

# Geographical trends in livestock densities and nutrient balances

Geographical trends in livestock densities and nutrient balances in South, East and South-east Asia

In South, East and South-east Asia, with both an increase of production and a shift to intensive production systems, phosphate overloads are estimated on 23.6% of this region's agricultural land, mainly located in eastern China, the Ganges basin and around urban centres such as Bangkok, Ho Chi Minh City and Manila. (Source: FAO LEAD)

The term 'Livestock revolution' describes the rapid expansion of livestock production in developing countries. Among the developing countries, Asia has the fastest developing livestock sector as a consequence of faster growth in human population, economy and urbanisation.

The livestock sector is responding to the increase in demand for livestock products with some drastic transformations. First, livestock production tends to concentrate in areas favoured by cheap input supplies (particularly feed), and by good market outlets for livestock products, particularly in the vicinity of large cities. Second, the proportion of livestock production met by specialised and intensive industrial systems is increasing rapidly and directly competing with land-based, small-scale production. Third, the production is shifting from ruminants to monogastrics that have a better feed conversion ratio. Fourth, vertical integration along the land-livestock-food chain creates economies of scope.

The geographical concentration of livestock in areas with little or no agricultural land leads to high impacts on the environment (water, soil, air and biodiversity), mainly related to manure and waste water mismanagement. Nutrient overloads can result from several forms of mismanagement amongst which are over-fertilisation of crops, over feeding of fish ponds, and improper waste disposal of agricultural (e.g. livestock) or industrial wastes. Nutrient overloads in the crop-livestock systems mainly occur when the nutrients present in manure are not properly removed or recycled. The major effects of animal waste mismanagement on the environment are: eutrophication of surface water; nitrate leaching and pathogen transfer; accumulation of nutrients in the soil if high doses of manure are applied and; water pollution in natural areas such as wetlands and mangrove swamps.

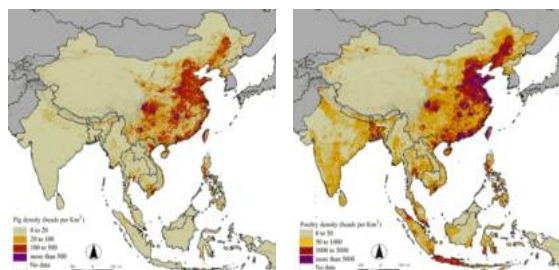
LEAD is assessing the contribution of livestock to nutrient fluxes, especially in the areas with nutrient overloads. This study focussed on South, East and South-east Asia .

## LIVESTOCK DENSITIES

China and India account for more than 85% of the total livestock biomass, showing a slightly higher livestock biomass density than the average in the region. India , Nepal , Bhutan , Bangladesh , Myanmar , Laos , and Cambodia are characterised by high total biomass densities, and strong ruminant component. While China , Thailand , Vietnam , Philippines , Malaysia , and Indonesia , have lower total biomass densities and a larger share of monogastric to total biomass.

The maps of livestock densities present pigs and poultry distribution in the region. For the two species, high concentration levels are observed around urban centres such as Hanoi , Bangkok , Manila , Guangzhou , and in highly populated areas such as the south-eastern Chinese coast or the area between Shanghai and Beijing . In general poultry production concentrates more in peri-urban areas than pig production, which can be related to higher level of industrialisation of the

former. In China, both populations present a strong West-East gradient, but the pig densities gradient is smoother, with densities that are still relatively important in south-eastern provinces such as Yunnan, Ghizhou and Sichuan. Densities in India follow a quite different geographical pattern, with pigs mainly located in the Ganges basin, when poultry are observed in the whole country, mainly around cities. Finally, the two populations are clearly contrasted in the Islamic countries Bangladesh and Indonesia, where very low pig densities and strong poultry population are observed.



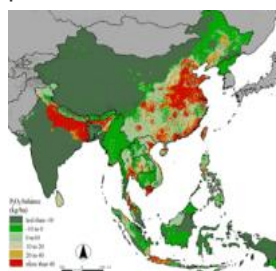
## NUTRIENT BALANCE

Nutrient balance was estimated as the difference between total Phosphate ( $P_{2O_5}$ ) present in chemical fertilisers and manure, and the total Phosphate content of the harvested crops

(including grazing). Phosphate was chosen as indicator of the nutrient balance status, because it has a high environmental importance; it usually is the first nutrient which constrains the livestock carrying capacity of land and; the calculation is more accurate than for nitrogen, for which various losses (ammonia volatilisation, denitrification, leaching etc.) and inputs (fixation by legumes, atmospheric deposition) are difficult to quantify reliably.

There is a strong heterogeneity across the study area regarding the  $P_{2O_5}$  balance, from areas estimated to have a negative balance to areas with high surpluses. Considering the assumptions and estimates made, it was decided to consider that a mass balance lower than  $-10$  kg of  $P_{2O_5}$  per ha of agricultural land would characterise a phosphate deficit and, symmetrically, that a mass balance higher than  $+10$  kg of  $P_{2O_5}$  per ha of agricultural land would characterise a phosphate overload. In-between, the nutrient fluxes are said equilibrated.

