Nitrogen prediction model in smallholder farming system integrating pig and fish farming in the urban and rural areas of Kinshasa

Mafwila P[1,2], Bindelle J[2], Kalala G[1,2], Kambashi B[1], Rollin X[3], Dochain D[3]
[1]University of Kinshasa, [2]University of Liège, [3]Catholic University of Louvain

Introduction

- Most farms in Sub-Saharan Africa are turning to integrated systems combining aquaculture with pig farming to address the problem of low farm productivity,
- Mathematical models can predict the evolution of N pools, which is the major limiting element in both aquatic and terrestrial productions of agricultural in integrated farming,
- The objectives of this work is to design new integrated systems with improve their stability to various external factors.

Figure 1. integrated agriculture, aquaculture system in Mbankana

Model description

1. Pig module

$$LW=110\left(\frac{LW2}{LW1}\right)^{\left(\frac{0.356-e^{(-0.01368*time+0.775)}}{0.644}\right)} \quad (1)$$

Feed intake (KgFM) = - 28.758 + 0.7395 x PW + 0.00395 x PW^2 (2)

N feces (g) = 27.907-30.15 x diOM+0.01793 x CP+5.1458 x Feed intake (3)

N urine (g) = -21.20 + 0.134 x CP + 10.15 x Feed intake (4)

2. Fish module

$$v\frac{dNw}{dt}=\begin{bmatrix} afl\ xNfl+Q\ x\ afg(Nfg-Nw)+seddepth\ x\ kls\ x \\ \frac{(Ns-Nw)}{(24\ x\ waterdepth)} \\ -q\ x\ Nw-(\mu max\ x\ lighlim\ x\ mrphyto\ x\ Xph) \end{bmatrix} \quad (5)$$

Results

- The N fecal predicted for fattening period is 861.85 gN/pig vs 988.68 gN/pig for on field measured,
- The N Urinary predicted for fattening period is 765.39 gN/pig vs 887.55 gN/pig for on field measured,
- Any variation in food quality leads to a change in the quantity of fecal and urinary nitrogen produced and in the evolution of nitrogen in the pond water

Table 1. Variation of feed content and equivalent N fecal and urinary production from fattening pig

Level of variation	Crude Protein (g/kg)	N fecal (gN/pig)	N urinary (gN/pig)	DM (g/kg)	N fecal (gN/pig)	N urinary (gN/pig)
Basal diet	187	861.85	765.39	893	861.85	765.39
-10%	168.30	861.51	763.89	803.70	776.74	687.39
-20%	149.60	861.18	762.39	714.40	691.63	609.38
-30%	130.90	860.87	760.88	625.10	606.51	531.38
+10%	205.70	862.22	766.89	982.30	843.39	843.39
+20%	224.40	862.59	768.40	-	-	-
+30%	243.10	862.97	769.91	-	-	-

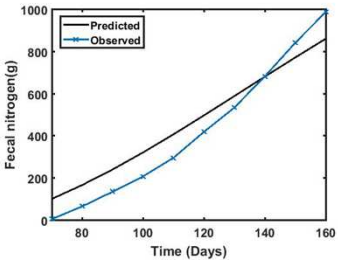

Figure 2

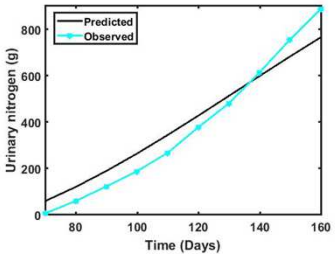

Figure 3

Figure 2 = Cumulative Fecal N production during predicted time,
Figure 3 = Cumulative Urinary N production during predicted time

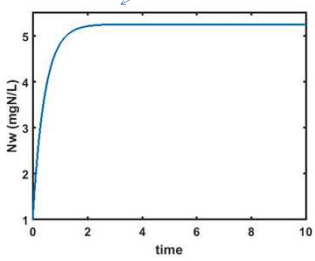

Figure 4

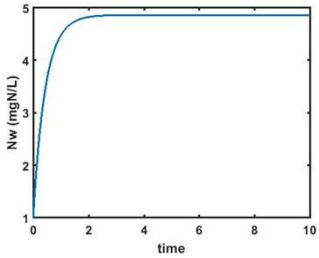

Figure 5

Figure 4 = N water evolution with addition of N from pig manure produced by basal diet
Figure 5 = N water evolution with addition of N from pig manure produced by nasal diet (-30% of Dry matter)

Conclusion

- The model gives a reading of the nitrogen level on the farm and can provide guidance in flow management.
- The model gives an estimate of the amount of fecal and urinary nitrogen very close to the amounts measured in the field.
- The values of the nitrogen evolution in water must be taken with caution since the calibration and validation of the water module has not yet been done

Acknowledgements

The project was supported by the Académie de Recherche et d'Enseignement Supérieur.