# Seminar Biogas Eletrosul

## Florianopolis

## 8. - 10. Dezember 2010

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REPÚBLICA FEDERATIVA DO BRASIL
REPÚBLICA FEDERAL DA ALEMANHA

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# Main Problems of Tupandi-Farmers

- High water consumption on the pig-farms

- Too much nutrients in the slurry

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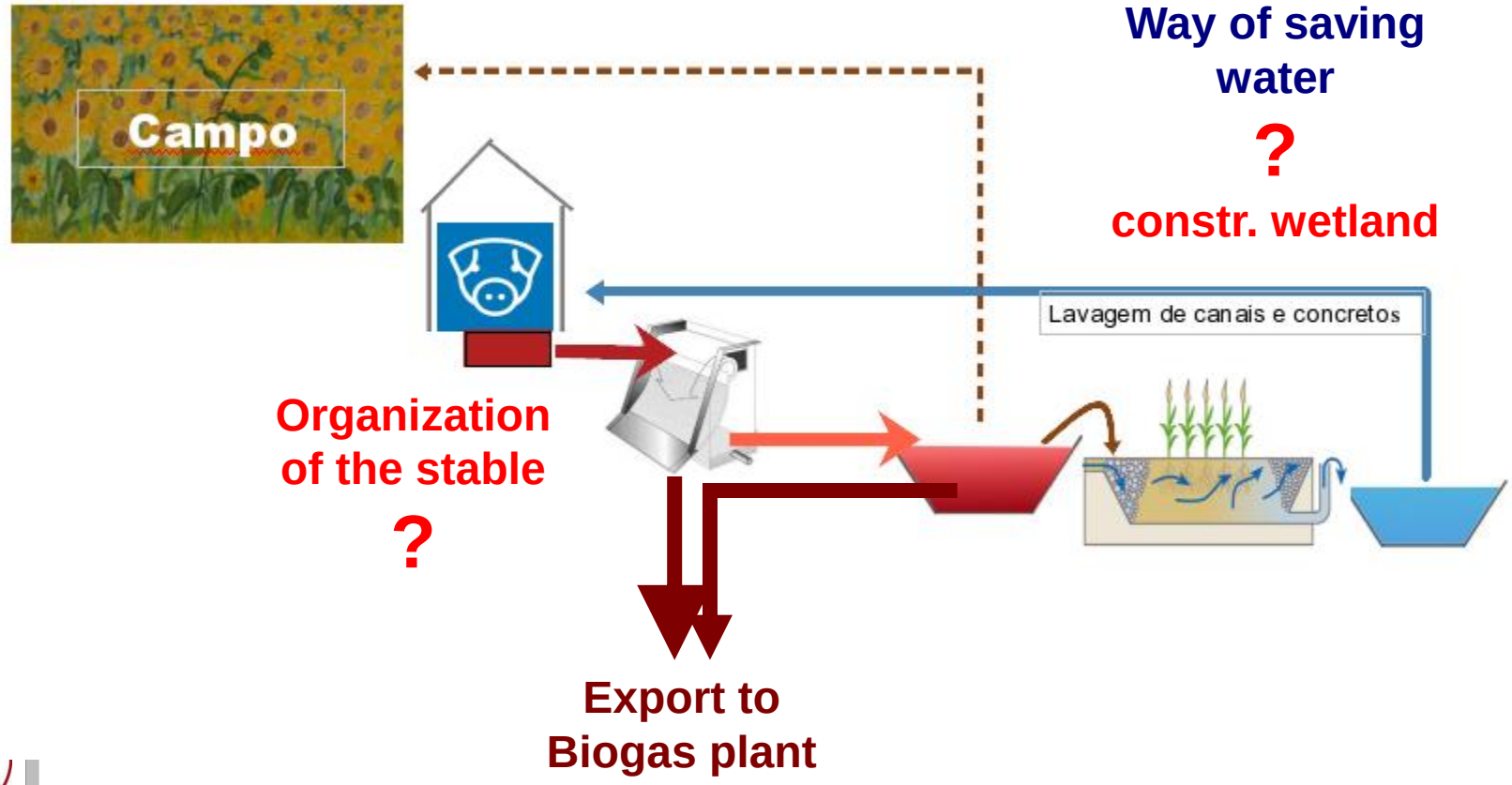
# Farm-scheme of de-fertilization and water reduction

