Available technologies and strategies for nutrient and energy recovery

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Available technologies and strategies for nutrient and energy recovery

- The challenges
- Prinicipal options of manure management
- Key aspects of livestock production respecting the environment
- Crucial issues
- Technology available to support sustainable manure management
- Current situation, case studies Europe and arising countries (Asia)
- Personal conclusions

The challenges

- The quantitatively most important product of livestock is excreta (urine, feces)
  - e.g. 1 fattening pig = 100 kg animal, 300-600 kg excreta
- Livestock excrete 60-95% of the nutrients taken up in feed (N – nitrogen, P – phosphorous etc.)
- Livestock waste can have serious environmental impacts
  - Surface water pollution (nutrients, org. matter) → eutrophication (incl. marine ecosystems)
  - Groundwater pollution (nitrate)
  - Pathogens (spread via water)
  - Emissions to atmosphere (ammonia, methane, nitrous oxide etc.)

→ Livestock waste has to be handled in a way that does not harm the environment

Principal options for handling manure

resource

1. Recycling as fertilizer on crops (or feed)
   - Energy recovery possible

- Proper manure management is crucial

waste

2. Manure treatment to remove substances with environmental relevance
   - Organic substance and N can be degraded
   - Minerals/heavy metals must be taken out of system to alternative use or proper disposal
   - Energy recovery possible by anaerobic digestion

- Costly
- Harm to environment only prevented if facilities are properly dimensioned and fully functioning
- Nutrients are wasted, especially N (fossile fuel) and P (limited resource)

waste

3. Uncontrolled release to the environment

- Not acceptable for environment reasons

Which options are appropriate ?

- Existing farms in area with lacking potential for recycling: Treatment is often the only solution
  - Can it really meet environmental limits (discharge standards) ?
  - Is it economically bearable ?

- Existing farms in area with potential for recycling: Recycling will usually be cheaper and saver than treatment

- New farms: In most cases economically beneficial to choose farm location according to manure recycling potential in the icinity

- Combination of treatment (e.g. biogas and recycling) can be appropriate if the treatment brings special benefit (e.g. electicity for EVAP-system)

→ Zero discharge must be the aim !

Key aspects of livestock production respecting the environment

- **No discharge of waste/effluents to surface waters**
  - All excreta must be collected and managed
- **Land livestock balance (for manure recycling)**
  - Sufficient land (own or neighbouring with manure contract)for recycling (balance between nutrients in manure and crop requirements)
  - In ruminant systems: Livestock numbers not surpassing roughage supply
  - Livestock production based on concentrate: in areas with crop production
  - In areas with land livestock imbalance: Minimise nutrient excretion and reduce livestock numbers
- **Good manure management**
  - Manure used only according to crop nutrient requirements (time and dose)
  - No serious environmental impacts (run-off/overflow, excessive doses etc.)
  - Low emission techniques: manure treatment if necessary

Key aspects of livestock production respecting the environment (2)

- **No risk for human and animal health**
  - No introduction of pathogens into drinking water resources and food chain
  - No introduction of antibiotics and pharmaceutical substances to the environment → careful use of such substances
  - must be recycled on land or treated to meet discharge standards
  - Prevention of zoonotic diseases
- **No harm to soil fertility**
  - No heavy metal accumulation (restrictive use of heavy metals)
  - No excessive doses of manure on land
- **Respecting the quality of live of (non-agricultural) population**
  - Prevention of odour and fly nuisance near settlement areas
- **Manure treatment to improve manure characteristics or achieve special benefit (biogas, compost et.)**

Crucial issues

- Especially specialized pig and poultry production face problem with nutrient surplus (no local link to land)
- Manure treatment alone does not usually solve the problem (or only at very high cost) → remaining nutrients have to be removed
- Water use in animal housing must be minimized to reduce slurry volume (high cost for storage and application)
- For large specialized livestock farms (especially pigs and poultry) and in areas with high livestock density the transport distance (costs) to the crop site is quickly a limiting issue
- If manure has to be transported over large distances, as much as possible solid manure should be produced

Technology available to support manure management with low environmental impact

- **Livestock housing systems**
  - Slurry housing systems (all excreta collected in slurry; fully or partly slatted)
  - Slurry/solid manure housing systems (slurry and solid manure produced)
  - Solid manure systems (only possible with sufficient litter)
  - Special low emission (NH_3) housing systems
  - Optimized ventilation techniques, EVAP cooling, thermal insulation
  - Air scrubbing (biofilters, chemical scrubbers)
- **Manure storage**
  - Concrete or metal tanks (preferentially covered)
  - Covered lagoon (with liner floor to prevent leaching losses)
  - Covered solid manure stores

Technology available to support manure management with low environmental impact

- **Manure treatment**
  - Physical separation (slurry → solid and liquid fraction; filtration, centrifugation)
  - Anaerobic digestion → biogas (benefit depends on potential for electricity use)
  - Aerobic treatment (reduces organic substance and N content)
  - Composting → compost
  - Drying of solid manure
  - Etc.
- **Manure application**
  - Conventional low cost equipment for transport
  - Slurry tanks (transport and spreading) for tractors or self-propelled
  - Low NH_3 emission spreading techniques (trailing hoses, trailing shoe, injection)
  - Solid manure spreaders

