INIAP

Effect of diet manipulation on manure characteristics

I: Agronomical features and atmospheric emissions

II: Energy recovery of biogas

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EAAP MEETING - ANTALYA

Instituto Nacional de Investigação Agrária e das Pescas
Ministério da Agricultura, do Desenvolvimento Rural e das Pescas

INTRODUCTION

- Problems related with intensive livestock:
  - Concentration in specific regions in a country
    - High concentration of units
  - Insufficient areas available for disposing the manure at farm level
  - Heavy legislative pressure by EU

INTRODUCTION (Cont.)

IPPC

- **Integrated Pollution Prevention Control**

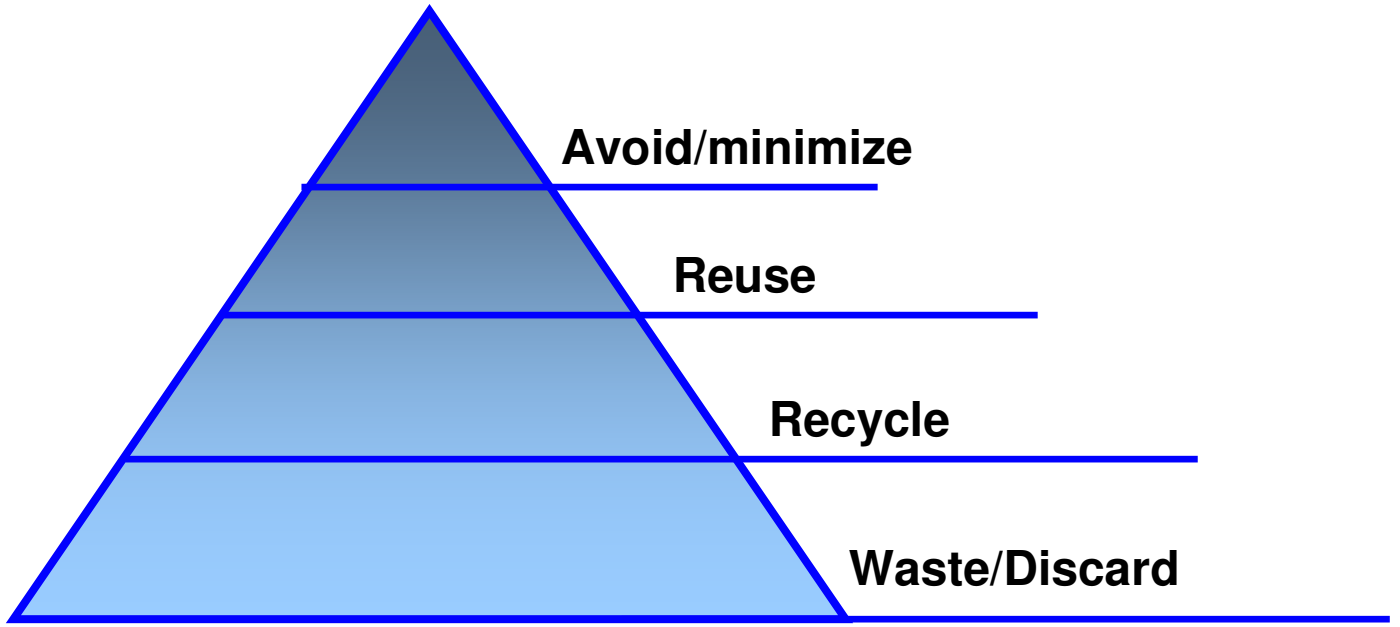
- Instalations are required to apply for an **Environmental Licence** , with the adoption of **Best Available Techniques**

Strategies of Waste Management

INTRODUCTION (Cont.)

- **IPPC**

Hierarchy of Waste Management Strategies



Adapt. Burton and Turner (2003)

INTRODUCTION (Cont.)

NH3 Excretion (g/animal/day)

T= 8.36

N= 2.65

Reduction = **5.71 g** x 365 days → **2.08 kg/Year**

Portuguese indigenous swine population = 4 500 000

30 - 100 kg → 105 days

Factor Year = 105/365 = 0,29

Mean efective number = 4 500 000 x 0,29

→ **1 305 000 PIGS**

Total Reduction in NH3 Production

1 305 000 x 2.08

1 996 Ton/Year

Moreira et al., EAAP 2005

I: Agronomical features and atmospheric emissions

OBJECTIVES

- To evaluate the effect of nitrogen and phosphorus dietary manipulation on pig manures characteristics: composition and agronomical application as fertilizer.