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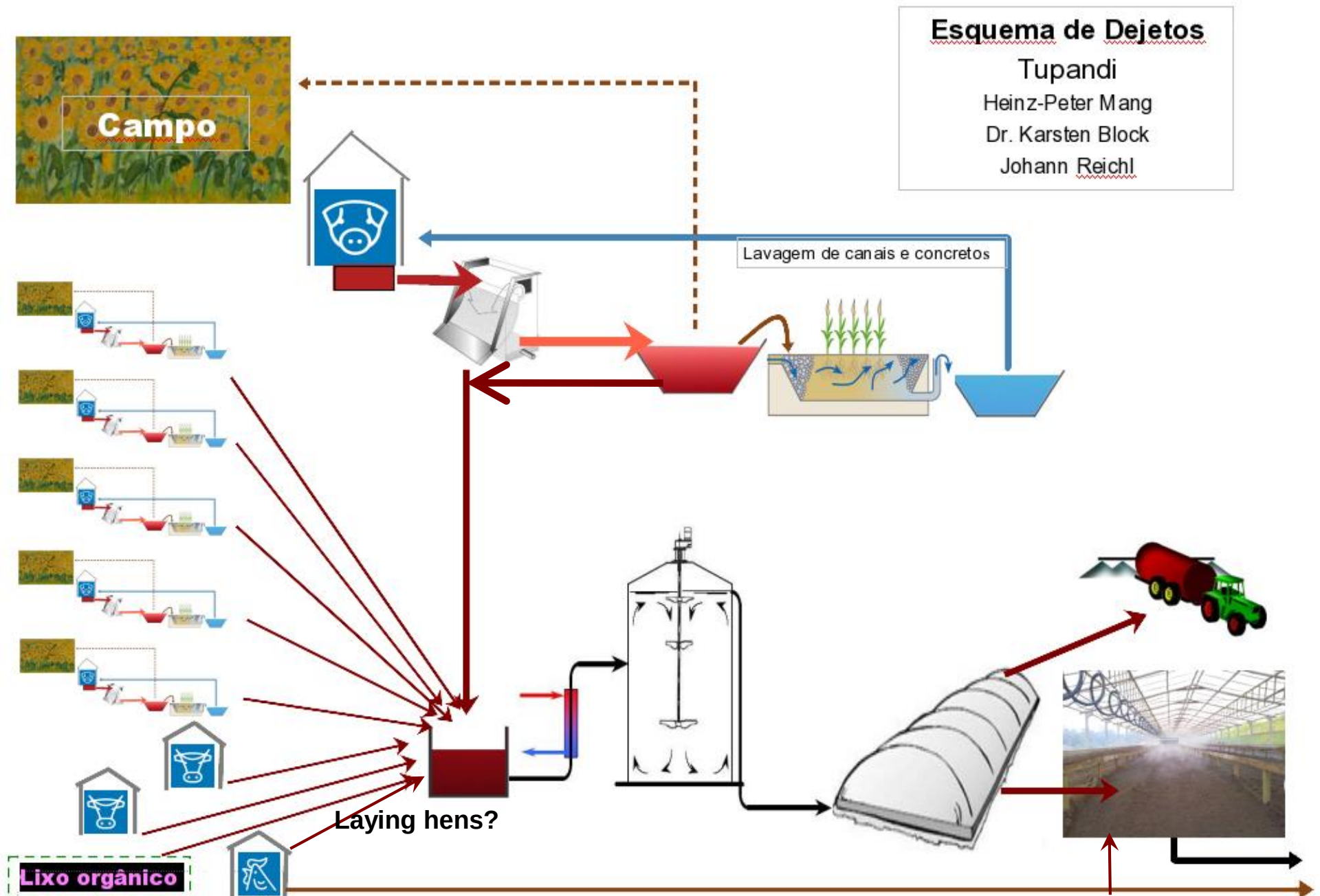
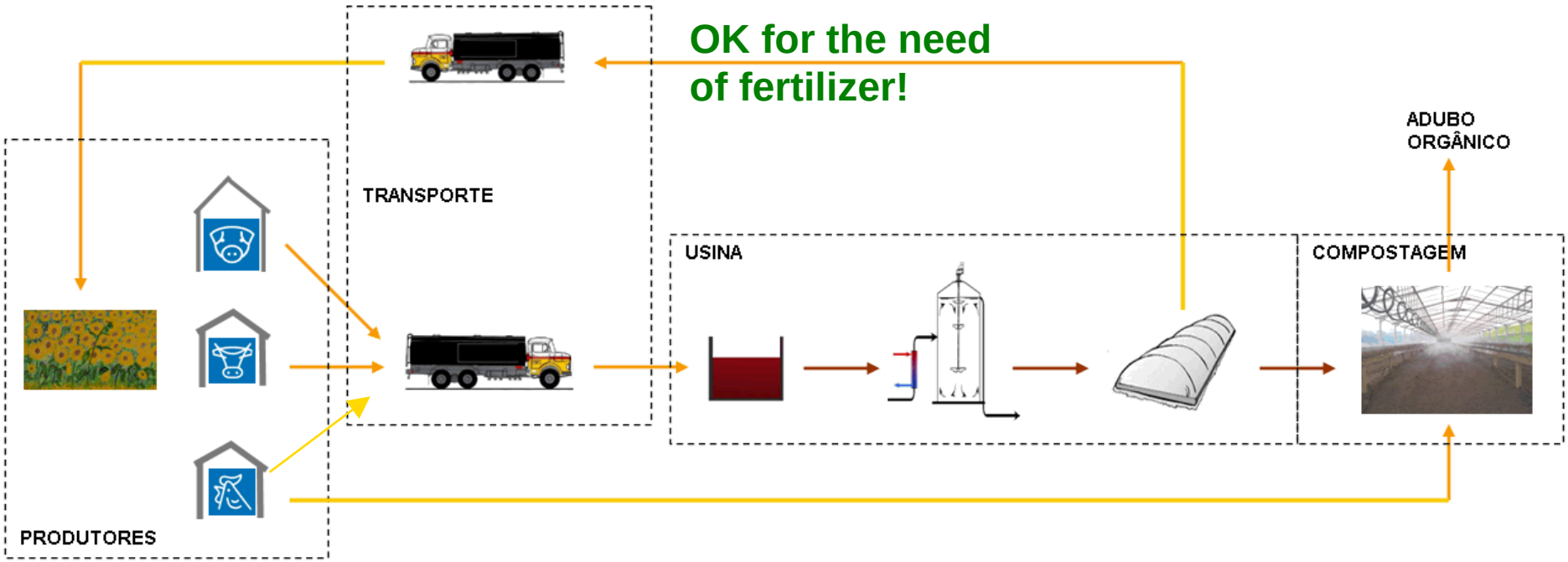
# Scheme of Slurry & Digestate in Tupandi



