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SEFARI Fellowship: Quantifying 'Ag of the Middle' in the North Highlands of Scotland

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Contents

Enhancing Agroecology in the North Highlands

This report presents key findings and recommendations for improving agricultural practices in the North Highlands. It emphasizes the need for a workshop with industry experts to address regional challenges and opportunities, better identification of semi-natural habitats within farms, and refining the transport network to account for delays and travel costs. Additionally, accessing ScotEID data and using a Bayesian Belief Network approach are recommended to understand decision making to ensure the agricultural payment support framework delivers for AOTM farms.

Key Findings

1. AOTM farmers excel in agroecological interventions and nature conservation, such as supporting wading birds, yet these activities are not always sufficiently supported in the agricultural payment system. Shetland farmers emphasise the importance of on-island livestock markets and processors for efficient local supply.

2. Among the 5462 AOTM farms, 1229 focus on cattle, 2519 on sheep, and 1714 on mixed livestock with 48% having over 10% semi-natural habitat. Farms focusing on beef production tended to have less semi-natural habitat, with 63% having at less than 10% compared to 48% for sheep systems and 50% for sheep and beef systems.

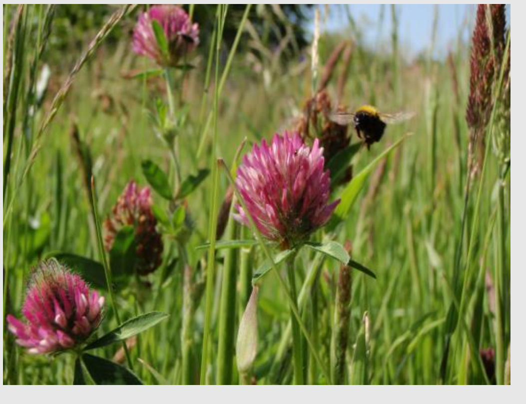
3. Farms are within an 8-hour transport window to market averaging 34 minutes (21 miles), with a maximum travel time of 3 hours 27 minutes (86 miles). However, distance to processors averages 1 hour 17 minutes (47 miles) with a maximum of 6 hours 38 minutes (181 miles), notably affecting Orkney farms without local processors. Identifying beef production systems via census data proved inaccurate, highlighting the additional value that ScotEID animal tracking data would provide.

Recommendations

- Conduct a workshop with industry experts and stakeholders to identify regional challenges, constraints, opportunities, and propose agri-environmental measures. Investigate improving identification of semi-natural habitats within farm boundaries and integrate data on additional aspects like peatland condition.

- Refine the road and ferry network to account for delays and gather feedback from farmers on typical journey times. Identify typical vehicle types and associated travel costs, including fuel, ferry, and transportation.

- Obtain access to ScotEID data for analysis of production systems, breed specialization, and livestock movement. Combine wider data sources within a Bayesian Belief Network to identify optimal elements of the new agricultural payment support framework for AOTM farms.



Background and Objectives of the SEFARI Fellowship

This project highlights small-to-medium-scale farming enterprises (AOTM) and showcases the wider public benefits that they offer (such as biodiversity conservation, tourism, and the production of high-quality food).

Background

The SEFARI fellowship titled "Quantifying 'Ag of the Middle' (AOTM) in the North Highlands of Scotland" was supported by a robust, industry-led steering group comprising the FFCC, NHI, SCF, and SAOS. It integrated transdisciplinary expertise and GIS modelling to develop a Bayesian Belief Network (BBN) model for exploring agroecological practices in the region. The team investigated the challenges faced by farmers, such as distances to markets and abattoirs, and identified opportunities like food sovereignty and community initiatives. Understanding cattle farming systems within the NHI supply chain, categorised as Breeder Finishers, Store Producers, and Finishers, was key to assessing supply chain dynamics and environmental impacts. The study emphasised a holistic approach to agricultural sustainability, considering a range of environmental factors beyond just carbon emissions.

Objectives

1. Assess and map the agricultural landscape of the North Highlands from an agroecological and AOTM perspective.

2. Identify agroecological practices for beef farmers in the North Highlands with the greatest economic and ecological potential for adoption.

3. Identify and map beyond-the-farm routes to market for beef cattle that utilise identified agroecological practices.

4. Provide suggestions on how these options and pathways can be integrated into agricultural and rural development payment programs.