METHODOLOGY

Productive trials

- 45 Large White x Land Race growing/finishing males (35 – 90kg)
- Three experimental diets
  - Diet **T** – 18% crude protein, bicalcic phosphate
  - Diet **N** – 15% crude protein and amino acid balanced
  - Diet **P** – 18% crude protein, monocalcic phosphate
- Total collection and storage of manures **T**, **N**, **P**
  - Physical, Chemical and Microbiological evaluation

METHODOLOGY (Cont.)

Agronomical Studies

- Manures (**T**, **N**, **P**) were evaluated in fertilization studies,
  - Four levels of application (0, 42.5, 85, 170 kg.ha^{-1} of organic N).
  - Complete randomized block design, with three replications

- Sorghum was used as plant test (60kg/ha).
  - Vegetal biomass production was quantified.

METHODOLOGY (Cont.)

Agronomical Studies

- Air emissions were monitored
  - For the treatment corresponding to the highest dose of N application (170 kg. ha^{-1})
  - At six times after soil application:
    - before spreading (initial situation),
    - 15 minutes and 4 hours after spreading (time of the day with the highest temperature),
    - 12 hours after the scattering (the night period)
    - 15 minutes and 4 hours after incorporation in the soil (the highest temperature).

- The leachates from treatments 0, 85, and 170 kg . ha^{-1} were collected from lysimeters and chemically analysed.

RESULTS

Ingredient Composition of experimental diets *(kg/ton)*

Productive Phase	Growing*			Finishing**		
Diet	T	N	P	T	N	P
Barley	150	150	150	250	300	250
Wheat	250	250	250	250	185	250
Maize	272	367	270	223.5	331	222.5
Soybean Oil	19	8.0	20	12	5.0	12
Soybean Meal (42%)	277	188.5	277	236	141	236
Methionine	0.70	1.0	0.70	0.70	1.2	0.70
Lysine	1.3	3.6	1.30	1.3	3.8	1.30
Threonine	0.30	1.3	0.30	0.70	1.8	0.70
Calcium Carbonate	6.8	7.5	11	9.0	12.5	12.3
Monocalcium Phosphate	-	-	10.5	-	-	8.0
Dicalcium Phosphate	13.7	13.6	-	10.3	10.7	-
Salt	4.2	4.5	4.2	4.5	6	4.5
Premix (growing*/ finishing**)	5.0	5.0	5.0	2.0	2	2.0

RESULTS (Cont)

Composition of experimental diets

	Growing*			Finishing**		
	T	N	P	T	N	P
Calculated Composition						
Crude protein (%)	18,0	15,4	18,0	17,0	14,0	17,0
Total Ca (%)	0,70	0,70	0,70	0,69	0,81	0,70
Total P (%)	0,61	0,59	0,61	0,55	0,53	0,55
Available P (%)	0,35	0,35	0,35	0,30	0,30	0,30
Analyzed Composition (n=3)						
Crude protein (%)	17,1	15,2	18,0	15,1	13,1	16,9
Total Ca (%)	0,58	0,55	0,80	0,68	0,81	0,73
Total P (%)	0,49	0,48	0,65	0,47	0,45	0,55

RESULTS (Cont)

Nitrogen and Phosphorus Composition of manures (%DM)

	T	N	P	*sem*	*S*
Total N	4,56	4,65	5,12	*0,87*	*ns*
Soluble N	2,05	2,25	2,64	*0,66*	*ns*
N - NH3	2,39	2,30	3,18	*1,34*	*ns*
Total P	4,15	3,66	4,22	*1,27*	*ns*

RESULTS (Cont)

Sorghum Productions (kg DM/ha) (n=20)