# Schema Eletrosul:

## complete slurry is transported to the biogas plant

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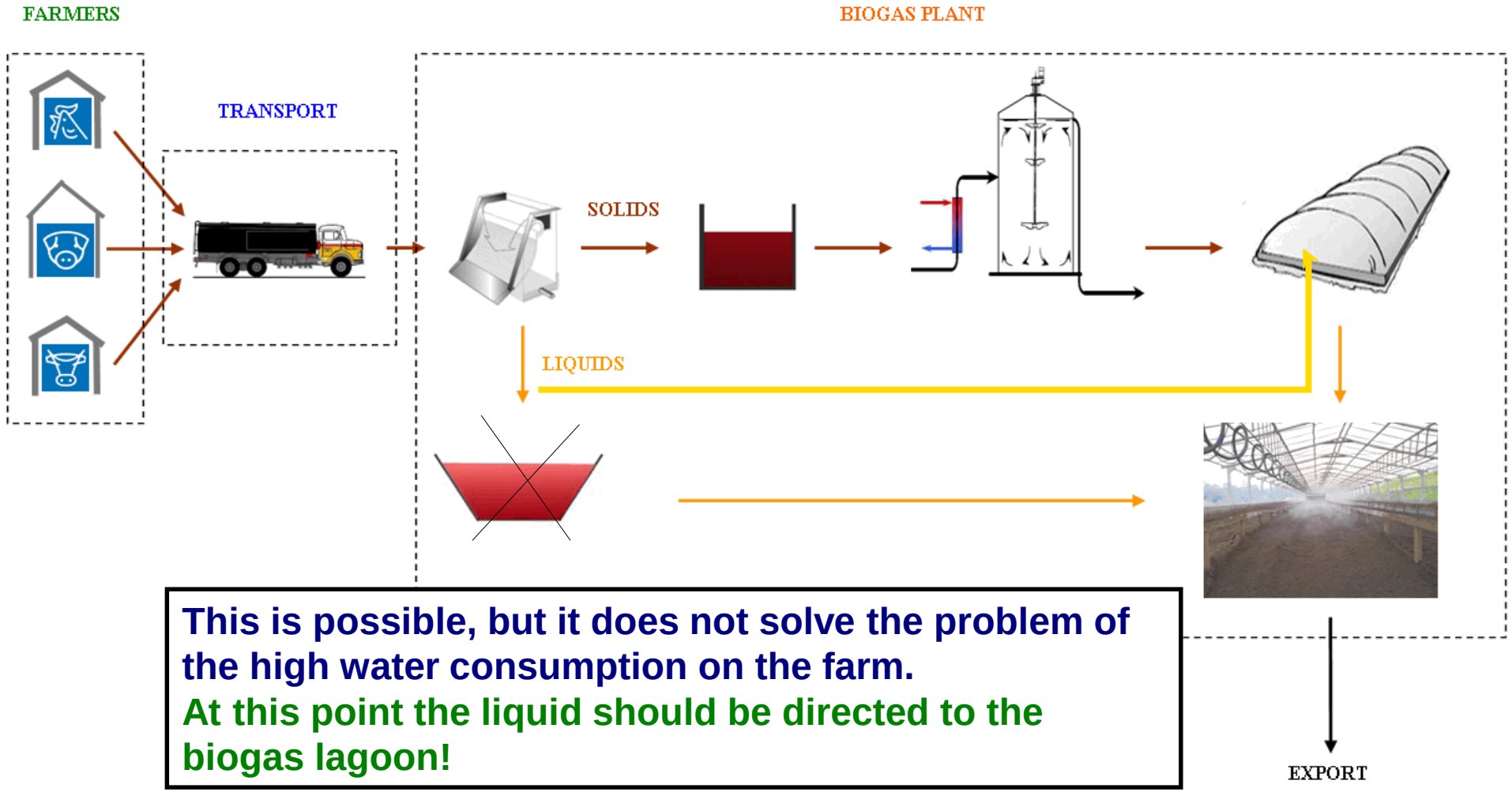
