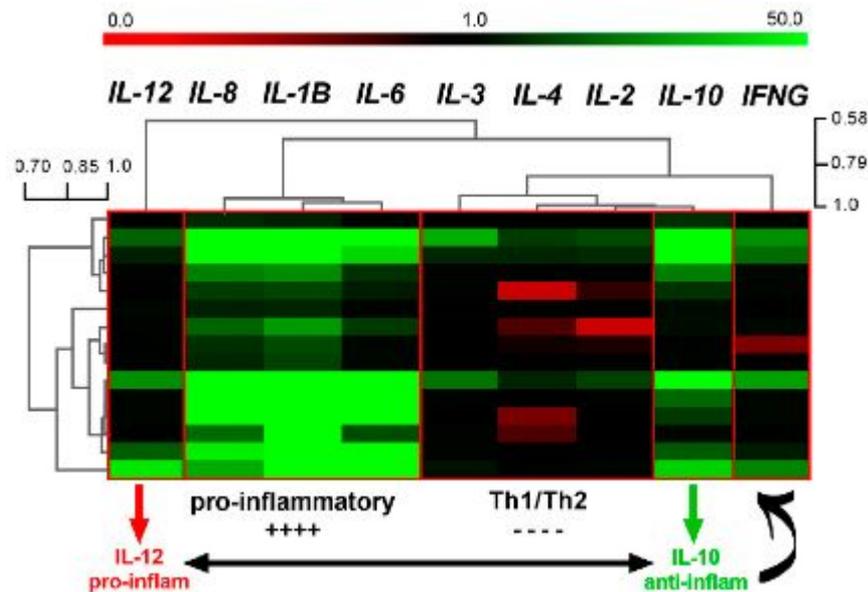
2740

Nofi

Table 5. Leukocyte subsets (hematological and flow cy

Item	d 0 ²	d 7		
		CT ³	SDPP ³	XT ³
Leukocyte count, thousands· μL^{-1}	14.9	12.3	13.4	15.9
Lymphocytes, %	31.2	48.4	45.4	43
Monocytes, %	3.8	4	5.8**	4.7
Neutrophils, %	65.6	46.2	47.6	51.1
Eosinophils, %	—	1.4	1.1	1.2
SWC3 ⁺ , %	20.9	19.8	24.7	22.2
CD21 ⁺ , %	31.7	19.2	18.1	16.8
$\gamma\delta\text{TCR}^+$, %	26	21.2	18.6	22.5
CD4 ⁺ , %	9.4	9.6	10	11.4
CD8 ⁺ , %	21.2	29.5	26.3	25.1
CD8 ^{low+} , %	15	24.4	19.9	20
CD8 ^{high+} , %	6.2	5.2	6.4	5.1
CD4 ⁺ CD8 ⁻ , %	0.4	4.9	4.3	5.4
CD4 ⁺ CD8 ⁺ , %	6.4	4.4	4.4	4
CD4 ⁻ CD8 ⁺ , %	13.8	28.8	24.9	22.2

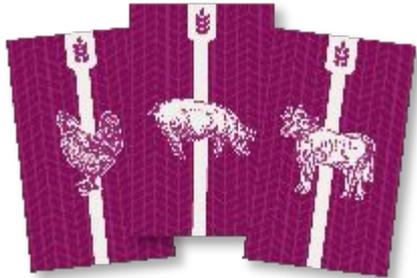
Cambios celulares



Cambios en citoquinas

Inconvenientes de esta aproximación

- Estos índices funcionan mucho mejor en sanidad donde los efectos son mucho más marcados que la varibilidad basal
- La reducción de la respuesta immune a un solo concepto es muy simplista

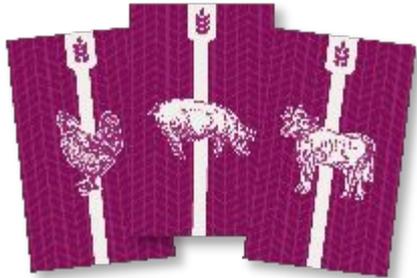


A por una nueva aproximación



Kirk Klasing

Mechanistic



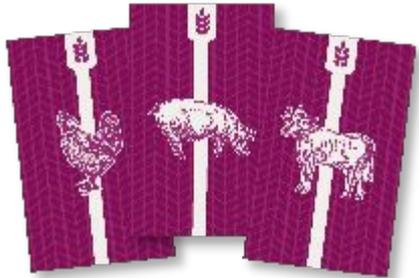
En la salud, tipos de respuesta inmune

Innata vs adaptativa

Específica vs inespecífica

Celular vs humoral

...