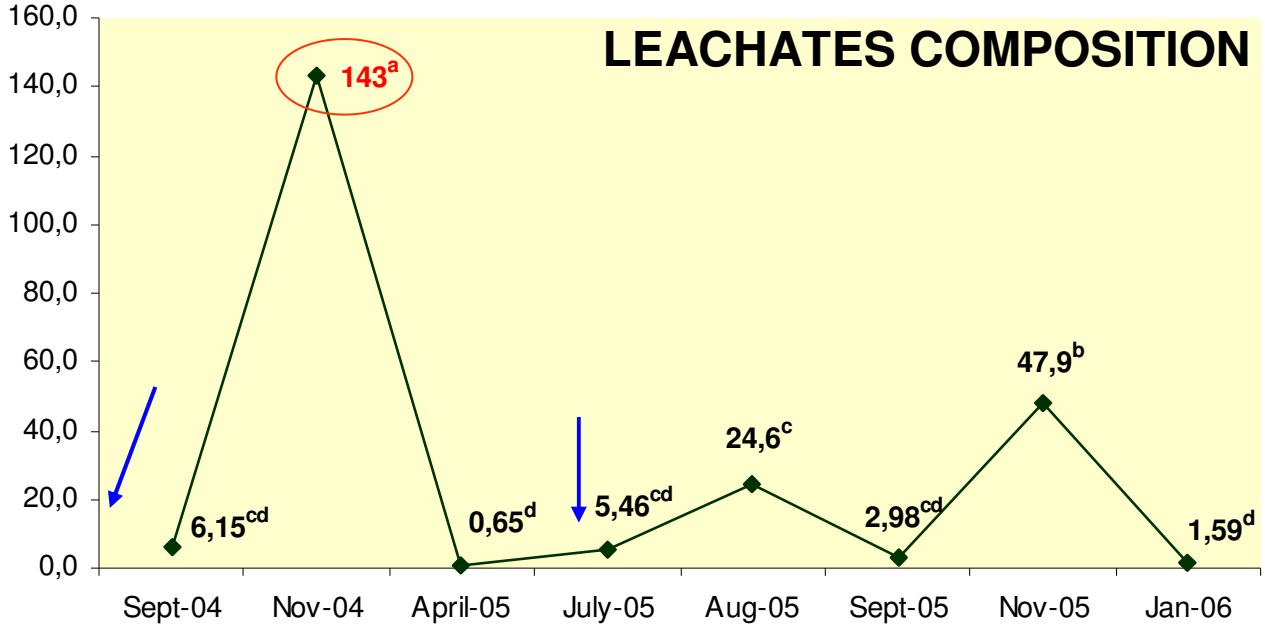
Experimental treatments	1st cut	2nd cut
0	6691	6504
T1 – 42,5 kg N/ha	7899	9166
T2 – 85 kg N/ha	7153	9561
T3 – 170 kg N/ha	7851	11896
N1 – 42,5 kg N/ha	7019	10072
N2 – 85 kg N/ha	7818	8437
N3 – 170 kg N/ha	9124	7886
P1 – 42,5 kg N/ha	4685	9569
P2 – 85 kg N/ha	7047	7840
P3 – 170 kg N/ha	8845	10291
sem (±)	*1030*	*1281*
Coef. Variation (%)	*24*	*24,3*