The map of estimated  $P_{2O_5}$  mass balance in show areas having a negative  $P_{2O_5}$  balance estimation are mostly located in West China and South and West India (28.9% and 69.2% respectively of the countries' cropped area). It is also estimated that 42.6% of cropped area in Nepal, Bhutan, and Bangladesh have a negative balance. This is important information with regard to the potential  $P_{2O_5}$  depletion of soils. In India, this situation could be related to scarce use of chemical fertilisers and relatively high yields. For the whole study area, 39.1% of the agricultural land are estimated to be in a balanced situation with regard to  $P_{2O_5}$ . In all countries, balanced fluxes are calculated on more than 45% of the agricultural land, except for India where it is calculated on 5.2% only. Most of the crops and pastures in countries such as Laos, Cambodia and Philippines are estimated to have balanced  $P_{2O_5}$  fluxes. The same holds for the Chinese provinces located in the Northeast, and the South (except the coast).

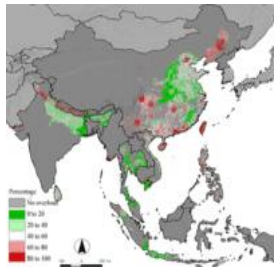


Nutrient overloads are identified in North East India, East China, Coast of Vietnam, Java Island, Central and North Thailand, with especially high surpluses at the periphery of urban centres. For the whole study area, it is estimated that 23.6% of the agricultural land is subject to  $P_{2O_5}$  surpluses. High (more than  $20$  kg of  $P_{2O_5}$  per ha of agricultural land) and very high (more than  $40$  kg of  $P_{2O_5}$  per ha of agricultural land) surpluses being expected on 15.4% and 4.0% respectively of the study area. China, India, Thailand, Vietnam, Philippines, Malaysia, and Indonesia appear to be the most concerned with high and very high overloads. On the contrary, Nepal, Bhutan, Bangladesh, Myanmar, Laos, and Cambodia are generally characterised by limited geographical spread of  $P_{2O_5}$  surpluses.

The comparative analysis of phosphate excreted by livestock and phosphate from chemical fertiliser gives an indication of the actual impact livestock may have on nutrient fluxes. Both for the whole study area, and for territories characterised by an overload of more than  $10$  kg of  $P_{2O_5}$  per ha of agricultural land, livestock excretion accounts for around 40% of the  $P_{2O_5}$  load. The

map of estimated contribution of livestock to total P<sub>2</sub>O<sub>5</sub> supply on agricultural land shows a contrasted pattern. Chemical fertilisers represent the bulk of the P<sub>2</sub>O<sub>5</sub> load in lowlands where rice is the dominant crop: Ganges basin, eastern and southern Thailand, Mekong delta, and eastern China ( Jiangsu, Anhui and Henan provinces). On the other hand, manure represents more than half of the phosphate surplus in north-eastern China ( Liaoning and Jilin provinces), south-eastern China ( Sichuan, Hubei, Fujian and Guangdong provinces), Taiwan, and at the periphery of urban centres such as Hanoi, Ho Chi Minh, Bangkok, and Manila. Monogastrics are generally dominant in these areas.

## CONCLUSIONS



Livestock distributions show two contrasted contexts in the study area. On one hand the ruminant dominated areas, mostly in the North and West, in which biomass densities can reach high levels. Production systems are mixed or extensive, mostly traditional, and the livestock densities follow agro-ecological patterns. On the other hand, the south-eastern part of the study area is dominated by monogastric species.

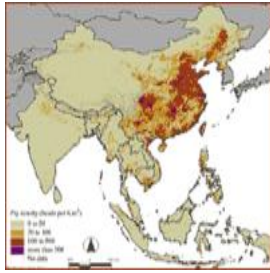
There, under market pressure, and in a framework of weak regulations, traditional mixed livestock/crops farming systems have progressively split into specialised crop and livestock activities that operate in different geographical areas, the location of livestock production being driven by transport costs minimization as well as labour and services availability. While there are differences between pigs and poultry, the overall trend of production points towards greater production and processing concentration around urban centres.

If similar loads of P<sub>2</sub>O<sub>5</sub> are reached in areas dominated either by ruminants or monogastrics, it is mainly in the later that nutrient overloads are observed. This can be related to 1) the nearly inevitable land-livestock link for ruminants (roughage) versus the trend to landless monogastrics production with exogenous feed sources, 2) the high densities of monogastric in peri-urban areas (where crop uptake is low), and 3) the higher economic development of areas where monogastric species are dominant, allowing for high chemical fertiliser application rates.

P<sub>2</sub>O<sub>5</sub> overload is a concern in almost a quarter of cropland in the study area. If P<sub>2</sub>O<sub>5</sub> originating in livestock is offset by chemical fertiliser sources in crop intensive lowlands, it nevertheless represents 40% of the total P<sub>2</sub>O<sub>5</sub> load in the study area, with peaks around urban centres and in livestock specialised areas.

These observations suggest that there is high potential for better integration of crop and livestock activities. In overloaded areas, part of the chemical fertilisers could in fact be substituted by manure, thus substantially decreasing the environmental impacts on land and waters. If the potential substitution seems obvious, its implementation on the ground, at provincial and farm level, raises a series of issues and constraints. Adequate action, including policy formulation, and development of technological packages is therefore required. In this respect, the LEAD initiative contributes through local and regional projects to the design and testing of various policy options, including command and control instruments (e.g. spatial planning; land/livestock balances; environmental authorisation), economic instruments (e.g. market based quota systems; subsidies for investment in manure management equipment), information (e.g. awareness building, capacity building), and the integration of environmental objectives in livestock and agricultural sectorial policies. The initiative also develops decision support tools for the selection of best manure management technological packages according to local objectives and constraints.

In this perspective, the results of this study represent useful decision support information for policy making and targeted interventions. Similar analyses are in progress for Latin America.



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Yes