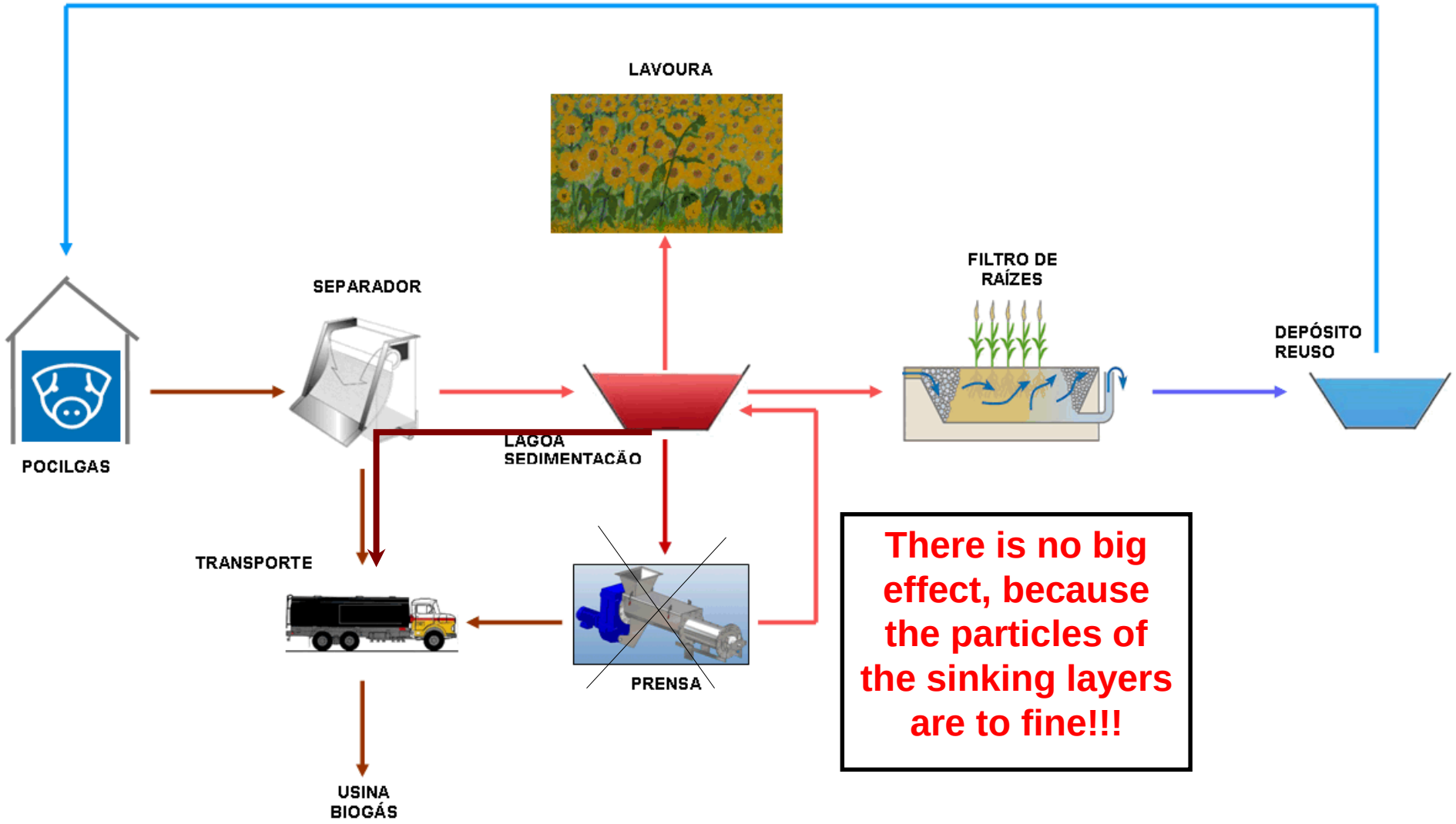
| | | |
|---|---|---|
| High transport capacity | Highest energy production from biogas | Big aral of composting, if there is no reduction of water on the pig farms |