N extraction by Sorghum

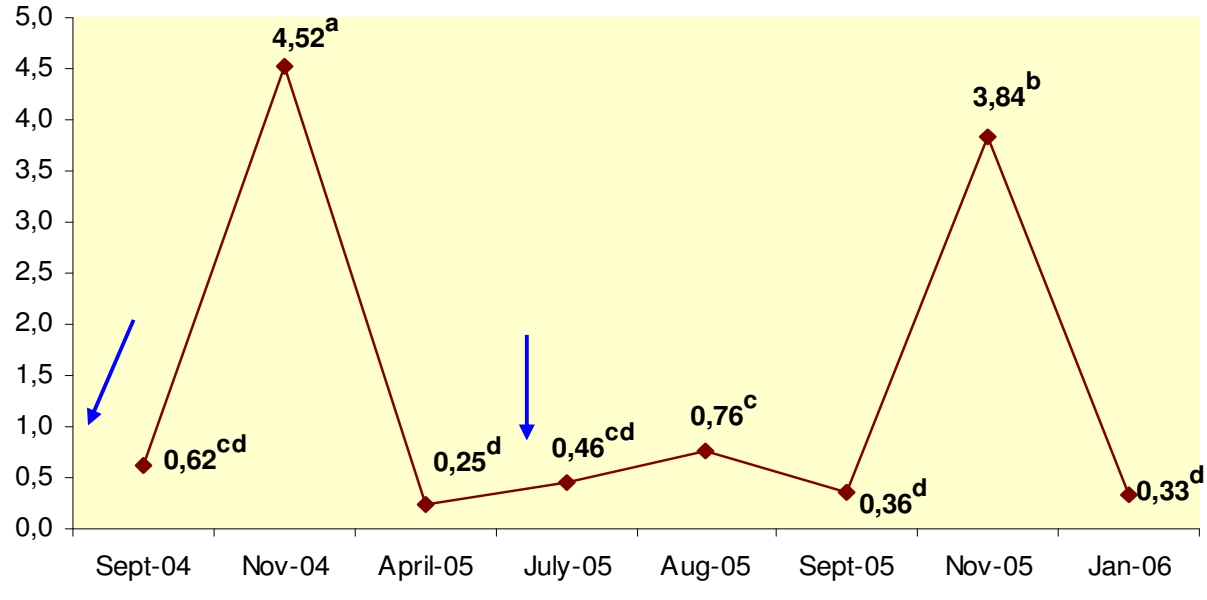
1st cut – 170 kg/ha

2nd cut – 206 kg/ha

RESULTS (Cont)

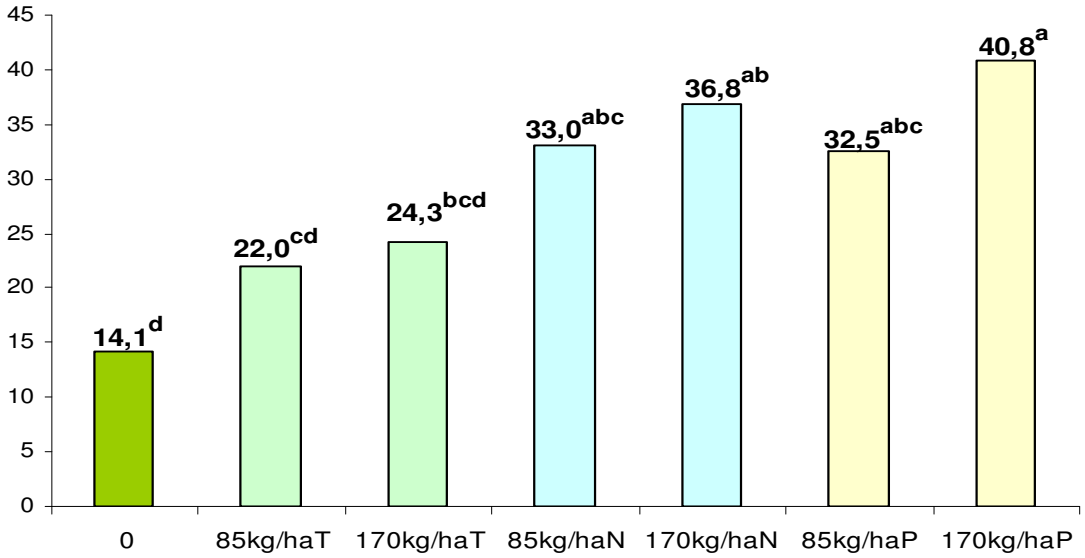


Variation of $N\text{-}NO_3^-$ in leachates with time (mg/l)

