

Planning an Agent-Based Network for Livestock Production and Meat Distribution in Mongolia

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ABSTRACT

This paper reviews the problems of livestock production in Mongolia and proposes an agent-based meat distribution network composed of multiple players. Agents sell and buy products and services, equipped with intelligent capacity of knowledge and physical capacity of freezing meat stock, livestock, and forage stock. Local governments and communities are the key for enhancing food security. The network, as a whole, is green, clean and resilient to climatic and market disturbance.

Keywords: food security, agent-based network, local development, meat freezing storage

INTRODUCTION

Mongolia is a land-locked country that spans arid and semi-arid ecological regions. The ecological systems are extremely vulnerable to climate change and intensive human development. The steppe has low primary productivity, rendering it suitable for the sparse scattering of the nomadic people over a large area. However, today, half of the 2.8 million Mongolians live in the capital city, Ulaanbaatar (UB). Except in such cities as Erdenet and Darkhan, the population in each of Mongolia's *aimags* (i.e., provinces) is less than 30,000 persons. Food is produced in the vast land while consumers are extremely concentrated in the capital. This geographic imbalance of production and consumption renders the issue of food security in Mongolia special in three dimensions. First, the government must secure safe and nutritious food for all of its citizens, including those in remote lands; second, the highest priority is to ensure sufficient food for citizens living in the capital; third, it is critical to sustain the nomadic society while its people tend to prefer the convenience of urban life. The first dimension requires the erasure of poverty. The second demands a high level of productivity by connecting the remote countryside with cities. The third pursues inclusive development. Each dimension sheds light on different temporal and spatial scales. We believe that only when these three dimensions are tackled together will resilient and sustainable food security be achievable.

This research reviews the problems of livestock production in Mongolia and proposes an agent-based meat distribution network equipped with freezing meat storage in addition

to livestock and forage stock. This network could collect livestock from herders, rather than conventional peddlers and wholesalers, and store frozen meat to protect them from climatic disasters and market disturbance. The network would empower the local government and communities by activating the food industry. This would help reach the national goal of food security by being clean, green, and resilient in the long term.

PROBLEMS OF MEAT DISTRIBUTION IN MONGOLIA

Undeveloped market economy in rural areas

Nomadic Mongolians move around the steppe to migrate alongside water and grass. Livestock have traditionally been a living food storehouse, as people acquire food by killing animals whenever and wherever, as need dictates (Siurua and Swift, 2002). This lifestyle based on self-producing and self-consuming subsistence has been conserved by half of the population in over 99% of the national land in Mongolia. This is an extreme example of a low-cost and low-carbon lifestyle. However, productivity is low. In total, 150,000 households and 300,000 herders owned 52 million animals in 2014. Most herders have kept animals for self-consumption rather than production for a wider market. Mongolians consumed 273,700 tons of meat in 2013 and only 965 tons were exported in 2012 (<http://ubpost.mongolnews.mn/?p=4852>). The large number of animals has raised grazing pressure on the pastureland, which has resulted in the over-grazing and general degradation of the ecological system in every *aimag* (Olonbayar, 2010). This has also left ecosystems and livestock alike vulnerable to extreme weather. *Dzuds* (i.e., severe winters) have occurred recurrently in past decades, resulting in the death of tens of millions of animals (ERST_UNDP_NEMA, 2010; Sternberg, 2010). Herders who consequently lost animals have had to work at mining sites or migrate to cities (Mayer, 2015). This accelerated the population concentration in Ulaanbaatar, and again aggravated the imbalance between meat production and consumption.

Poor infrastructure for meat distribution and processing

Mongolian livestock was state-owned during the socialist era before 1990. Production and distribution were centrally planned. Every year, the government made production plans and allocated products to *aimags* and then *soums* (i.e., districts) in the spring. Each *soum* would collect the required number of animals, and then trek the herd to Ulaanbaatar while fattening the animals. Herders would reach the city in the autumn, which would be the best time to ship the herds to market (Edstrom, 1995). The trip would be harsh and risky, extending for several months and spanning thousands of kilometers. After the 1990s, the trekking system collapsed. Livestock became privatized and meat distribution opened up to the market. Individual merchants or private traders became the main power holders in rural areas, collecting animals and transporting them to slaughterhouses in nearby large cities, mainly Ulaanbaatar (Ichinkhorloo and Thrift, 2015). The increased stocking rates closer to the capital severely degraded the grassland landscape. Meanwhile, herders in rural areas continued to migrate each year from winter to summer while grazing lands and keeping animals for survival, although they could still suffer significant losses through *dzud*. Moreover, they would discount the prices heavily when selling because they did not know the market very well.

Regarding the market-based meat distribution process, transportation and slaughtering are conducted under poor hygienic conditions, without freezing and refrigerating. Wholesalers buy meat at slaughterhouses and sell to the central market, food markets, and supermarkets. Meat products from small slaughterhouses are distributed to food markets and retailers in unrefrigerated trucks. Only 13% of meat products are processed in plants with reasonable hygienic standards. Food markets sell meat products, of which almost 100% is contaminated with chemical components, bacteria, and heavy metals

(FAO/WHO, 2002). All of these effects can result in bacterial growth on the meat with a higher risk of food poisoning, among other risks.