# Central Separation




**This is possible, but it does not solve the problem of the high water consumption on the farm.**
**At this point the liquid should be directed to the biogas lagoon!**

# Proposal of Eletrosul




**There is no big effect, because the particles of the sinking layers are to fine!!!**

# Main Problems of Tupandi-Farmers

- High water consumption on the pig-farms

- Too much nutrients in the slurry

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# Structure of the target group network Tupandi

| Group representatives | Function & role |
|---|---|
| 1. Policy makers from the selected regions. | Promoting |
| 2. Local, regional and national authorities | Contractual partners & co-operators |
| 3. Energy and energy trade companies | Contractual partners & buyer of electricity |
| 4. Energy and environmental agencies | Monitoring |
| 5. Farmers and farmers associations and organizations | Contractual partner, waste producer, fertilizer user & co-operators |
| 6. Local food processing industries | Waste producer, heat energy user |
| 7. Veterinary services and control authorities | Monitoring |
| 8. Energy and environment planning authorities. | Contractual partners & investors |
| 9. Financing institutes | Financial services & loans |

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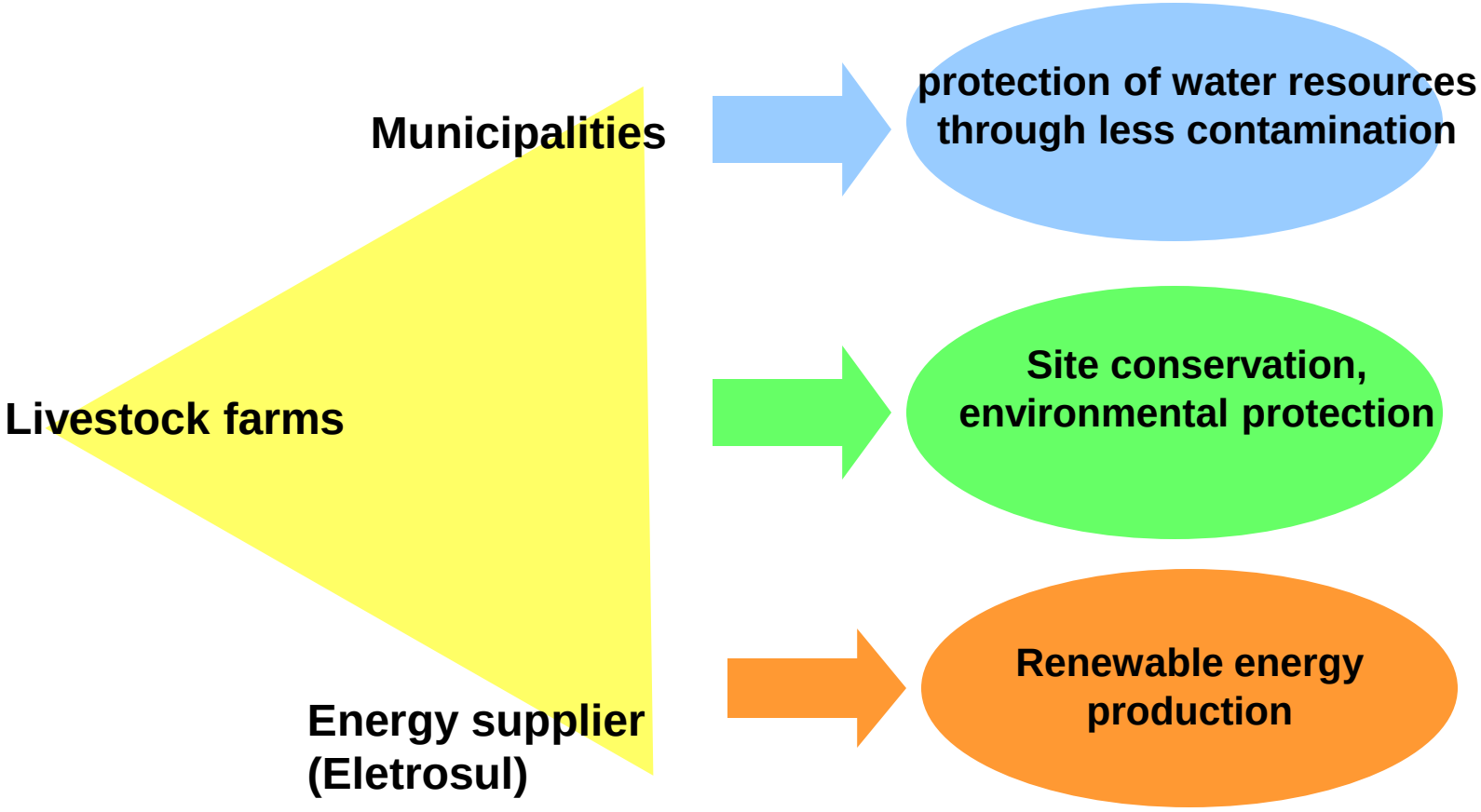
# Manure Management = Triple Win

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# Municipality of Tupandi

| Benefits | |
|---|---|
| Rural development | New business, new local activity |
| | New jobs, up to 10 directly associated to the biogas plant operation and transport services |
| | Implementation of green heat and electricity |
| | Increased waste recycling |
| Environmental improvements | Protection of fresh water systems |
| | Improved hygienic standards due to sanitation of manure |
| | Less odor nuisances |
| | Contribution to meet national environmental targets |
| Green House Gas reduction | Reduction of $CO_2$, $CH_4$, $N_2O$ emissions |

# Farming sector, with livestock and crop or fruit production

| Benefits | |
|---|---|
| Cheap and easy way to dispose waste | Environmental friendliness can be used as argument for marketing purposes |
| Improved image for stable business | Easy compliance with requirements on waste recycling |
| Meet hygienic standards | Reduce fresh water consumption |
| Improved fertilizer and soil conditioner available | No contribution to groundwater pollution |

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# Eletrosul and local grid company

| Benefits | |
|---|---|
| Energy from renewable source at competitive prices | The satisfaction of environmental energy consumption |
| Market options for green electricity trade | Market options for heat from renewable sources |
| Construction and operation of extensive technical facilities | Market for financing and insurance of extensive technical facilities. |

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# Problems of the calculations with slurry