Irish Moiled Calf

Sally Crowe

Methodology

Land Use

Land Parcel Information System (LPIS) data, combined with the 2021 June Agricultural Census, provides summary information on 5,462 farm businesses (Figure 1), including holdings, locations, field boundaries, land cover, ineligible features, and livestock numbers (excluding dairy cattle).

A holding, synonymous with a farm, is managed as a single entity and comprises one or more land parcels with distinct boundaries. Accurate mapping of these holdings is essential for managing agricultural subsidies and complying with CAP regulations. However, maintaining and updating LPIS data is complex and requires regular updates and technical expertise, posing challenges for farmers.

Distances

To calculate distances to marts and abattoirs, location data from the Institute of Auctioneers and Appraisers, the Shetland Livestock Marketing Group, and Food Standards Scotland was used. A road and ferry network layer were created by merging Ordnance Survey Open Roads data with Scottish Government Ferry Routes data, including typical speed data.

Average speeds were set using the Department for Transport Free Flow Vehicle Speed Statistics (2014), based on car towing speeds on various road types. Motorway, A and B roads were set to the national speed limit, urban roads were set at 30 MPH, restricted local access roads at 20 MPH, and other roads at 40 MPH, with adjustments made based on free flow statistics.

Composition of Habitats

Evaluating farm environmental performance often focuses on carbon emissions, where smaller, extensively managed farms with rare breeds may appear less efficient. However, this overlooks the wider public goods these farms provide.

In the North Highlands, we calculated the area of semi-natural habitats—non-productive areas excluded from payments—for beef, sheep, and mixed livestock systems (Table 1). These semi-natural habitats, modified by human activity yet retaining natural features, support high biodiversity and provide crucial ecological services like water regulation, soil fertility, carbon storage, and habitat connectivity. Examples include areas of scrub, small woodlands, and wetland habitats that support a diversity of species and deliver a range of wider benefits.

Case Studies

Discussions with the AOTM steering committee and SAC advisors highlighted the diverse public goods provided by small to medium-sized farms in the North Highlands are challenging to capture through GIS modelling. Recognising the various challenges faced by these farmers and crofters, comprehensive social data collection was deemed beyond the project's scope. However, to gain deeper insights, two farmers/crofters were selected for case studies. Selection, guided by the steering group and SAC advisors, focused on landowners in different locations with varied management approaches and supply chains.

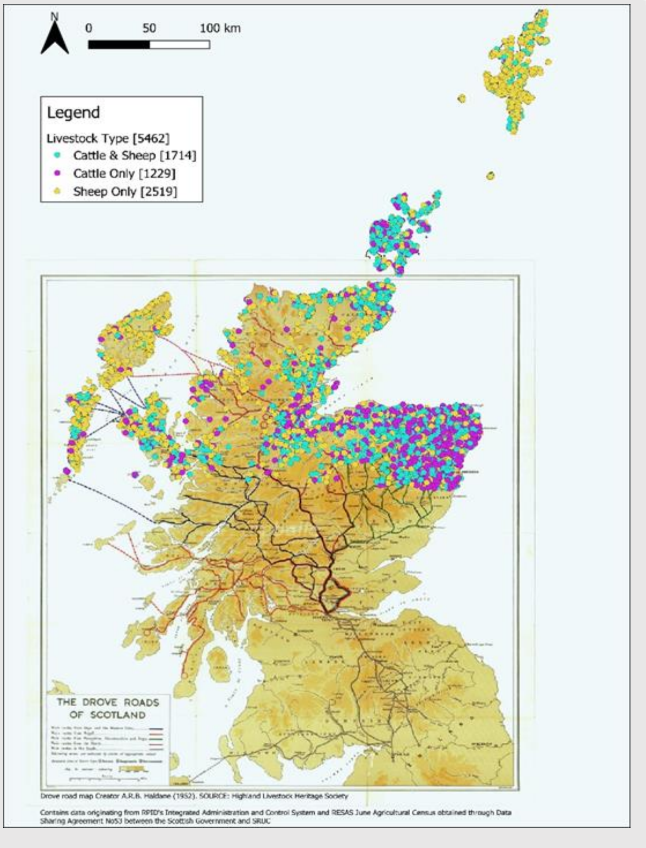


Figure 1: Farm businesses within the project area of interest categorised by type and overlaid onto a map showing the old drove roads of Scotland (A.R.B. Haldane, 1952).