En la salud, respuesta innata vs adaptativa

Innate Immune Defense



Heterophils



Monocytes/ Macrophages

Eficacia de la respuesta

Especificidad de la respuesta

Coste de la respuesta

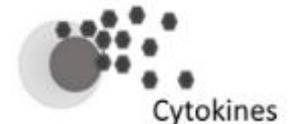
Adaptive Immune Defense



Lymphocytes

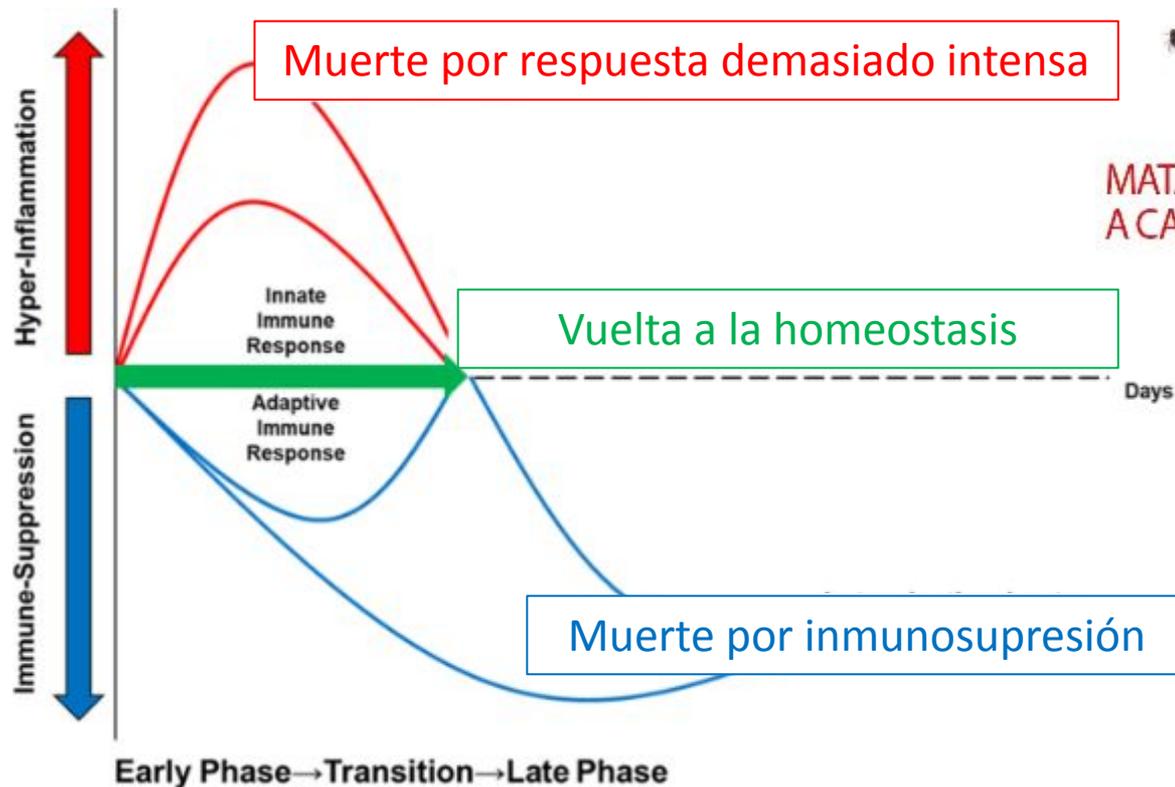


Antibodies

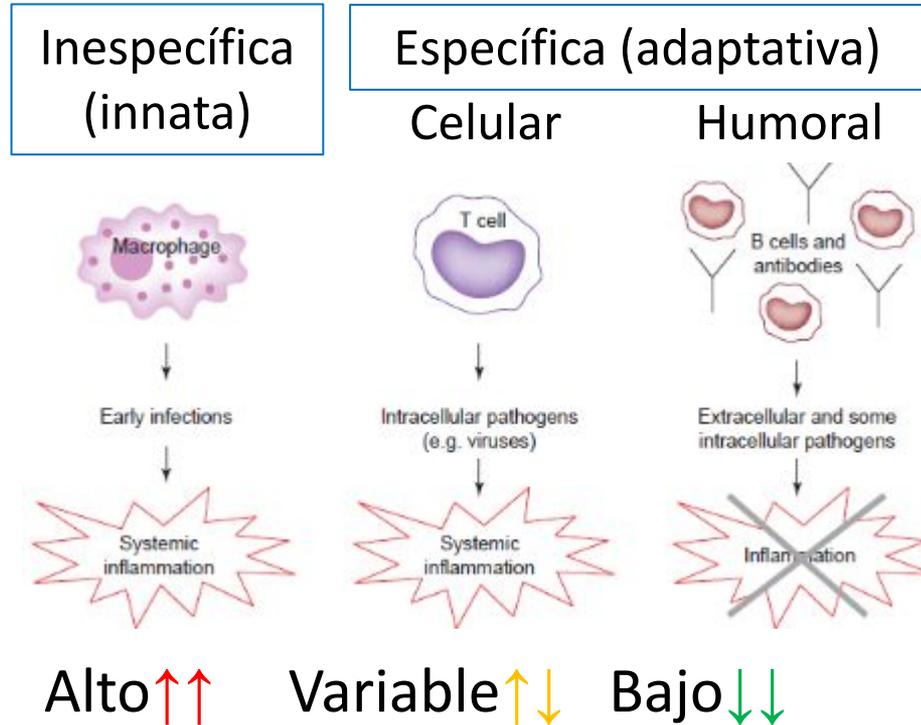


Cytokines

Eficacia: Respuesta innata vs adaptativa



Especificidad y coste de la respuesta inmune



Coste: Respuesta humoral y crecimiento

Pollo bursectomizado vs pollo normal

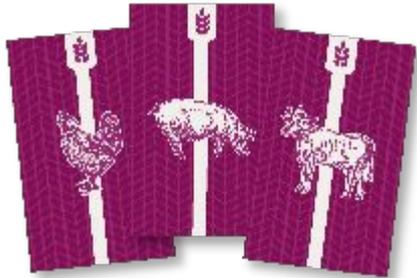
Respuesta
mayoritariamente
inflamatoria, innata
e inespecífica



Respuesta tanto
específica (adaptativa)
e inespecífica (innata)

<500g

1200g



Inmunomodulación, el ejemplo de las aves

- Uso mucho mas eficiente de nutrientes
- Menos inmunidad materna
- Mejor modelo (n, manejo...)

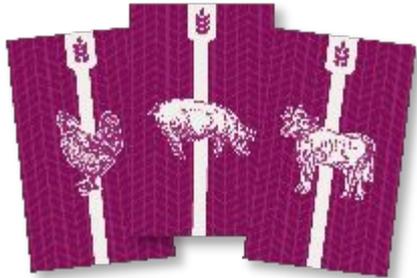
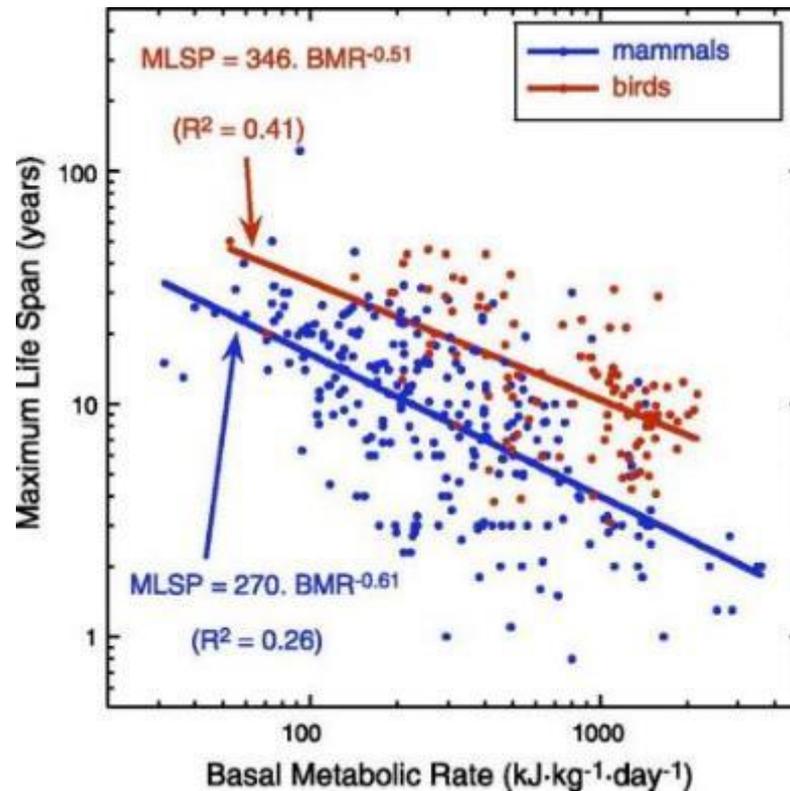