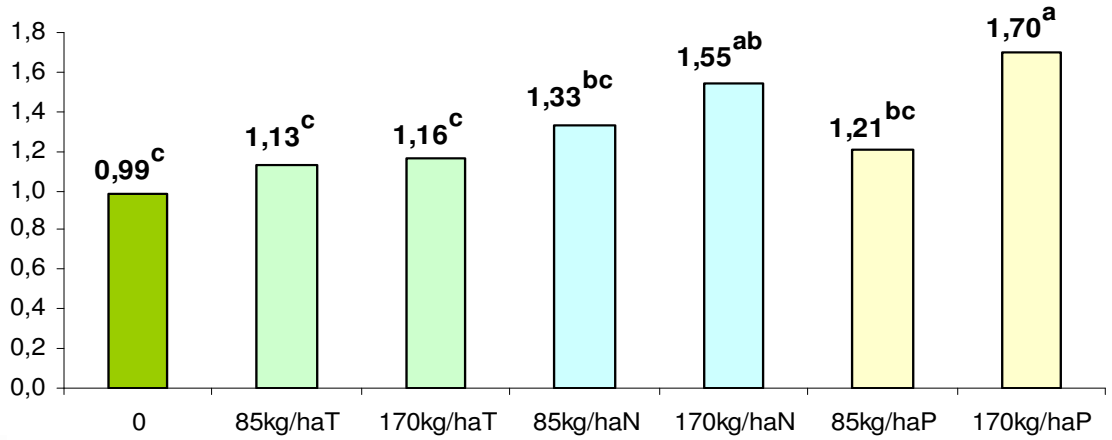


Variation of $N\text{-}NH_4^+$ in leachates with time (mg/l)

RESULTS (Cont)



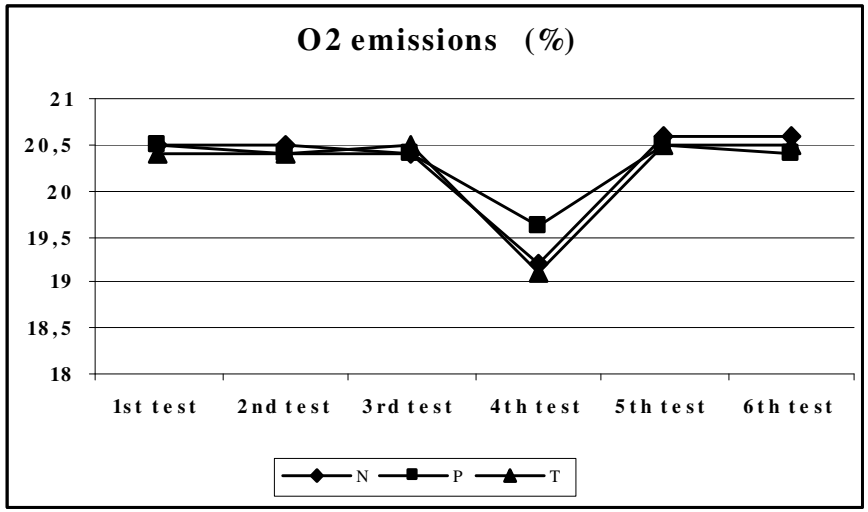
Variation of N-NO3⁻ in leachates with dose and type of manure (mg/l)

