Chicken farming in grassland increased environmental sustainability and economic efficiency: main findings from a ten-year demonstration SUMAMAD project in China

Jiang Gaoming, PhD
Professor of Institute of Botany
Chinese Academy of Science
1 Introduction and objectives
1.1 Main ecological problems

1) Sandstorm ranks among the most serious environmental calamity, posing threats to both husbandry and social sustainability;

2) Government-allocated funding for the restoration of degraded grassland (tree planting, fencing grassland, or rearing dairy milk cows) has been tested to be short-lived and ineffective.

3) In the SUMAMAD project, we utilize natural grasslands for chicken farming instead of the traditional cows and sheep.
Sandland is easily degraded however also easily restored through natural process (Normile et al., 2007)
1.2 **Objective of the project**

1) A demonstration project has been established to show the local people how our proposed solution can generate higher incomes, while having little damaging to their lands;

2) The objective of the project was designed to test whether chicken farming in grassland can **mitigate degradation and yield more profit** than traditional sheep raising

3) It illustrates the **feasibility and advantages** of chicken farming in grasslands, offering a new perspective for maintaining future grassland sustainability.
2 Materials and methods
Figure 1: Sketch of Zhenglan Banner, with a point view on the location of Bayinhushu Gacha (Village) where the SUMAMAD Hunshandake Sandland project is located.
Material and Methods

- The SUMAMAD team coordinated and helped Bayinhushu Gacha (the project village) to establish a Company to produce and market the grassland chicken
- Farmers have been trained in carrying out the new income generation activities
- Eleven household farmers participated, and 22,000 chickens were rented, with chicken houses being built in the grassland
Organic food productions in the project area
Alternative income-generating activities such as forages, chicken farming and ecotourism;
Development and certification of organic foods (chicken and milk) in Hunshandake Sandland;
Use the liquid and solid wastes from the biogas plants to fertilize the green house, solving the vegetables shortage problem;
Plant community, soil features, and underground water movement were compared under different land use patterns.
3 Result and Discussion
3.1 *Environmental sustainability*

1) Free-range chicken in grassland significantly reduced above ground biomass (in dry weight) by 32% without statistical difference between different supplementation treatments.

2) The above ground biomass in chicken grazed plots was 3.1 times that in sheep grazed plots.

3) It is possible that under the stocking rate of this experiment, chicken grazed less than sheep.

4) The allocation of biomass (root: shoot ratio) was also significantly changed by sheep grazing, while chicken grazed plots showed no significant difference from the control group.
Figure 2. Effects of grazing treatment on the importance value index of species belonging to four plant families: Asteraceae, Chenopodiaceae, Poaceae and Brassicaceae. Values are mean ± SE (n=4). Abbreviations for treatments are defined in Figure 1. Columns with different letters indicate significant differences at $P < 0.05$.

Figure 3. Effects of grazing treatment on aboveground and belowground plant biomass (A) and root: shoot ratio (R : S) (B). Values are mean ± SE (n=4). Abbreviations T1: chickens fed with corn, T2: chickens fed with both corn and insects, T3: traditional sheep grazing, CK: the control without grazing. Columns with different letters indicate significant differences at $P < 0.05$. 

*Figure 2.* Effects of grazing treatment on the importance value index of species belonging to four plant families: Asteraceae, Chenopodiaceae, Poaceae and Brassicaceae. Values are mean ± SE (n=4). Abbreviations for treatments are defined in Figure 1. Columns with different letters indicate significant differences at $P < 0.05$. 

*Figure 3.* Effects of grazing treatment on aboveground and belowground plant biomass (A) and root: shoot ratio (R : S) (B). Values are mean ± SE (n=4). Abbreviations T1: chickens fed with corn, T2: chickens fed with both corn and insects, T3: traditional sheep grazing, CK: the control without grazing. Columns with different letters indicate significant differences at $P < 0.05$. 

---

### Table 1: Importance Value Index by Plant Family and Treatment

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Poaceae</th>
<th>Asteraceae</th>
<th>Chenopodiaceae</th>
<th>Brassicaceae</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>0.2</td>
<td>0.4</td>
<td>0.6</td>
<td>0.8</td>
</tr>
<tr>
<td>T2</td>
<td>a</td>
<td>b</td>
<td>ab</td>
<td>a</td>
</tr>
<tr>
<td>T3</td>
<td>c</td>
<td>c</td>
<td>ab</td>
<td>b</td>
</tr>
<tr>
<td>CK</td>
<td>a</td>
<td>a</td>
<td>ab</td>
<td>b</td>
</tr>
</tbody>
</table>