Table 1. Mechanisms by which diet affects immunity

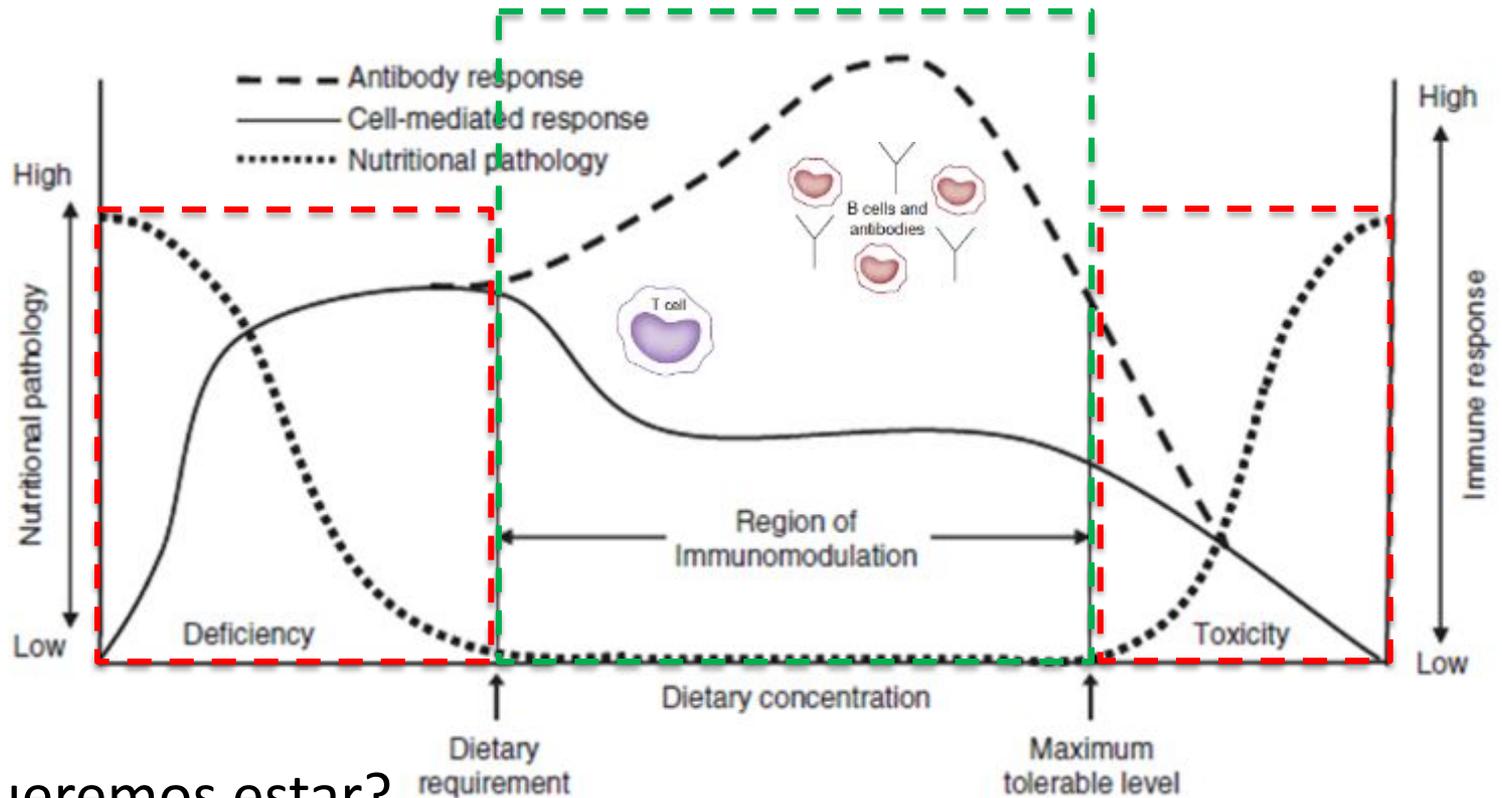
Mechanism	Nutrients
Nourish the cells of the immune system	All
Nourish pathogens	Biotin, iron
Modify the responses of leukocytes	Energy, PUFA, vitamins A, D, E
Protect against immunopathology	PUFA, vitamin E
Influence the microbial ecology of the gut	Fibre
Stimulate the immune system	Lectins, protein antigens

En la salud, aves



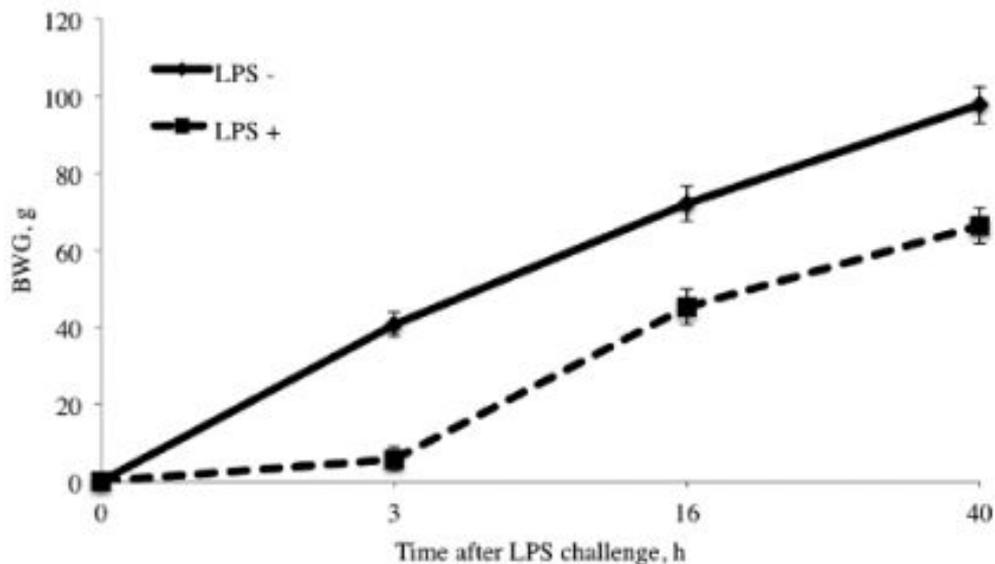
La respuesta inmune y antioxidante es superior en las aves

En la salud, inmunomodulación



Donde queremos estar?

En la salud, retos inmunológicos



Efecto en el crecimiento de pollos a las 3, 16 y 40 h tras un reto inmunológico con LPS de Salmonella

LPS – Respuesta innata

Concanavalina A – Celulas T

Vacunas – Respuesta específica

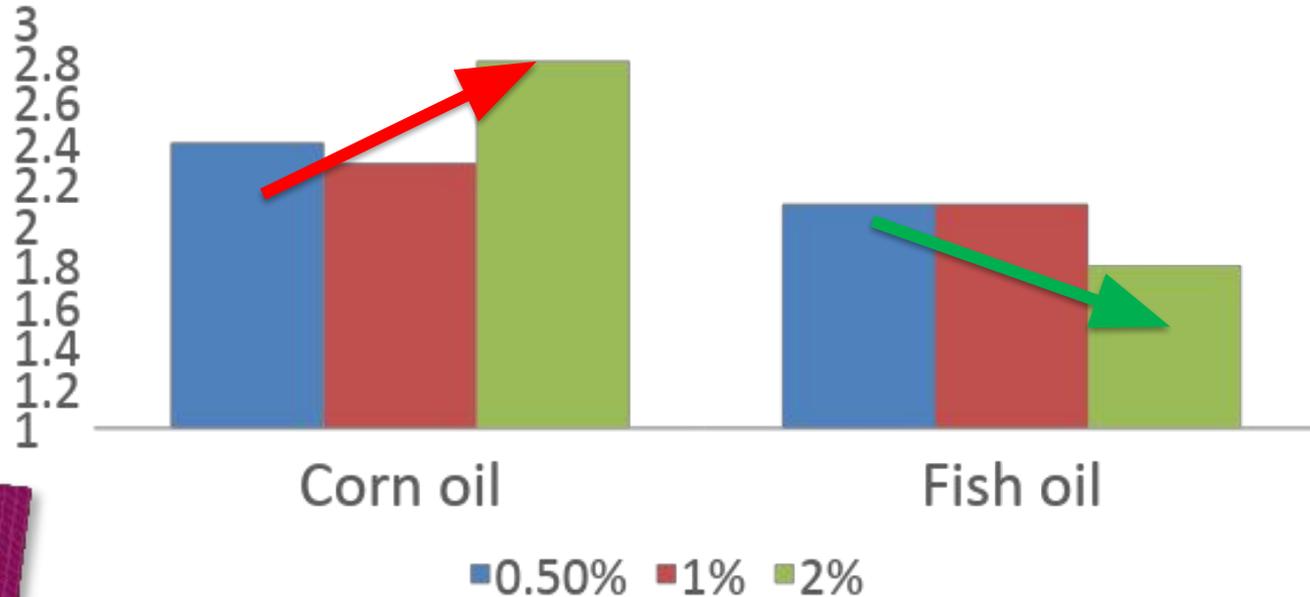
Eimeria – Respuesta a parásitos

Fitohemaglutinina, *S. aureus*...