**Summary information, calculated by ELETROSUL**

| | Substrate | Quantity of animals | Quantity | TS (%) | VS (%TS) (oTS) | t TS | t oTS |
|---|---|---|---|---|---|---|---|
| Manure | Fattening Swines | 26.910 | 56.511 m³/a | 14,1% | 57,2% | 7.968 | 4.558 |
| Manure | Sows and Suckling Swines | 7.973 | 65.111 m³/a | 3,6% | 61,5% | 2.344 | 1.442 |
| Manure | Suckling Swines | 32.000 | 13.440 m³/a | 3,4% | 54,5% | 457 | 249 |
| Manure | Cattle | 560 | 1.970 t/a | 18,4% | 50,1% | 362 | 182 |
| Manure | Poultry | 90.000 | 1.800 t/a | 21,5% | 51,6% | *387* | *200* |
| Sum from Surry without Poultry | | | 137.032 m³/a | | | 11.131 | 6.430 |

**Calculation of Slurry on Base of the Animals (on Base of German experience [1])**

| | Substrate | Quantity of animals | Quantity dung/a | Slurry per animal & year [1] | TS % [1] | t TS | Differenz BR - DE |
|---|---|---|---|---|---|---|---|
| Manure | Fattening Swines | 26.910 | 72.657 m³/a | 2,7 m³/a | 5,0% | 3632,85 | 4335,201 |
| Manure | Sows and Suckling Swines | 7.973 | 74.946 m³/a | 9,4 m³/a | 3,5% | 2623,1 | -279,121 |
| Manure | Suckling Swines | 32.000 | 25.600 m³/a | 0,8 m³/a | 5,0% | 1280 | -823,04 |
| Manure | Cattle | 560 | 11.312 m³/a | 20,2 m³/a | 10,0% | 1131,2 | -768,72 |
| Manure | Poultry | 90.000 | 2.019 t/a | 0,02243 t/a | 50,0% | 1009,35 | -622,35 |
| Sum from Surry without Poultry | | | | | | 8.667 | |

**Comparison of the production of slurry: Data German / Brasil**

| | Substrate | Slurry per animal & year [1] | Slurry per animal & year [2] | Slurry per animal & year [3] |
|---|---|---|---|---|
| Manure | Fattening Swines | 2,7 m³/a | 2,6 m³/a | 2,1 m³/a |
| Manure | Sows and Suckling Swines | 6,4 m³/a | 9,9 m³/a | 8,1 m³/a |
| Manure | Suckling Swines | 0,800 m³/a | 0,511 m³/a | 0,420 m³/a |
| Manure | Cattle | 20,2 m³/a | m³/a | m³/a |
| Manure | Poultry | 0,02243 t/a | t/a | t/a |

1 LfL Basisdaten für die Ermittlung des Düngungsbedarfs, Stand Juli 2010

2 FATMA: Instrução ormativa - IN-11 / Suinocultura

3 ELETROSUL: Survay of slurry in tupandi

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# Calculations on base of the nutrients

Tupandi: current situation

| No. | | Number of livestock | Nutrients (kg) | | | | Slurry | | |
|---|---|---|---|---|---|---|---|---|---|
| | Animal species | | N (-losses in stable) | N (- losses of distribution) | $P_2O_5$ | $K_2O$ | Total amount (t, m³) | DM | Total t of DM |
| | **Excrements** | | **545.605** | **465.701** | **372.731** | **420.311** | **104.007** | | **7.271** |
| 1062 | Fattening swines; 700 g daily weight increase; 28 to 117 kg; standardized feed | 26910 | 224.160 | 192.778 | 148.005 | 150.696 | 40.365 | 7,50% | 3.027 |
| 1046 | Sows & piglets; pigletsup to 8 kg; 20 grown up piglets; 200 kg weight increase per place and year; standardized feed | 7973 | 146.225 | 125.753 | 107.636 | 90.095 | 31.892 | 4,00% | 1.276 |
| 1054 | Piglets from 8 to28 kg; 130 kg weight increase per place and year; standardized feed | 32000 | 76.608 | 65.883 | 51.200 | 70.400 | 19.200 | 4,00% | 768 |
| 1032 | Milking cow, 8000 kg milk | 560 | 56.168 | 46.058 | 22.960 | 76.720 | 11.200 | 10,00% | 1.120 |
| 1067 | Laying hens; 17,6 kg mass of egg; standardized feed | 90000 | 42.444 | 35.229 | 42.930 | 32.400 | 2.160 | 50,00% | 1.080 |

**Required arable land (about) on base of** **90 kg $P_2O_5$/ha*year = 4.141 ha**

**Area of Tupandi Total** (http://pt.wikipedia.org/wiki/Tu) **59,541 km2 *100 = 5.954 ha**

*** 40 % arable land (???) = 2.381,6 ha**

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# Reduction of DM and nutrients depending on different separation technology

| Technology | Reduction in % of ... | | |
|---|---|---|---|
| | DM | N | $P_2O_5$ |
| Curved screen [15] | 6 - 31 | 3 - 6 | 2 - 12 |
| Screw press separator [10] | 37 | 15 | 17 |
| Lagoon for sedimentation [16] | 56 | 33 | 52 |
| ***Expected total reduction*** | ***60*** | ***38*** | ***66*** |

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# Situation Tupandi after separation and cleaning lagoon