### Table 2: Biomass (g m$^{-2}$) by Treatment

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Aboveground</th>
<th>Root</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>160</td>
<td>a</td>
</tr>
<tr>
<td>T2</td>
<td>80</td>
<td>b</td>
</tr>
<tr>
<td>T3</td>
<td>0</td>
<td>c</td>
</tr>
<tr>
<td>CK</td>
<td>80</td>
<td>a</td>
</tr>
</tbody>
</table>

### Table 3: Root: Shoot Ratio (R : S) by Treatment

<table>
<thead>
<tr>
<th>Treatment</th>
<th>R : S</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>a</td>
</tr>
<tr>
<td>T2</td>
<td>b</td>
</tr>
<tr>
<td>T3</td>
<td>c</td>
</tr>
<tr>
<td>CK</td>
<td>a</td>
</tr>
</tbody>
</table>
Figure 4. Effects of grazing model on relative growth rate (A) and feed conversion rate for chickens (B). Values are mean ± SE (n=4). Abbreviations: T1: chickens fed with corn, T2: chickens fed with both corn and insects.
Figure 5. Effects of grazing treatment on soil water content (0-20cm)(A) and soil bulk density (B). Values are mean ± SE (n=4). Abbreviations T1: chickens fed with corn, T2: chickens fed with both corn and insects, T3: traditional sheep grazing, CK: the control without grazing. Columns with different letters indicate significant differences at $P < 0.05$. 
3.2 Economical beneficence

1) The new land-use patterns of chicken farming, baby cattle breeding and organic tofu production have tested successful in the demonstration households of Bayinhushu Gacha (village), Zhenglan Banner (County);
2) One family earned some 50 000 CHY in selling free-range chicken, and 30 000 CHY in selling organic eggs, and another 30 000 CHY in selling the harvested hays;
3) The economic income of local herdsmen has been raised about six times compared with the traditional practice of raising sheep;
4) In the last year of the SUMAMAD project, farmers from 10 household have raised 28000 free range chickens per year.
3.2 Impact to police makers

- The SUMAMAD project yielded great impacts both home and abroad, China Daily, Daizhong Daily, Xinhua News Agency made several reports.
- The State Council decides to continually support another 87.9 billion CYN in controlling the wind-dust resource upper Beijing-Tianjin regions (2013-2023). Some 30 billion will be spent for natural restoration of the degraded ecosystem. 10 years ago, before our project, there was nearly no funding for natural restoration.
- Xilingol League, has bought and distributed 400 thousands chickens to its 10 Banners or Counties to control grasshoppers.
Dr. Goaming Jiang, Institute of Botany, the Chinese Academy of Sciences

The grasslands of Inner Mongolia in northern China are seriously degraded as a result of over-grazing and the pressures of a growing population. Herdsman in Hunshandake and their families struggle to make a living on land that has nothing left to give. Native species have disappeared, and the loose topsoil triggers sand storms that blow to Beijing and beyond. Reversing desertification has at times seemed impossible, but Dr. Jiang has found a way. His research has shown that by removing human disturbance on degraded land, land could be restored in a matter of years. To do so, he persuaded herdsman to stop the grazing of large animals like goats, and instead adopt chicken farming, tofu production and eco-tourism, taking the pressure off the land. In an added benefit, chicken droppings help to fertilize the soil. Not only has the land improved, but the incomes of the Bayinheshu villagers have nearly doubled. Dr. Jiang also encouraged the community to help youth find educational opportunities in the cities, allowing the land time to rehabilitate and support more farmers in the future. The project has received media attention and spurred changes in China’s policy for grassland restoration and management, including compensating farmer losses if grasslands are used for ecosystem restoration.
6 Conclusions
6 Conclusion remarks-1

- Our hypothesis has been tested successful by a ten year SUMAMAD project that utilizing natural grasslands as both habitat and feed resources for free range chicken.
- Replacing the traditional husbandry system with chicken farming would increase environmental sustainability and raise income of the local family.
- Aboveground biomass elevated from 25 g m⁻² for grazing sheep to 84 g m⁻² for chicken farming.
- In contrast to the fenced grassland, chicken farming did not significantly decrease aboveground biomass, but increase the root biomass by 60%.
6 Conclusion remarks-2

- Compared with traditional sheep grazing, chicken farming significantly improved soil surface water content (0-10 cm), from 5% to 15%. Chicken farming did not affect the soil bulk density in the 0-10 cm.
- Grasslands provided a high quality organic poultry product which could be marketed in big cities.
- In terms of economic efficiency, chicken farming yielded a six-time greater return than that of traditional sheep grazing, as both chicken and hay could be sold.
- Chicken farming is an innovative alternative strategy in increasing environmental sustainability and economic income.
Thank you!