En la salud, Inmunomodulación por n3:n6

Korver et al., 1997

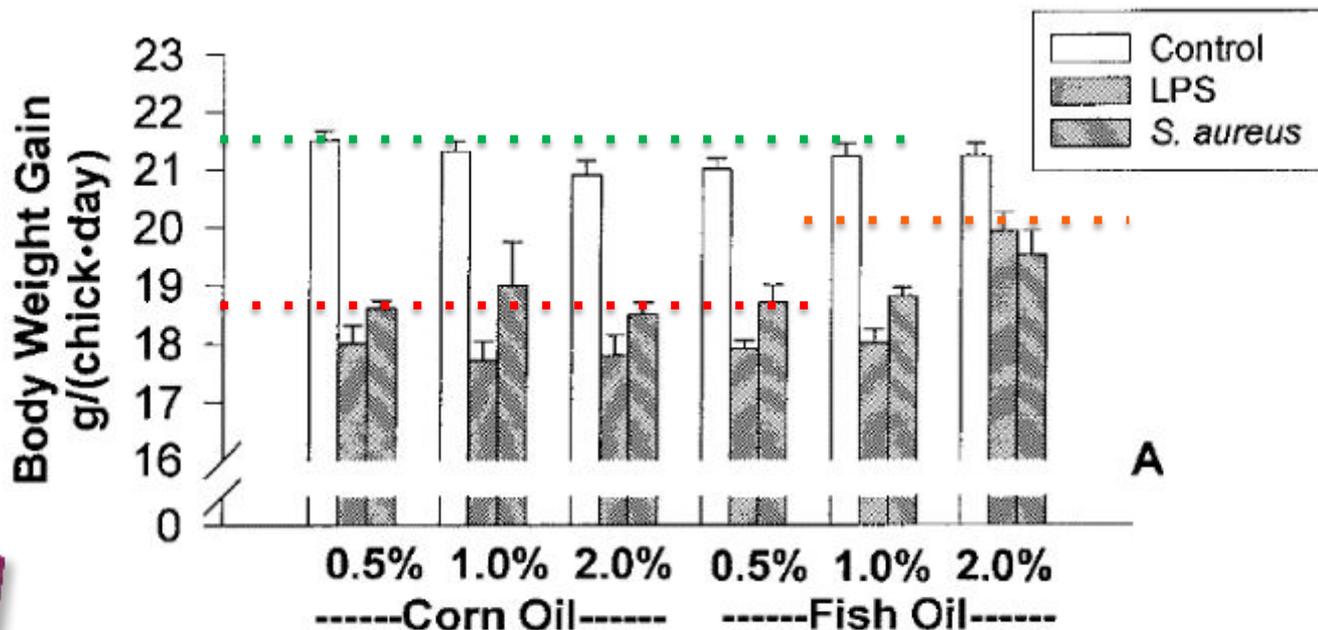
Nivel de IL-1 en células estimuladas con LPS



Cual será el efecto sobre los rendimientos?



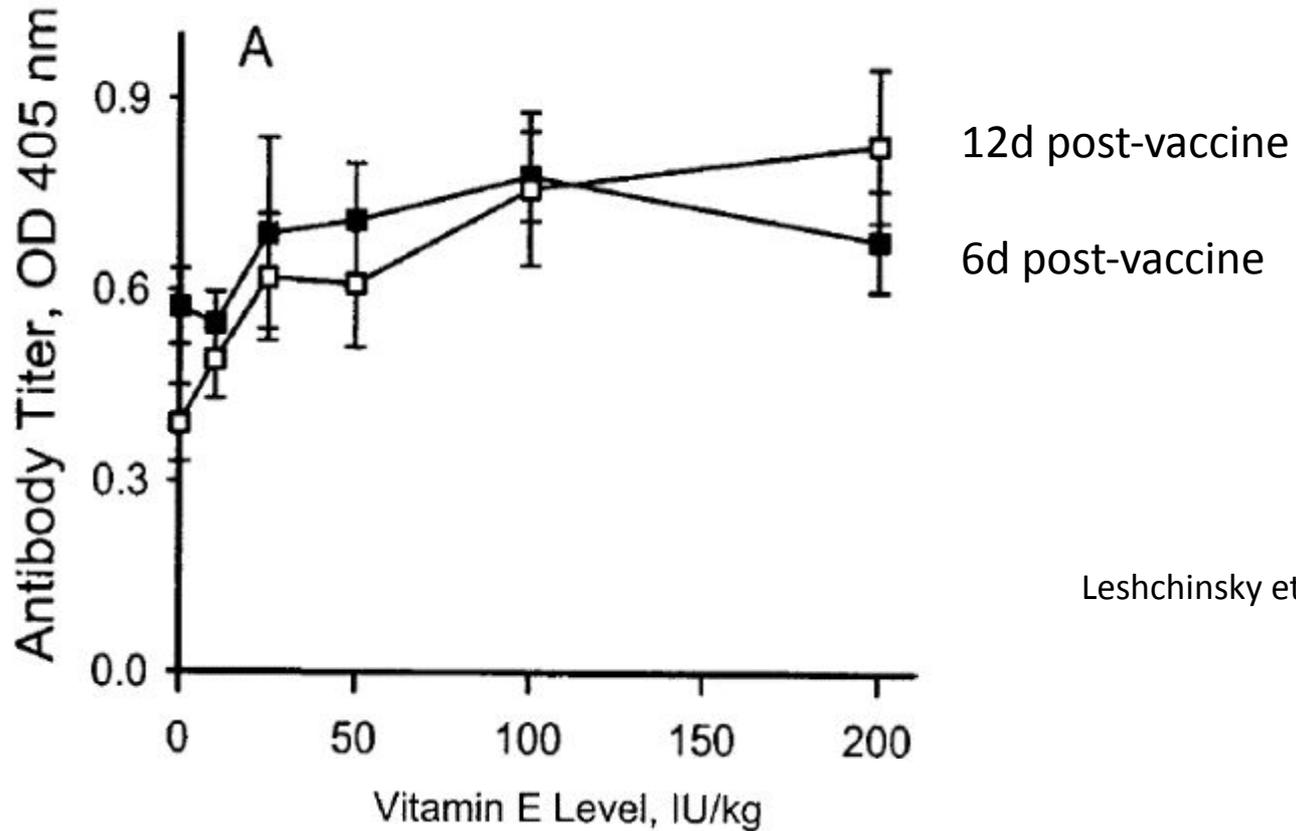
En la salud, Inmunomodulación por n3:n6



Korver et al., 1997

< fiebre
< proteínas de fase aguda

Anticuerpos para bronquitis infecc. según dosis de vit. E



Leshchinsky et al., 2001

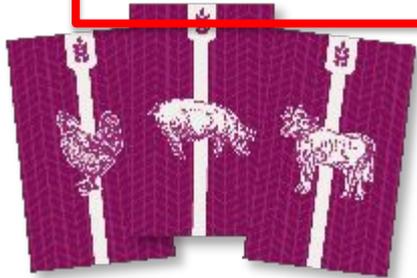
Sanidad



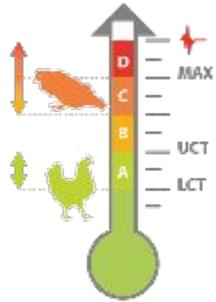
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Que variables tenemos en cuenta al formular dietas?



Clima

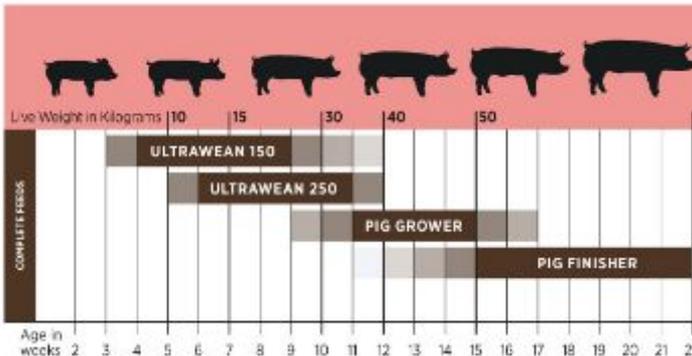


Genética

Sanidad??