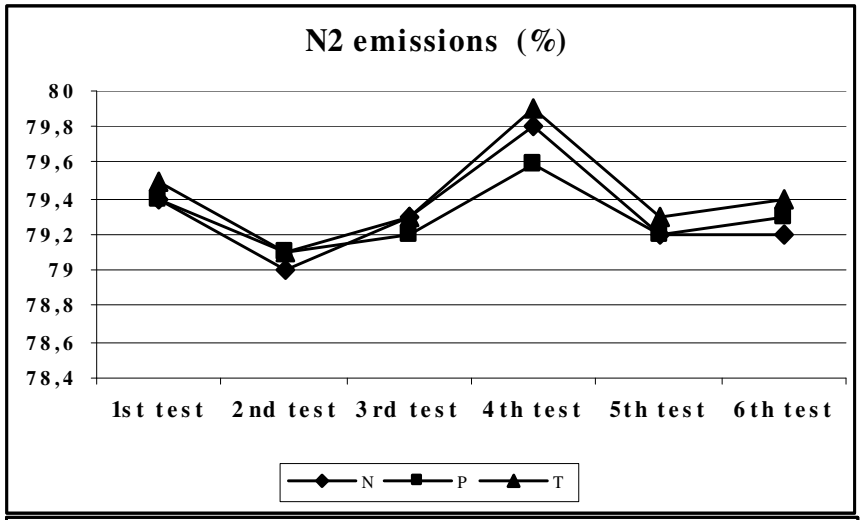


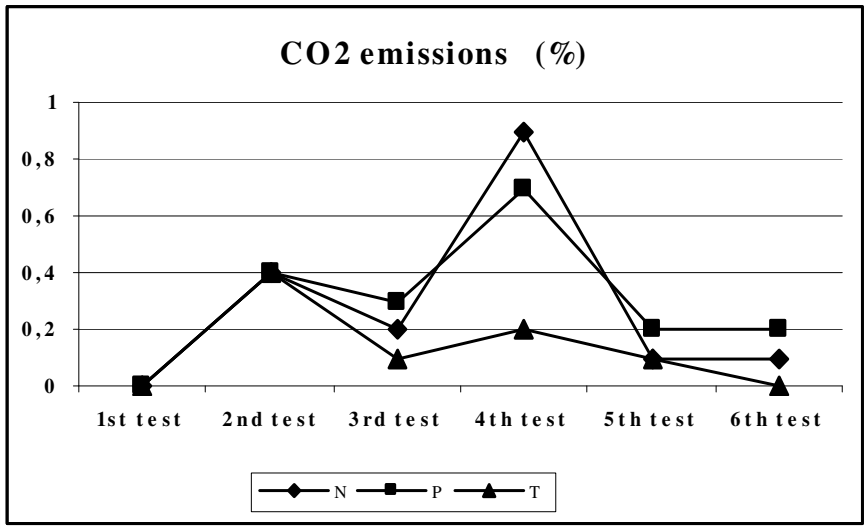
Variation of N-NH4⁺ in leachates with dose and type of manure (mg/l)

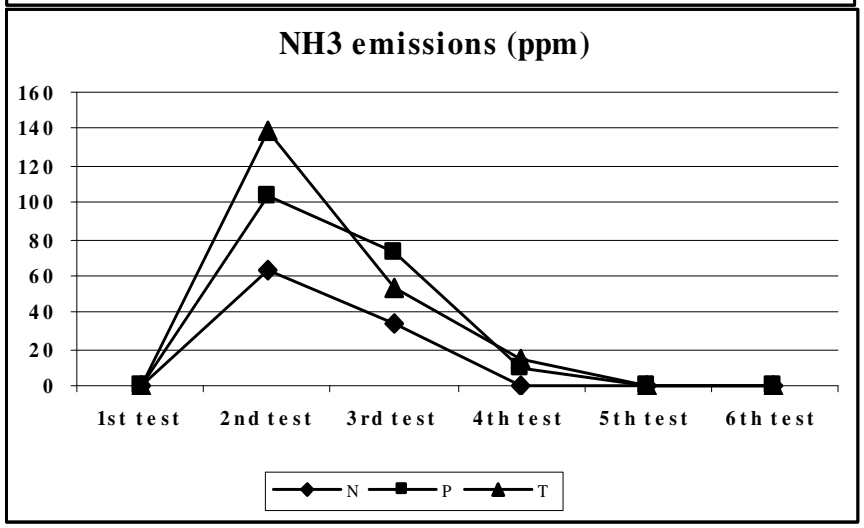
RESULTS (Cont)

Gaseous emissions following pig slurry application









(Sousa et al, 2006)

CONCLUSIONS

- The maximum level of fertilisation presented the highest vegetal biomass productions.
- Sorghum N extraction capacity varied between 170 and 206 kg/ha.
- The highest leachate nitrates were observed in November, after the 2nd cut
  → lack of sorghum for soil extraction
- Leachate nitrates were superior where the highest levels of manure were applied and for P, followed by N and T derived manure
- The lowest ammonia and CO2 emissions were observed for manure N.

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II: Energy recovery of biogas