Results

Composition of habitats

- Farms with over 10% semi-natural habitat are common in sheep and mixed beef & sheep enterprises (52% and 50% respectively), but less so in beef-only farms (37%).
- Larger sheep farms tend to have more semi-natural habitat due to their location on poorer land with more ineligible features.
- Small beef farms (3-20 ha) have a higher percentage of semi-natural habitat than medium-sized farms (21-100 ha), indicating their value for biodiversity.
- High Nature Value (HNV) habitats, such as species-rich grasslands, are crucial for biodiversity but often lack sufficient protection under current agricultural policies.
- Semi-natural habitats, influenced by human activity but retaining natural characteristics, are also at risk of conversion to more intensively managed agricultural land or forestry.
- Utilising detailed habitat data and high-resolution maps can improve our understanding of farm habitats, supporting targeted conservation strategies and sustainable land management.
- Sympathetic management of these semi-natural habitats can help farmers qualify for environmental subsidies, balancing productivity with conservation.
- Enhanced collaboration among stakeholders can integrate agricultural productivity with environmental stewardship, promoting sustainable land management practices.

Farm Size	Farm Count (number)	Average of Semi-Natural Habitat (as a % of farmland)	Count of farms with Semi-Natural Habitat > 10 %
Beef & Sheep	**1714**	**24.26**	**856**
< 3 ha	42	9.75	7
3-20 ha	330	19.25	135
21-100 ha	631	17.76	266
> 100 ha	711	33.21	448
Beef Only	**1229**	**15.85**	**458**
< 3 ha	52	9.52	11
3-20 ha	331	17.44	119
21-100 ha	528	13.06	186
> 100 ha	318	19.88	142
Sheep Only	**2519**	**32.36**	**1305**
< 3 ha	379	13.64	76
3-20 ha	1203	26.88	538
21-100 ha	655	39.11	439
> 100 ha	282	65.22	252
Total	**5462**	**26.10**	**2619**

Table 1: Composition of semi-natural habitats in the North Highlands and Islands area. Semi-natural habitats are only included where they are noted in LPIS data (i.e. in productive land parcels or as known ineligible features).

Results

Distance to auction markets and processors

Initial analysis calculated the direct distance to the nearest mart or abattoir. Further analysis used road and ferry networks to identify the quickest routes and actual travel distances.

- Farms in Lewis, Orkney, and the mainland had similar distances to auction markets (Table 2; Figure 2) . Uist farms were closer, while Shetland farms were further away.

- Shetland had the highest average travel times due to additional ferry journeys. Mainland travel times were affected by some farms being on the Isle of Canna *. Uist, Lewis, and Shetland farms were closer to processors (Table 3; Figure 3) compared to the mainland, whereas Orkney had increased travel times due to the 2018 abattoir closure.

- Average and maximum travel times to markets and processors were similar, with an increase for mainland farms lacking local processors. Orkney's travel times were higher due to ferry reliance. The analysis likely underestimated travel times by not accounting for ferry wait times and elevation changes.

- Four mainland farms (around Scoraig) were not fully connected to the road network, requiring future amendments.

- More detailed modelling is planned to refine travel time estimates, incorporating farmer feedback and considering factors like fuel costs, ferry costs, and professional haulage expenses. The impact of travel times on different farm sizes and types will be explored.

- SAOS Ltd reported typical travel times to the nearest abattoirs in various Scottish regions. These times do not consider costs of transporting animals from crofts to abattoirs, which our analysis aims to complement.

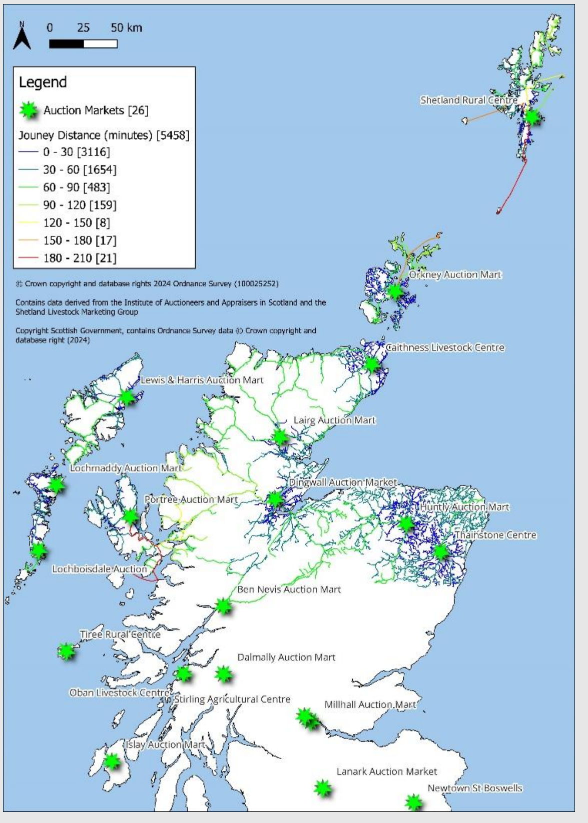


Figure 2: Routes to market classified by time (in minutes) with number of farms per category shown.