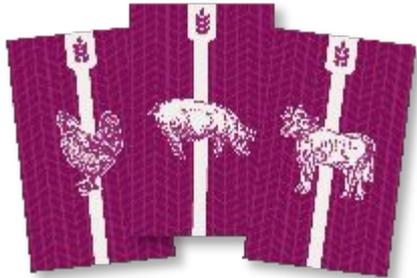
Edad

Producto/Canal



Objetivo:

¿Como podemos considerar el estado sanitaria de las granjas al formular dietas?



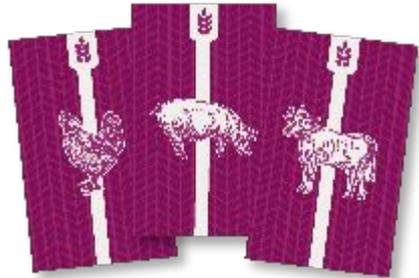
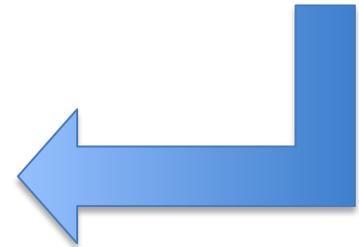
De vuelta a la patología



UCDAVIS
UNIVERSITY OF CALIFORNIA

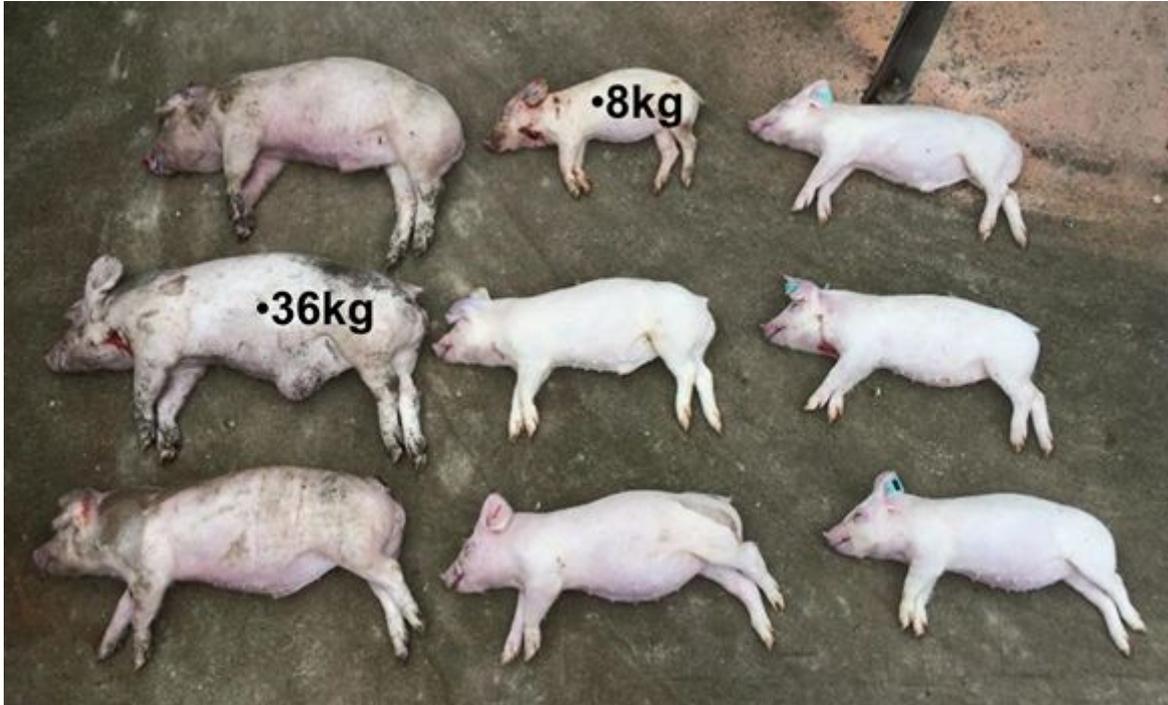


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de Barcelona



**Nutri
Forum
23**

En la enfermedad. ¿Que nos encontramos?



Animales de la misma edad

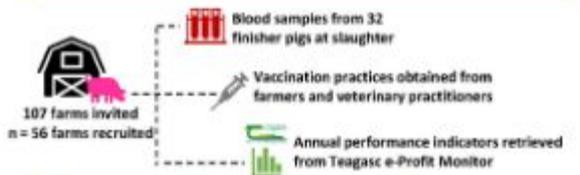
Sacrificados por diferentes patologías

Amplio rango de pesos

IC no tan diferente

Mayor edad a matadero

1 DATA COLLECTION



2 SCENARIOS

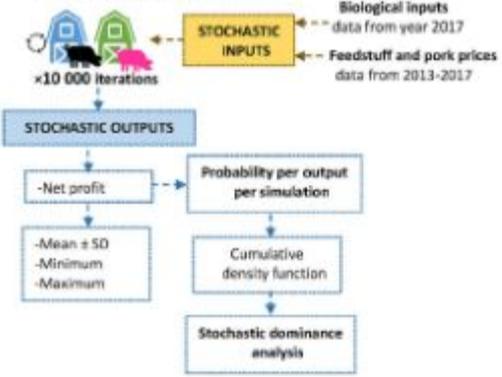
- Five scenarios based on herd status and vaccination strategy for PRRSV¹, SIV² and MHYO³
1. Unvaccinated PRRSV(-) farm vs. PRRSV(+) farm vaccinating gestating sows
 2. Unvaccinated PRRSV(-) farm vs. unvaccinated PRRSV(+) farm
 3. Unvaccinated SIV(-) farm vs. SIV(+) farm vaccinating gestating sows
 4. Unvaccinated SIV(-) farm vs. unvaccinated SIV(+) farm
 5. Unvaccinated MHYO(-) farm vs. MHYO(+) farm vaccinating pigs at weaning

3 BIO-ECONOMIC SIMULATION

A. Financial analysis



B. Monte Carlo simulation



¹ = Porcine reproductive and respiratory syndrome virus
² = Swine influenza virus
³ = *Mycoplasma hyopneumoniae*
⁴ = For each scenario, mean values from year 2017 obtain from the Teagasc e-Profit monitor
⁵ = For all scenarios, as per normal practice in Irish pig farms
⁶ = For each scenario, based on its average daily gain. Animal growth simulated for the wean-to-finish period assuming a weaning weight of 7 kg and a slaughter weight of 110.8 kg
⁷ = For all scenarios, as per NRC (2012) recommendations
⁸ = For all scenarios, market prices for the year 2017. For feedstuff prices, average monthly values were used and obtained from the Teagasc e-Profit monitor. Veterinary products and veterinary visits costs were obtained from a major veterinary distributor
⁹ = For all scenarios, market prices for the year 2017. Average monthly pork (kg) prices were used and obtained from the Teagasc e-Profit monitor

Financial Analysis of Herd Status and Vaccination Practices for Porcine Reproductive and Respiratory Syndrome Virus, Swine Influenza Virus, and *Mycoplasma hyopneumoniae* in Farrow-to-Finish Pig Farms Using a Bio-Economic Simulation Model

Johé Abbouze Cokohedji Diaz^{1*}, Rossa Mery Elyngard², Laurence Skelton³, Maria Rodrigues da Costa^{1,4}, Jarkko Niemi⁵, Finola C. Leonard⁶, Ilias Kyriazakis⁷ and Edgar Garcia Hernandez^{1,8}

