Ecological intensification of livestock production in native grasslands: a case of co-innovation in Uruguay

Summer ET0 = 185 mm month$^{-1}$
Winter ET0 = 35 mm month$^{-1}$
Project aim

Contribute to **GHG emission intensity reduction** and **natural grasslands conservation and restoration** while increasing **productivity and farmers’ income** without increasing risks and input use in grazing livestock systems based on natural grasslands.
Basic concepts and Techniques to support ecological intensification of cow-calf systems

Transition to more productive and ecologically intensive livestock systems requires increasing knowledge and control by farmers of the agroecosystem basic processes to benefit from their natural diversity.
Basic concepts and Techniques to support ecological intensification of cow-calf systems

Weaning

3.0 3.5 4.0 4.5 5.0 5.5 6.0

Body Condition

Pregnancy Diagnosis

Body condition at calving

Ovarian activity diagnosis

Temporary weaning

Flushing

March April May June July Aug September Oct Nov Dec Jan Feb

Calving period

Mating period

Primiparous cows

Multiparous cows

Forage allowance control

8 - 10 cm

8 - 12 cm

4 - 6 cm

8 - 10 cm
Win – Win hypothesis

• Increasing plant biomass (LAI) in natural grasslands increases:
  – forage growth rate,
  – animal energy consumption and meet production per animal unit and per ha,
  – animal selectivity and diet quality
  – biodiversity,
  – carbon sequestration
  – soil protection

• Increasing match between grassland production seasonality and animal energy requirements increases:
  – energy efficiency
  – animal energy consumption and meat production per animal and per ha,
  – Reproductive efficiency

• GHG emission per unit of product and per ha can be reduced by:
  – Increased reproductive efficiency and meat production per animal unit
  – Reduced stocking rate
  – Increased diet quality
  – Reducing use of chemical fertilizers and external sources of feed (grain)
Project time line

Baseline years

July 2017

2020 - 2021

2021 - 2022

2022 - 2023

Caracterization & Diagnosis

Redesign

Implementation, monitoring & evaluation

April 2020

Sep 2020

Nov 2020

July 2021

July 2022

Feb 2023

June 2023
Available water and forage production

- **Soil available water (% of total)**
- **Estimated average forage growth rate per month (kg DM ha$^{-1}$ month$^{-1}$)**
## Impact in Productivity

<table>
<thead>
<tr>
<th></th>
<th>Baseline average</th>
<th>20/21</th>
<th>21/22</th>
<th>Significance</th>
<th>21/22 vs Baseline (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stocking rate (AU ha(^{-1}))</td>
<td>0.85</td>
<td>0.77</td>
<td>0.73</td>
<td>P≤0.001</td>
<td>-14%</td>
</tr>
<tr>
<td>ovine/bovine</td>
<td>1.54</td>
<td>1.2</td>
<td>1.08</td>
<td>P≤0.04</td>
<td>-30%</td>
</tr>
<tr>
<td>Beef meat (kg ha(^{-1}))</td>
<td>80</td>
<td>83</td>
<td>87</td>
<td>P≤0.005</td>
<td>9%</td>
</tr>
<tr>
<td>Sheep meat (kg ha(^{-1}))</td>
<td>11</td>
<td>14</td>
<td>12</td>
<td>P≤0.003</td>
<td>9%</td>
</tr>
<tr>
<td>Beef meat per animal (kg AU(^{-1}))</td>
<td>116</td>
<td>127</td>
<td>139</td>
<td>P≤0.001</td>
<td>20%</td>
</tr>
<tr>
<td>Sheep meat per animal (kg AU(^{-1}))</td>
<td>93</td>
<td>137</td>
<td>149</td>
<td>P≤0.002</td>
<td>60%</td>
</tr>
<tr>
<td>Weaning weight (kg calf(^{-1}))</td>
<td>150</td>
<td>153</td>
<td>167</td>
<td>P≤0.01</td>
<td>11%</td>
</tr>
<tr>
<td>Weaning weight (kg lamb(^{-1}))</td>
<td>18</td>
<td>22</td>
<td>24</td>
<td>P≤0.002</td>
<td>33%</td>
</tr>
<tr>
<td>Weaning percentage bovine (%)</td>
<td>70</td>
<td>67</td>
<td>73</td>
<td>NS</td>
<td>4%</td>
</tr>
<tr>
<td>Weaning percentage ovine (%)</td>
<td>63</td>
<td>68</td>
<td>76</td>
<td>P≤0.06</td>
<td>21%</td>
</tr>
<tr>
<td>Pregnancy rate bovine (%)</td>
<td>74</td>
<td>77</td>
<td>87</td>
<td>P≤0.04</td>
<td>17%</td>
</tr>
</tbody>
</table>
## Impact in Economic results

<table>
<thead>
<tr>
<th></th>
<th>Baseline average</th>
<th>20/21</th>
<th>21/22</th>
<th>Significance</th>
<th>21/22 vs Baseline (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross Income Beef (USD ha(^{-1}))</td>
<td>125</td>
<td>127</td>
<td>177</td>
<td>P≤0.0001</td>
<td>42%</td>
</tr>
<tr>
<td>Gross Income Sheep (USD ha(^{-1}))</td>
<td>27</td>
<td>20</td>
<td>24</td>
<td>NS</td>
<td>-11%</td>
</tr>
<tr>
<td>Total Costs (USD ha(^{-1}))</td>
<td>102</td>
<td>98</td>
<td>102</td>
<td>NS</td>
<td>0%</td>
</tr>
<tr>
<td>Net family income (USD ha(^{-1}))</td>
<td>52</td>
<td>54</td>
<td>104</td>
<td>P≤0.001</td>
<td>100%</td>
</tr>
<tr>
<td>Corrected NFI (USD ha(^{-1}))</td>
<td>50</td>
<td>62</td>
<td>62</td>
<td>P≤0.001</td>
<td>24%</td>
</tr>
</tbody>
</table>
In 2021-2022, 68 and 77% of farms reduce GHG emissions per ha and per kg of meat produced, respectively, compared to baseline.
GHG emissions – income and productivity

Variation in net income (USD ha⁻¹)

Variation in GHG emissions (Kg CO₂ ha⁻¹ year⁻¹)

Year 2021-2022 minus Baseline

Variation in meat production (kg ha⁻¹)
GHG emissions – income and productivity

Variation in GHG emissions (Kg CO₂ ha⁻¹ year⁻¹)

Variation in stocking rate (AU ha⁻¹)

Variation in meat production per animal (kg AU⁻¹)

Year 2021-2022 minus Baseline
GHG emissions – income and productivity

Variation in net income (USD ha$^{-1}$) vs. Variation in GHG emissions per kg meat produced (Kg CO$_2$ kg$^{-1}$) for Year 2021-2022 minus Baseline.
Monitoring and evaluation of environmental variables

• Monitoreo ambiental intensivo en 20 predios participantes y 20 vecinos:
  – Productividad → EVI
  – Altura de pasto
  – Emisiones de CH4 y N2O → Modelo del IPCC Tier 2.
  – Composición de la dieta con microhistología de heces.
  – Calidad de las dietas estimada por calidad de heces
  – Digestibilidad y calidad del forraje.
  – Diversidad vegetal y aves
  – Suelo → C, N y PMN, Textura, etc..
  – Calidad de Aguas
  – Caracterización de paisajes y muestreo de diversidad de especies
  – Proporción de arbustos

• Monitoreo ambiental en todos los predios:
  ☀ Mediciones satelitales de Productividad → EVI
  ☀ Emisiones de CH4 y N2O → Modelo del IPCC Tier 1