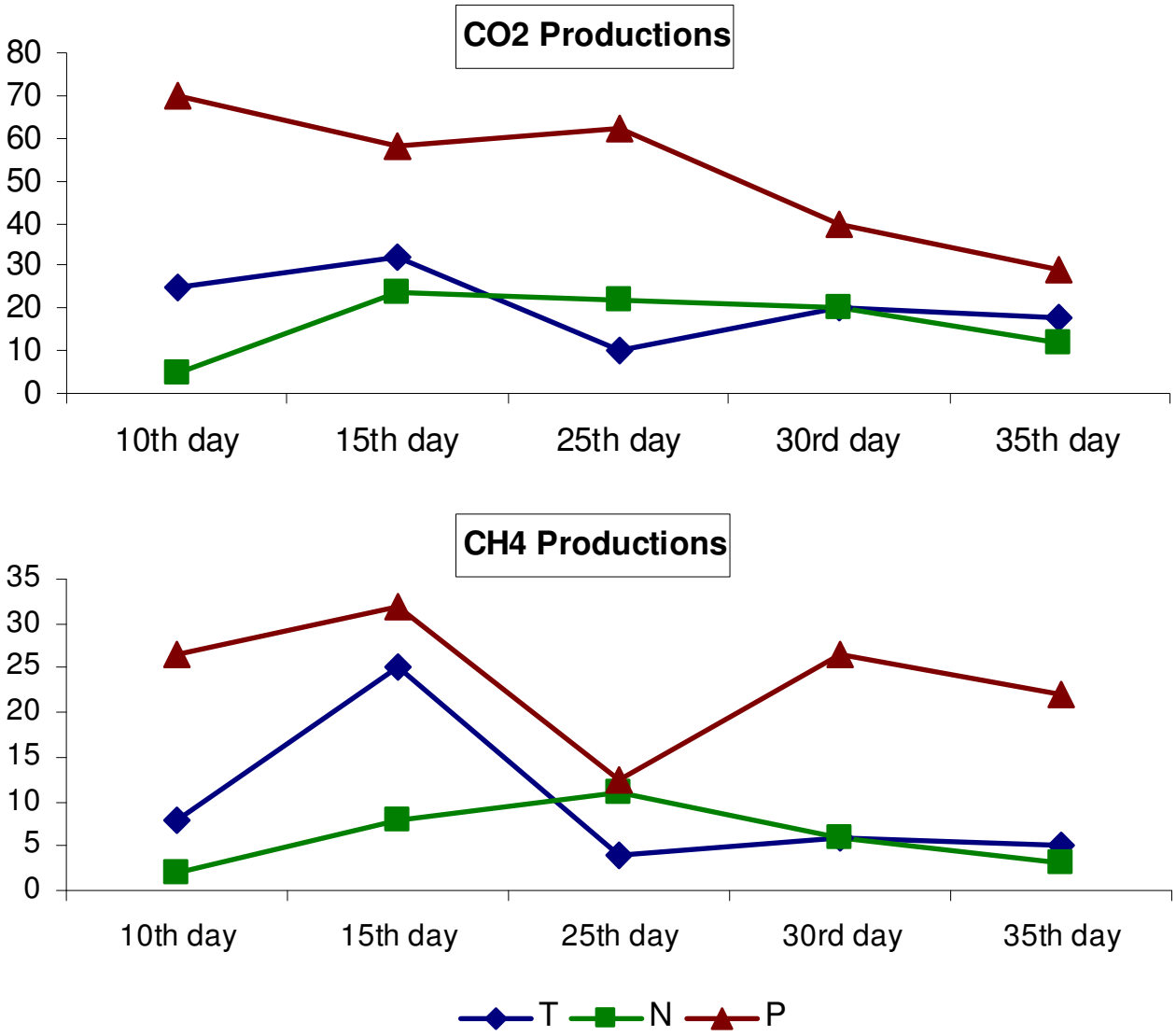
OBJECTIVES

- To evaluate the effect of dietary nitrogen and phosphorus manipulation on the optimisation of biogas production, by the energetic valorisation of manures

METHODOLOGY (Cont.)

- Lab scale Biodigestors (3 l capacity)
  - Incubation of manures **T**, **N**, **P**
  - Batch system of 35 days
  - Gas measurements at 5 days intervals

RESULTS


CO2 Productions
80
70
60
50
40
30
20
10
0
10th day
15th day
25th day
30rd day
35th day
CH4 Productions
35
30
25
20
15
10
5
0
10th day
15th day
25th day
30rd day
35th day
T
N
P

CONCLUSIONS

- Manure from pigs fed diet P presented the best profile of CH_4 production.
- After the 15th day of incubation all manures presented a decrease of CO_2 values indicator of a degradation of anaerobic conditions.
- Manure from pigs fed diet N showed the lowest gas productions.
- N manure presents limited efficiency in energy recovery as biogas.


THANK YOU