Calderón Díaz et al., 2020

Modelo bioeconómico

56 granjas

Modelo 728 cerdas ciclo cerrado

En la enfermedad, el programa de alimentación cambia

Output	PRRSv		
	Positive		
	Negative ^a	Vaccinated ^b	Unvaccinated ^a
Feed usage, ton			
Gestation feed	540.5	540.5	540.5
Lactation feed	367.8	367.8	367.8
Creep feed	60.5	59.3	60.1
Link feed	142.7	139.8	141.6
Weaner feed	916.1	1,058.2	1,085.8
Finisher feed	3,380.9	3,308.9	3,409.4
Sales			
No. finisher pigs sold	19,136	18,408	18,980
No. of tons of meat sold	1,592.8	1,532.5	1,580.1

Financial Analysis of Herd Status and Vaccination Practices for Porcine Reproductive and Respiratory Syndrome Virus, Swine Influenza Virus, and *Mycoplasma hyopneumoniae* in Farrow-to-Finish Pig Farms Using a Bio-Economic Simulation Model

Julie Adriana Calderón Díaz¹, Rossa Mary Ferguson², Laurence Shelton³, Maria Rodrigues da Costa^{1,4}, Jarkko Niemi⁵, Finola C. Leonard⁶, Ilias Kyriozakis⁷ and Edgar García Menéndez^{1*}

Calderón Díaz et al., 2020

En la enfermedad: principal coste, la alimentación

Item	€/year				
	PRRSv(+)		SIV(+)		MHYO [®] (+)
	vac ^b	unvac ^c	vac ^d	unvac ^c	
Total Sales	-97824	-19801	-31208	-1720	-140486
VARIABLE COSTS					
Feed costs	+17522	+48877	+97842	+53072	-644
Other variable costs	+4479	-673	+10975	-51	+16263
Total variable costs	+22001	+48203	+108817	+53021	+15619
Total fixed costs	0	0	0	0	0
Depreciation costs	0	0	0	0	0
Total costs	+22001	+48203	+108817	+53021	+15619
Net Profit	-119825	-68004	-140025	-54741	-156106

Financial Analysis of Herd Status and Vaccination Practices for Porcine Reproductive and Respiratory Syndrome Virus, Swine Influenza Virus, and *Mycoplasma hyopneumoniae* in Farrow-to-Finish Pig Farms Using a Bio-Economic Simulation Model

Julia Askani, Calderón Díaz ¹, Rose May Pijpers², Jansow Staflor³, María Rodríguez de Cordero⁴, Jarkko Niemi⁵, Fátima G. Leonard⁶, Marja Aylazova⁷ and Edgar García-Muñoz⁸*

Calderón Díaz et al., 2020

Clasificación de granjas: Patógenos vs signos clínicos

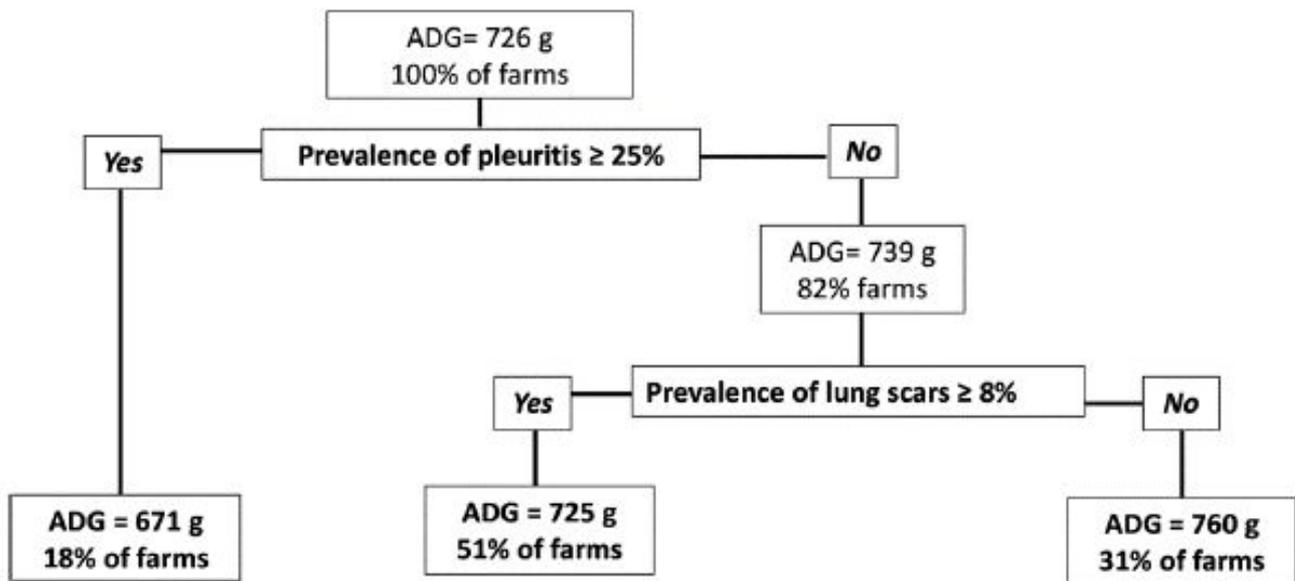


Table 2 Annual physical outputs obtained from the Teagasc Pig Production Model [30] for the simulation^a of effects associated with different prevalence of pleurisy and lung scars on slaughter pigs on farm performance and profitability

Output	LPLSC ^b	LPHSC ^c	HP ^d
Feed usage, ton			
Gestation feed	540.5	540.5	540.5
Lactation feed	367.8	367.8	367.8
Creep feed	77.3	76.7	76.5
Link feed	142.3	141.2	140.9
Weaner feed	1137.1	1301.7	1253.1
Finisher feed	3164.9	3150.1	3377.6
Sales			
No. finisher pigs sold	19,188	18,772	18,564
Meat sold, ton	1595.1	1560.6	1555.4

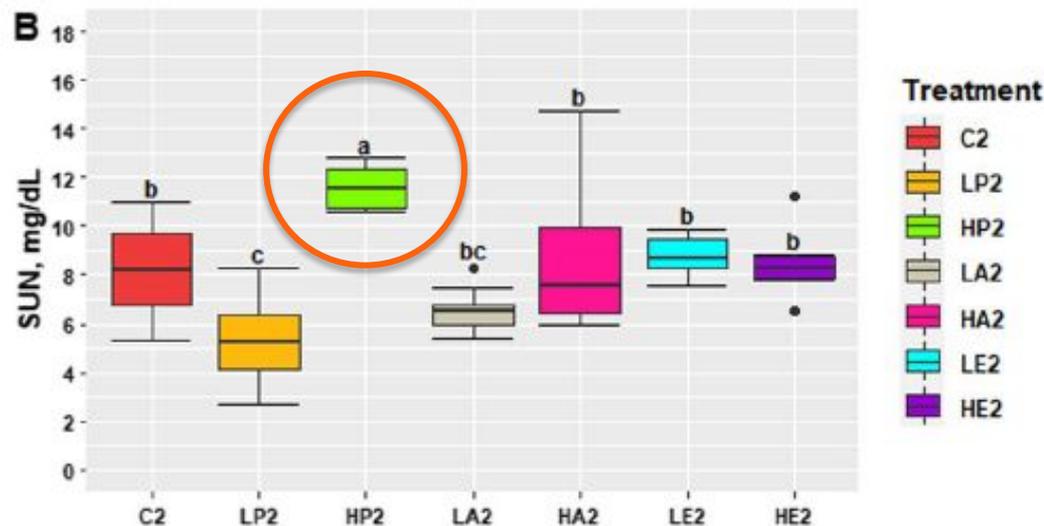
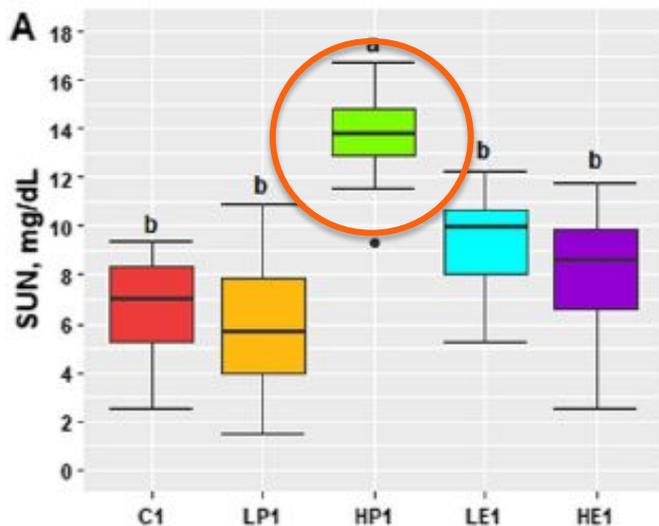
^aA 728 sow farrow-to-finish farm with weekly farrowing batches was simulated to represent three different scenarios