Tupandi: Result of sparation & lagoon on the situation of nutrients nutrients

| N (-losses in stable) | | $P_2O_5$ | | Total amount (t, $m^3$) | | Total t of DM | Total t of FM solids |
|---|---|---|---|---|---|---|---|
| 545.605 | | 372.731 | | 102.657 | 6,0% | 6.191 | estimated |
| Fluid | export of Solids | Fluid | export of Solids | Fluid | | export of Solids | DM |
| 62% | 38% | 34% | 66% | 40% | | 60% | 10% |
| 338.275 | 207.330 | 126.729 | 246.002 | 65.511 | 3,8% | 3.715 | 37.146 |

**Required arable land** 90 kg $P_2O_5$/ha*year = 1.408 ha

**Area of Tupandi Total (** 59,541 km2 *100 = 5.954 ha

* 40 % arable land (???) = 2.381,6 ha

**Input for biogasplant:** 3.715 t DM

**10 % content of DM** 37.146 t FM (estimated)

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# Biogas Potential from all slurry

**Tupandi: Theoretical potental of Biogas from slury**

| Animal places or ha | Substrate | Slurry per place and year [t or m³] | Slurry/day [m³ ort/ d] | Costs of Substrates [€ / ha, m³, t ] | Total costs substrates [€] | Mass of substrate [t] | Content of DM [%] | Dry matter [t] | Content of organic DM (oDM) [%] | Specific gas-yield [l/kg oDM] | Gasvolume [m³] | Content of methane [%] | Energy from biomass [kWh] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7.973 | Saws with piglets | 4,00 | 87,4 | 0 | 0€ | 31892 | 4,0 | 1.276 | 85,0 | 400 | 433.731 | 60,00 | 2.602.387 |
| 32.000 | Piglets, Slurry | 0,60 | 52,6 | 0 | 0€ | 19200 | 4,0 | 768 | 85,0 | 400 | 261.120 | 60,00 | 1.566.720 |
| 26.910 | Fattening swines | 1,50 | 110,6 | 0 | 0€ | 40365 | 7,5 | 3.027 | 85,0 | 400 | 1.029.307 | 60,00 | 6.175.845 |
| 90.000 | Laying hens | 0,024 | 5,9 | 0 | 0€ | 2160 | 50,0 | 1.080 | 85,0 | 650 | 596.700 | 55,00 | 3.281.850 |
| 560 | Cows | 20,00 | 30,7 | 0 | 0€ | 11200 | 10,0 | 1.120 | 85,0 | 300 | 285.600 | 55,00 | 1.570.800 |
| 0 | Solids from slurry | 1,00 | 0,0 | 0 | 0€ | 0 | 10,0 | 0 | 90,0 | 360 | 0 | 55,00 | 0 |
| | **Sum / Mean** | | **287,2** | | **0€** | **104817** | **6,9** | **7.271** | | | **2.606.459** | | **15.197.602** |

## Total Energy

| | | | | |
|---|---|---|---|---|
| Yield biogas | | | 2.606.459 | m³/Year |
| Energy gross | | | 15.197.602 | kWh |
| No gas | 14 | days/year | 96,2 | % available |
| Energy net | | | 14.614.680 | kWh |
| Fuel initiates | 4 | % share | 584.587 | kWh |
| x | 9,8 | kWh/l | 59.652 | l/Year |
| **Total available energy** | | | **15.199.268** | **kWh** |

## Electrical Energy

| | | | | |
|---|---|---|---|---|
| Motor runtime | 8200 | hours/a | 1.854 | kW/h |
| Electric efficiency | 35 | % | **649** | **kW el.** |
| Energy supply | | | 5.319.744 | kWh |
| Payment | 0,100 | R$ | **531.974** | **R$/Year** |

## Digester

| | | |
|---|---|---|
| Substrate/d | 287,2 | [m³/d] |
| Retention time | **20** | [d] |
| Volumetric loading | 2,9 | [kg oTS/m³ d] |
| **Volume digester** | **5.743** | **m³** |

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# Biogas from solids and sinking layers

**Tupandi: Theoretical potential of Biogas from slurry**

| Animal places or ha | Substrate | Slurry per place and year [t or m³] | Slurry/day [m³ ort/d] | Costs of Substrates [€/ha, m³] | Total costs substrates [€] | Mass of substrate [t] | Content of DM [%] | Dry matter [t] | Content of organic DM (oDM) [%] | Specific gas-yield [l/kg oDM] | Gasvolume [m³] | Content of methane [%] | Energy from biomass [kWh] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Saws with piglets | 4,00 | 0,0 | 0 | 0€ | 0 | 4,0 | 0 | 85,0 | 400 | 0 | 60,00 | 0 |
| 0 | Piglets, Slurry | 0,60 | 0,0 | 0 | 0€ | 0 | 4,0 | 0 | 85,0 | 400 | 0 | 60,00 | 0 |
| 0 | Fattening swines | 1,50 | 0,0 | 0 | 0€ | 0 | 7,5 | 0 | 85,0 | 400 | 0 | 60,00 | 0 |
| 0 | Laying hens | 0,024 | 0,0 | 0 | 0€ | 0 | 50,0 | 0 | 85,0 | 650 | 0 | 55,00 | 0 |
| 0 | Cows | 20,00 | 0,0 | 0 | 0€ | 0 | 10,0 | 0 | 85,0 | 300 | 0 | 55,00 | 0 |
| 37.146 | Solids from slurry | 1,00 | 101,8 | 0 | 0€ | 37146 | 10,0 | 3.715 | 90,0 | 360 | 1.203.530 | 55,00 | 6.619.417 |
| | **Sum / Mean** | | **101,8** | | **0€** | **37146** | **10,0** | **3.715** | | | **1.203.530** | | **6.619.417** |