Other actions to support manure management with low environmental impact

- **Feeding**
  - Ration content well adapted to animal requirements
  - Rations with reduced protein content for pigs and poultry (with use of pure amino acids)
  - Rations with reduced P content for pigs and poultry (with use of phytase)
  - Reducing heavy metal content of feed to minimal requirements of the animals
- **Water use**
  - High pressure equipment for cleaning in animal houses
  - No cooling of animals by sprinkling water
  - Covered slurry tanks to reduce rainwater

Current situation: Europe

- **Zero discharge is standard**
- Manure management highly variable (different housing, feeding and manure handling systems, climatic and structural conditions, tradition etc.)
- High proportion of liquid manure; slurry mostly stored in tanks
- Utilization of the manure on the same farm as it is produced is still most common, especially for slurry
  - Slurry transport to other farms/areas if legally required (e.g. Netherlands)
  - Enforced legislation on nutrient balance mainly in Switzerland, Denmark, Netherlands
- Most countries have guidelines about minimal period of storage for manure
- Special treatment rather uncommon

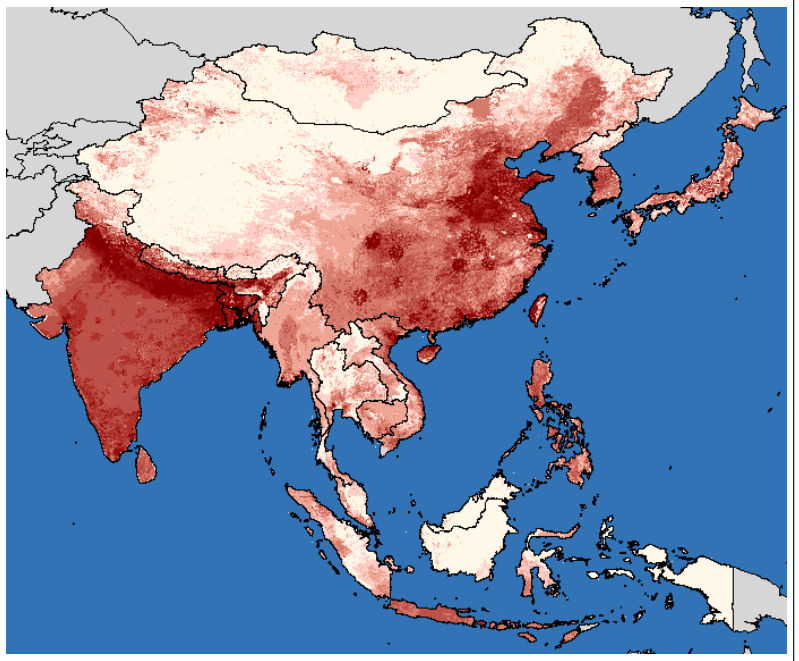
Current situation: Arising and developing countries

- Rapid growth of livestock production (especially in Asia and Latin America), predominantly of intensive sector
- concentration close to urban centres
- shift from ruminants to monogastrics
- large and specialized units with little or no land
- discharge of manure to surface water is common
- gaining importance of slurry based systems (often slurry not utilized)
- Often inappropriate manure management practice and infrastructure

→ Water pollution originating from livestock production

→Nutrient and heavy metal overloads on agricultural land

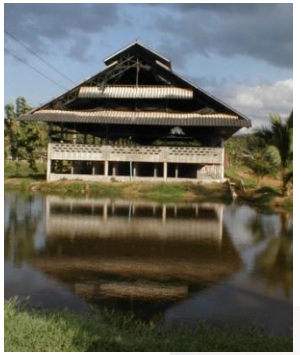
Estimated total livestock bio-mass in Asia (tons per km^2)



Case study: SE-Asia

- Large structural variability, e.g.
  - Thailand: majority of pigs on medium/large farms (>1000 pigs), mostly intensive
  - China: Both very large farms and backyard production
  - Vietnam majority of pigs on very small farms, but rather intensive
  - Cambodia, Laos: intensive only emerging

  → large variability in management



- Solid manure usually recycled (market demand)
- Liquid waste seldom recycled → discharge or other release to the environment
  → major source of pollution
- Fast increasing awareness
  → measures are intoduced

Personal conclusions

- **Zero discharge is possible,** but it takes:
  - Awareness of the problem
  - Legal action
  - Appropriate technology
  - Considerable investment
- The basic knowledge on good manure management technique is available, but
  - It has to be adapted to the specific situation
  - It takes time to introduce it in regions with no “tradition” (esp. for slurry)
- Manure recycling = geographically spread
- Liquid manure is a bigger problem than solid manure
- Intensive livestock production causes larger environmental impact than extensive, but extensive production can also cause serious problems

Thank you for your attention