Farm Location	Farm Count	Average Time to Market	Maximum Time to Market	Average Distance to Market (miles)	Maximum Distance to Market (miles)
Lewis	475	00:31:15	01:25:40	20.31	59.22
Mainland	3443	00:31:56	03:27:23	21.11	86.19
Orkney	530	00:39:31	02:32:51	15.96	37.37
Shetland	701	00:47:28	03:24:04	25.67	61.96
Uist	309	00:19:00	01:09:17	12.60	25.86
Total	**5458**	**00:33:52**	**03:27:23**	**20.64**	**86.19**

Table 2: Summary of the distance to markets and time to travel from farms & crofts in Scottish Islands and the mainland.

*Several abattoirs in Scotland offer the service of private kill or butchery. Not all abattoirs in Scotland offer these services and the information that we employed to compute distances do not clarify whether an abattoir offers any of these services.

Results

Beef Production Systems

Cattle farmers fall into three broad system types:

1. A *Breeder Finisher* breeds and finishes calves on farm.
2. A *Store Producer* breeds and keeps calves until they are 6-18 months then sells them to be finished elsewhere (i.e. to the finisher).
3. A *Finisher* breeds little or few cows, takes the store producers calves at 6-18 months then finishes them on farm.

Various factors influence the type of cattle farming systems adopted, such as land productivity, availability of byproducts like crop residues and food processing waste, and proximity to processors. These factors impact how long animals are kept and their growth rates, thereby affecting the efficiency and sustainability of the farming operations. Understanding these drivers enables stakeholders, including policymakers, researchers, and farmers, to develop targeted strategies to enhance beef production in the Northern Highlands. This knowledge supports policies that optimise land use, improve feed efficiency, and mitigate environmental impacts.

The Agricultural Census data was used initially to classify farms based on the ratio of breeding cows to young calves, but this method proved inaccurate. Accessing ScotEID data through EPIC Scotland would provide detailed information on individual animal movements and breeds, enabling accurate classification of breeding systems such as breeder finishers, store producers, and finishers. These data are essential for comprehending cattle farming dynamics in the region, identifying system distribution patterns, and assessing their efficiency and sustainability.

Collaborating with ScotEID will confirm the data's suitability for in-depth analysis, crucial for informing policies and practices that promote sustainable cattle farming. Initial approval has been granted for data access, with ongoing efforts focused on conducting a thorough data impact assessment and extracting meaningful insights for effective decision-making.

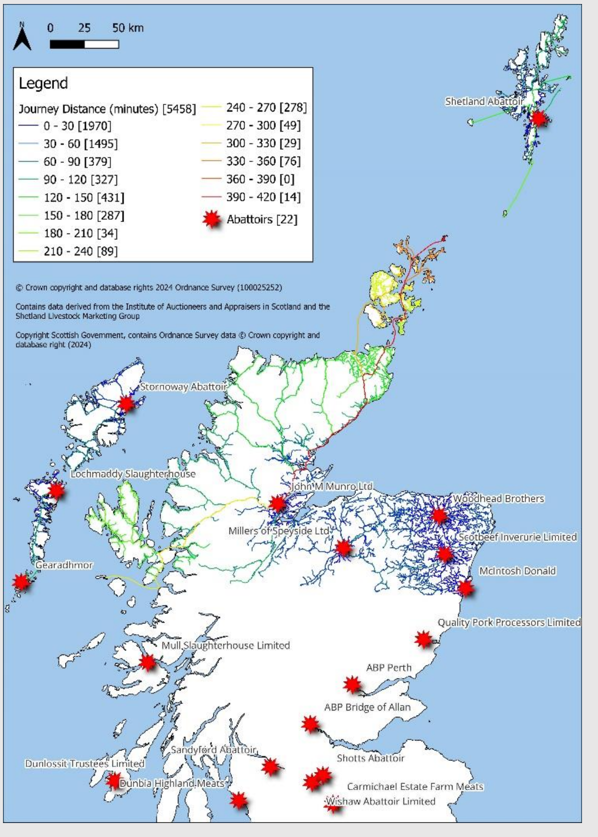


Figure 3: Routes to processors classified by time (in minutes) with number of farms per category shown.