| **Total Energy** | | | | |
|---|---|---|---|---|
| Yield biogas | | | 1.203.530 | m³/Year |
| Energy gross | | | 6.619.417 | kWh |
| No gas | 14 | days/year | 96,2 | % available |
| Energy net | | | 6.365.522 | kWh |
| Fuel initiates | 4 | % share | 254.621 | kWh |
| x | 9,8 | kWh/l | 25.982 | l/Year |
| **Total available energy** | | | **6.620.143** | **kWh** |

| **Electrical Energy** | | | | |
|---|---|---|---|---|
| Motor run time | 8200 | hours/a | 807 | kW/h |
| Electric efficiency | 35 | % | **283** | **kW el.** |
| Energy supply | | | 2.317.050 | kWh |
| Payment | 0,100 | R$ | **231.705** | **R$/Year** |

| **Digester** | | |
|---|---|---|
| Substrate/d | 101,8 | [m³/d] |
| Retention time | **20** | [d] |
| Volumetric loading | 4,3 | [kg oTS/m³ d] |
| **Volume digester** | **2.035** | **m³** |

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# Transport costs and value of pig slurry

**Type of Substrat:** Fattening pigs

| Nutrient | Market value R$/kg | Efici-ency [%] | Substrat /Standard) Content kg/t DM | Substrat /Standard) Value R$ | Substrat /Standard) Content kg/t DM | Substrat /Standard) Value R$ | Substrat /Standard) Content kg/t DM | Substrat /Standard) Value R$ |
|---|---|---|---|---|---|---|---|---|
| **Dry Matter [%]** | - | - | **4,0%** | - | **7,5%** | - | **9,0%** | - |
| Total N / NH4-N | 0,50 | 80% | 3,0 | 1,19 | 5,6 | 2,24 | 6,7 | 2,69 |
| P | 0,50 | 100% | 2,0 | 0,99 | 3,7 | 1,85 | 4,4 | 2,22 |
| K | 0,62 | 80% | 2,0 | 0,98 | 3,7 | 1,84 | 4,4 | 2,20 |
| Mg | 0,20 | 100% | 0,5 | 0,11 | 1,0 | 0,20 | 1,2 | 0,24 |
| CaO | 0,10 | 100% | 1,1 | 0,11 | 2,0 | 0,20 | 2,4 | 0,24 |
| **Price of Nutrients** | | - | | **3,37** | | **6,33** | | **7,59** |
| Distribution costs next to farm | | R$ 2,00 | | 1,37 | | 4,33 | | 5,59 |
| + Truck 5 km | | R$ 4,00 | | -0,63 | | 2,33 | | 3,59 |
| + Truck 10 km | | R$ 6,00 | | -2,63 | | 0,33 | | 1,59 |
| + Truck 30 km | | R$ 9,00 | | -5,63 | | -2,67 | | -1,41 |

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# Transport costs and value of compost

**Type of Substrat:** Compost

| Nutrient | Market value R$/kg | Efici-ency [%] | Substrat / Standard) Content kg/t DM | Substrat / Standard) Value R$ | Substrat / Standard) Content kg/t DM | Substrat / Standard) Value R$ | Substrat / Standard) Content kg/t DM | Substrat / Standard) Value R$ |
|---|---|---|---|---|---|---|---|---|
| **Dry Matter [%]** | - | - | **50,0%** | - | **60,0%** | - | **70,0%** | - |
| Total N / NH4-N | 0,50 | 80% | 14,2 | 5,67 | 17,0 | 6,8 | 19,8 | 7,93 |
| P | 0,50 | 100% | 25,8 | 12,92 | 31,0 | 15,50 | 36,2 | 18,08 |
| K | 0,62 | 80% | 22,5 | 11,16 | 27,0 | 13,39 | 31,5 | 15,62 |
| Mg | 0,20 | 100% | 0,8 | 0,17 | 1,0 | 0,20 | 1,2 | 0,23 |
| CaO | 0,10 | 100% | 1,7 | 0,17 | 2,0 | 0,20 | 2,3 | 0,23 |
| **Price of Nutrients** | | - | | **30,08** | | **36,09** | | **42,11** |
| Distribution costs next to farm | | R$ 2,00 | | 28,08 | | 34,09 | | 40,11 |
| + Truck 5 km | | R$ 4,00 | | 26,08 | | 32,09 | | 38,11 |
| + Truck 10 km | | R$ 6,00 | | 24,08 | | 30,09 | | 36,11 |
| + Truck 30 km | | R$ 9,00 | | 21,08 | | 27,09 | | 33,11 |

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# Thank your for your attention

Photo: www.bioenergie-steinfurt.de

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