^bScenario 1: a farrow-to-finish farm with prevalence of pleurisy < 25% and prevalence of lung scars < 8% with a wean-to-finish average daily gain (ADG) of 760g and reaching target slaughter weight at 24 weeks of age

^cScenario 2: a farrow-to-finish farm with prevalence of pleurisy < 25% and prevalence of lung scars ≥ 8% (LPHSC) with an ADG of 725g and reaching target slaughter weight at 25 weeks of age

^dScenario 3: a farrow-to-finish farm with prevalence of pleurisy ≥ 25% (HP) with and ADG of 671g and reaching target slaughter weight at 26 weeks of age

Clasificación de granjas: Uso de biomarcadores



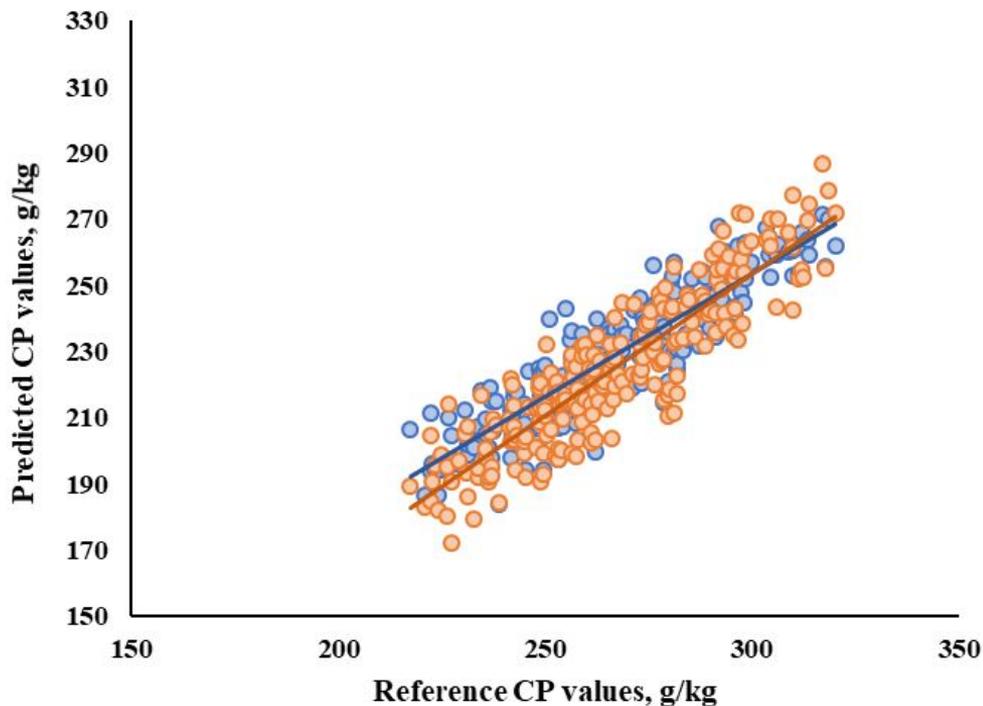
Urea, creatinina y otros biomarcadores en sangre

Clasificación de granjas: Uso de biomarcadores



Marcadores de estrés, respuesta inmune, redox...

Clasificación de granjas: NIR en heces



Predicted FDG

$$y = 0.7431x + 30.573$$

$$R^2 = 0.8083$$

● Predicted FDG

● Predicted FDNG

— Linear (Predicted FDG)

— Linear (Predicted FDNG)

Predicted FDNG

$$y = 0.8555x - 3.1855$$

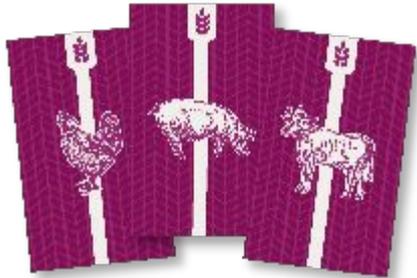
$$R^2 = 0.8023$$



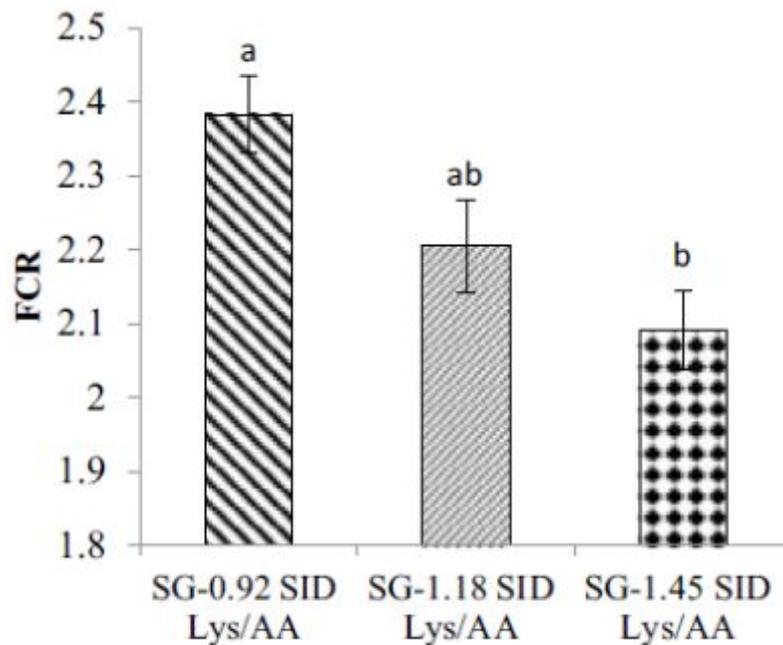
En la enfermedad. Ejemplo, el cerdo y los aminoácidos

Opciones a discutir:

- Suplementar dietas para mejorar el rendimiento
- Asumir que los crecimientos serán menores y formular más barato



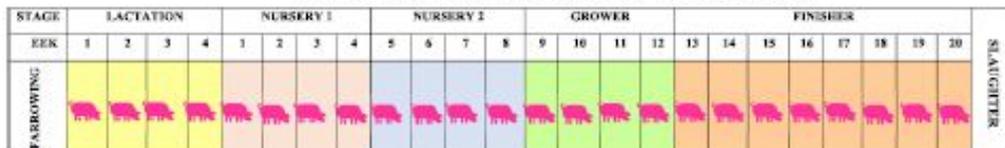
En la enfermedad. Suplementación de dietas