Farm Location	Farm Count	Average Time to Processor	Maximum Time to Processor	Average Distance to Processor (miles)	Maximum Distance to Processor (miles)
Lewis	475	00:30:47	01:25:03	20.07	58.88
Mainland	3443	01:02:43	04:33:19	42.04	125.60
Orkney	530	04:32:10	06:38:12	148.23	181.53
Shetland	701	00:47:27	03:24:02	25.66	61.95
Uist	309	00:35:30	02:00:07	24.34	59.67
Total	**5458**	**01:16:46**	**06:38:12**	**47.34**	**181.53**

Table 3: Summary of the distance to processors and time to travel from farms & crofts in Scottish Islands and the mainland.

Case studies

Farms and crofts in the North Highlands and Islands face unique challenges, with their benefits often overlooked. Two case studies highlight environmental benefits from extensively managed livestock systems, such as supporting rare species through careful grazing with hardy cattle and sheep breeds, reducing costs and labour. The studies also emphasise the local connection between food production and consumption, with high welfare and environmental standards. Despite opportunities like meat boxes, affordability and efficient input use are crucial. SAOS Ltd (2024) notes abattoirs' thin profit margins and high running costs, suggesting direct meat sales are viable mainly in high-end markets. An extension from SEFARI Gateway will fund further studies to support sustainable agriculture and local food chains in the Scottish Highlands.

Figure 4: Sally Crowe at Hawkhill Farm (Photo credits Sally Crowe)

Sally Crowe: Hawkhill Farm, Keith, Caithness

Runs a 30-acre croft, renting an additional 35 acres (Figure 4) and manages 70 Hill Cheviots crossed with Bluefaced Leicesters , 11 Irish Moiled cattle and laying hens .

- Livestock breeds selected for their ability to thrive on poor ground with low levels of inputs.
- Farms without agrochemicals, using rotational grazing and moving towards a grass-fed system, creating species-rich grasslands through Agri-environment and Climate Scheme funding.
- Fields host rare species like the great yellow bumblebee and corncrake and diverse swards support a variety of grasses, clovers, and wildflowers, improving resilience and livestock health.
- Breeds for efficiency, culling sheep that fail to conceive, need extra concentrate feed, have foot problems or poor mothering ability. and sells beef and lamb directly to consumers, offering meat boxes seasonally.
- Customer base has grown organically through word of mouth and Facebook, with 1,800+ followers.
- Selling locally Sally's rural customers are connected to where their meat comes from and recognise the high nature-value and good welfare standards on the croft.
- Conducts courses on selling meat boxes and social media training and supports farm income with diverse entrepreneurial activities.

Sally Crowe's innovative and sustainable approach at Hawkhill Farm demonstrates the potential for small-scale farming to thrive while benefiting the environment and local community.

Case studies

Sandy Fraser: Culswick, Shetland

Crofting in Culswick, Shetland for 40 years, home to SSSIs and several scheduled monuments (Figure 5).

- Created habitats such as a pond, wildlife area, and small-scale woodland.
- Preserved species-rich grasslands, supporting Shetland's indigenous heath-spotted orchid and various wildlife including a wide variety of waders.
- Scotland's most northerly herd of 40 pure pedigree Aberdeen Angus cattle and small flock of pure-bred Shetland sheep.
- Breeds cattle for moderate size, ease of calving, longevity, and gentle nature, focusing on traditional Aberdeen Angus traits and hardiness.
- Operates as a one-man business, making it imperative that cattle are easy to handle and calve.
- Uses homebred bulls and artificial insemination, maintaining a closed herd and high health status.
- Due to extreme climate, cattle are housed from November to late May/early June, with winter feeding predominantly homegrown silage, supplemented with barley, straw, and minerals.
- Summer grazing rotated across in-bye fields, silage aftermath, and improved hill ground.
- Produces most forage domestically to minimise reliance on expensive imported inputs.
- Faces challenges such as higher than average input costs, increased haulage costs, agricultural inflation, and limited machinery access.
- Balances crofting with outside work, valuing quality of life and environmental stewardship over profit.

Sandy Fraser exemplifies sustainable crofting, balancing livestock management with environmental enhancement and community values.

Figure 5: Sandy Fraser at Culswick

Next Step: A holistic approach to shape future policy

Bayesian Belief Networks (BBNs) graphically represent relationships between system factors, integrating quantitative data (e.g., farm size, livestock numbers) and qualitative data (e.g., perceptions and attitudes). They handle complex dependencies and model uncertainty effectively, providing a holistic understanding of agricultural systems. BBNs have been used in schemes like the Environmental Stewardship Scheme to identify factors influencing farmers' decisions and improve policy design.

Exploring New Frontiers

A draft BBN has been created (Figure 6) to explore the implementation of innovative agroecological practices, including silvo-pastoral systems and intercropping. This model will be refined using data sourced from the Agricultural Census, alongside insights gathered through stakeholder workshops and questionnaires. Early stakeholder engagement ensures the BBN accurately reflects real-world conditions and considers practical factors influencing the adoption of these sustainable practices.

Promoting Resilience

Agroecological practices enhance ecosystem services, fostering improvements in soil health, water retention, and biodiversity. Our research focuses on implementing these practices effectively in the Scottish Highlands to promote sustainable and productive landscapes resilient to climate change.

Enabling Informed Decision-Making

The BBN model evaluates farm suitability for agroecological practices by analysing environmental factors such as topography and climate conditions. Unlike traditional methods, BBNs integrate diverse data types and model probabilistic relationships, providing clear insights into the factors influencing successful outcomes.

Supporting Sustainable Futures

Increasingly accepted within the industry, BBNs contribute valuable insights to decision-making and policy formulation. By delivering these insights through trusted channels like agricultural advisors and leveraging digital tools, we ensure BBN results are accessible and actionable. This approach supports the wider adoption of agroecological practices, driving improved ecological and economic outcomes across the Scottish Highlands.

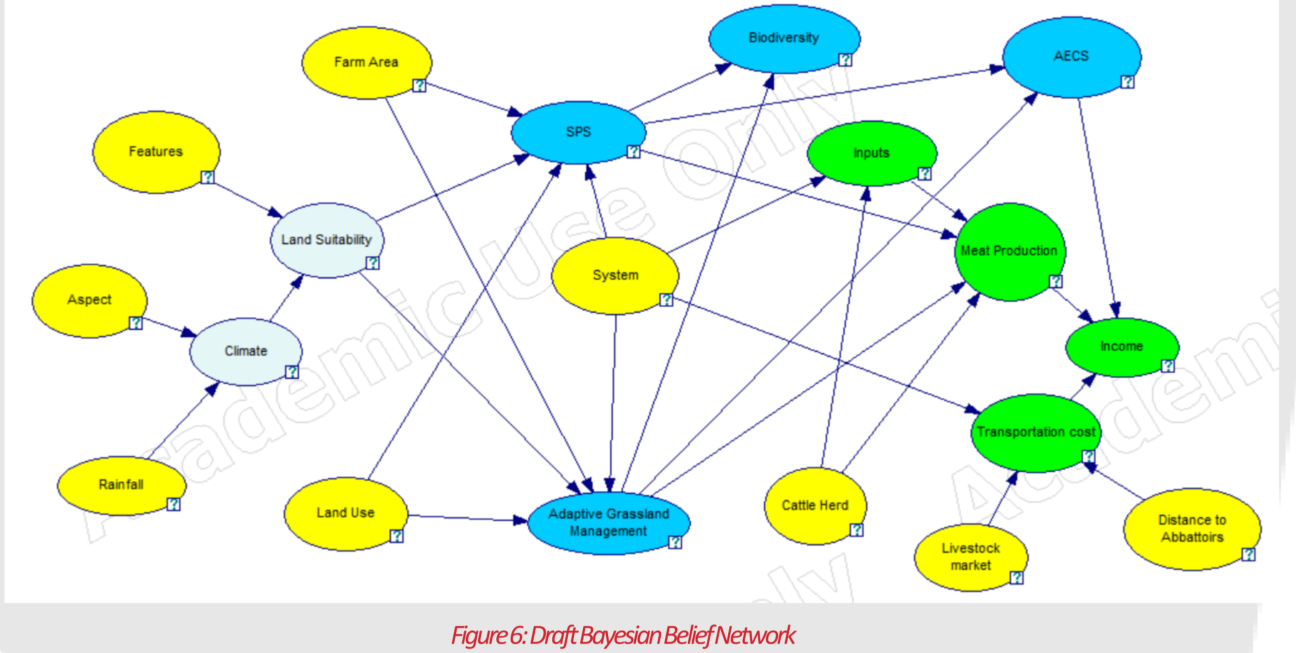


Figure 6: Draft Bayesian Belief Network

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