- Niveles de suplementación muy altos

- Subpoblaciones: enfermos y pequeños

EXPECTED TIME SPENT AND ANIMAL FLOW BY PRODUCTION STAGE



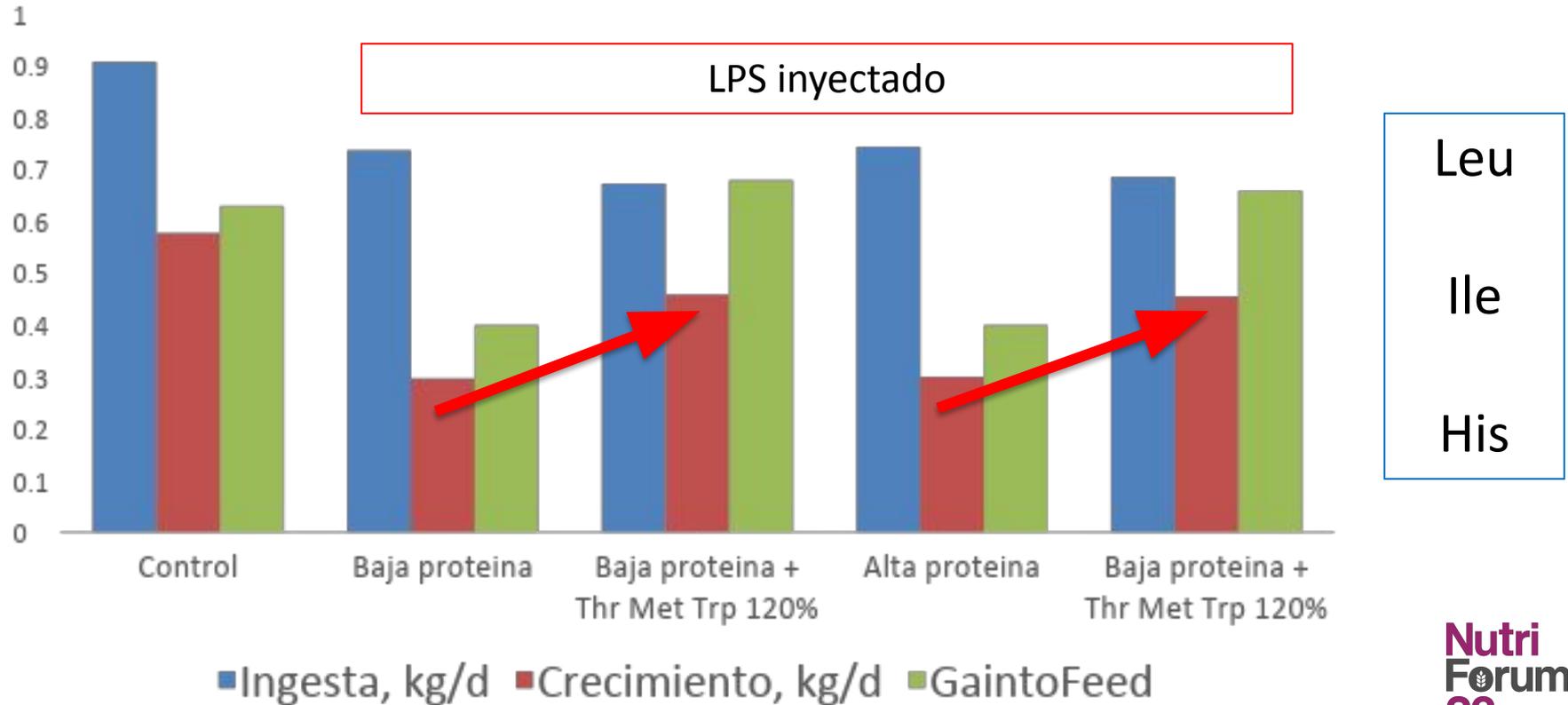
OBSERVED TIME SPENT AND ANIMAL FLOW BY PRODUCTION STAGE



- Cohort Description**
- 1 Pigs born 1 week later and weaned at 21 days of age
 - 2a Pigs weaned at 28 days of age and split by body size based on farmer subjective appraisal at 5 weeks post-weaning
 - 2b Pigs weaned at 28 days of age and split by body size based on farmer subjective appraisal at 5 weeks post-weaning from cohort 2a and at 5 weeks post-weaning from cohort 2c
 - 2c Smaller pigs weaned at 28 days of age and split by body size based on farmer subjective appraisal at 5 weeks post-weaning
 - 3 Pigs weaned at 35 days of age
 - 4 Pigs weaned at 49 days of age
 - Females selected as replacement gilts
 - Sick pigs that recovered and returned from the hospital pens
 - Dead pigs (17.8% of pigs)

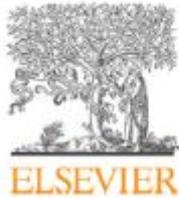
- Production Flow Description**
- 1 Pigs advancing through the production stages on a "timely" manner
 - 2 Pigs delayed from advancing from the 1st to 2nd nursery stage by 1 week
 - 3 Pigs delayed from advancing through the production stages by > 1 week

En la enfermedad. Suplementación de dietas



En la enfermedad. Importancia de la anorexia

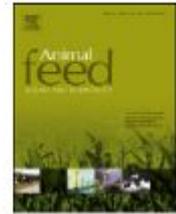
Animal Feed Science and Technology 156 (2010) 1–9



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Review

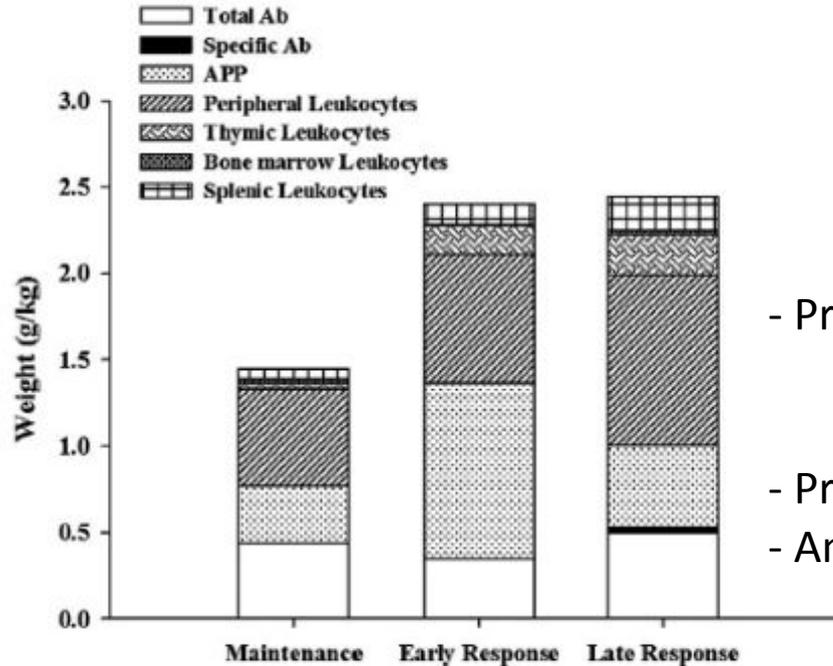
Is anorexia during infection in animals affected by food composition?

Ilias Kyriazakis^{a,b,*}

Muy difícil...

En la enfermedad. Importancia de la anorexia

g/kg



- Producción de células

- Proteínas de fase aguda

- Anticuerpos

Peso de los componentes celular y proteico del Sistema inmune en pollos antes, 24h y 5d después de un reto con *E. coli*.

Conclusiones

- La inmunomodulación de animales sanos es posible y existen muchos productos en el mercado aunque no todos funcionan en todo los casos.
- Para mejorar la respuesta inmune: definir el problema, población afectada y que tipo se quiere mejorar (reto).
- Buscar siempre confirmación de cambios fisiológicos en parámetros productivos.
- Incluir la sanidad en la formulación es difícil con un enfoque clásico pero los nuevos avances y el contexto productivo lo hacen más cercano.

Nutri Forum

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ABRIL



Gracies
Gracias
Thank you
Go raibh míle maith agat