Lack of policy integrity and implementation

Meat is a staple of Mongolian culture. About 42% of the Mongolian labor force engages in agriculture, mainly herding livestock, and contributes 20% of their gross domestic production (GDP) to this activity <<http://www.nationmaster.com>>. With shrinking food reserves and soaring food prices, the Mongolian government recognized the importance of stable food supply and introduced a national meat reserves program in 2005. The country has initiated the National Programme for Food Security in 2009 (Mongolia, 2009). This program's overall goal of food security is to provide the entire nation with secure supplies of accessible, nutritious, and safe food to enable healthy livelihoods and high labor productivity. However, the policy has not led to any significant reductions of price fluctuations (Goodland, 2010). Despite the price subsidies for consumers and direct funding for participating meat packers the consumer prices have continued to rise rapidly (Ichinkhorloo and Thrift, 2015). We think this is not solely a food security issue but a matter that involves the rebuilding of the nomadic society while balancing the development of the capital and rural areas. In the transition to the market economy, the development of supportive food industrial infrastructure for meat logistics was ignored. Storehouse closed, cooperative production collapsed, community facilities were abandoned, and public services of the local government degraded (Finke, 2003). It would be time again to develop the food security that would be entrenched on the endemic resources of the vast land while favoring nomadic culture.

AGENT-BASED MODEL OF LIVESTOCK PRODUCTION AND MEAT DISTRIBUTION

Food security is supported by three models in modern Mongolia (Figure 1). Model A is bartered with limited exchange among relatives and neighborhoods in *soums* and *aimags*. The supply chain is short with less intermediate costs, consequently with no value added. Model B builds on the semi-formal connections intermediated by merchants and wholesalers. The food of the capital is mainly supplied in this way today. This model is vulnerable to weather conditions and diseases. Model C is formal business between large-scale herders and slaughterhouses. Sellers and buyers in this model are powerful in their facilitation of transportation and even maneuvering of market prices (Ichinkhorloo and Thrift, 2015). This model is often recommended as a favorite solution to secure food supply because of its high productivity; however, it produces less interaction with local governments and yields limited effects on local economies.

A problem common to the three models above is the lack of local players: *soums*, *aimags*, and herders. *Soums* and *aimags*, as governing authorities, take the responsibility of managing pasturelands. They also have to develop the local economy and preserve nomadic culture. In one word, they are the stewards of their national land. For most *soums* and *aimags*, livestock is essentially the only resource, and therefore, the ways through which the potential of these resources may be activated are the key for local development. Here, we introduce an agent-based network of model D by improving food industrial infrastructures, especially freezing storage.

According to the agent-based simulation theory, an agent is an actor behaving autonomously and interactively in an explicit space on bounded rationality (Epstein 2007). The agents in Model D are herders, livestock traders, enterprises, *soum/aimag* governments, wholesalers, retailers, and consumers. Agents collect sparsely distributed livestock from herders, store meat in freezing storage, and deliver meat products to beneficiary markets. Different from the agent-based systems on established infrastructure (Liu, 2014). The agent of model D is embedded with intelligent and physical capacities.

By the notions of alertness, efficiency and risk-taking (Ross and Westgren, 2009). The intelligent capacity here is defined as the alertness of an agent to environmental change. The physical capacity is the size of freezing stock, livestock and forage stock of an agent. Multiple agents autonomously act and interact in an explicit landscape by the rational use of the physical capacity of the three stocks. While pursuing individual efficiency, the network as a whole must meet the national requirements of sustainable development: green (low CO₂ emissions), clean (good hygiene), and resilient to disturbance (i.e., disasters). For comparison, we summarized the features of the four models in Table 1.

Regarding risk-taking, this model integrates the socio-economic and -ecological goals in the long term and the short term, in which the development of pooling capacity of the three stocks shall be essential. In the short-term, the priority of the network is to secure the food supply to urban residents, which requires the prioritization of efficiency in the quick collection of livestock and meat storage that is close to the urban market. In the long-term and broader definition, consumers include both city residents and local herders. A planned agent network should reduce the number of value chains and increase the profits of small- and middle-scale herders. Herders and communities with storage facilities may directly sell and send produced food to urban consumers.

REQUIREMENTS FOR IMPLEMENTING THE AGENT-BASED MODEL

Integrated management of natural resources, products, and markets

The agent-based model considers livestock production and meat distribution to be nation-wide in the long term. When enough livestock is fed and food is reserved in freezing and storing facilities, the market becomes more resilient. The agent-based model operates at the intersection of livestock feeding, meat production, and the consumer market. In this sense, the stock of animals, storage of meat products, and market demand should be managed in integrative ways. This would require collaboration among government offices, central and local departments, as well as enterprises and herders' communities (Balval and Baljinnyam, 2013).

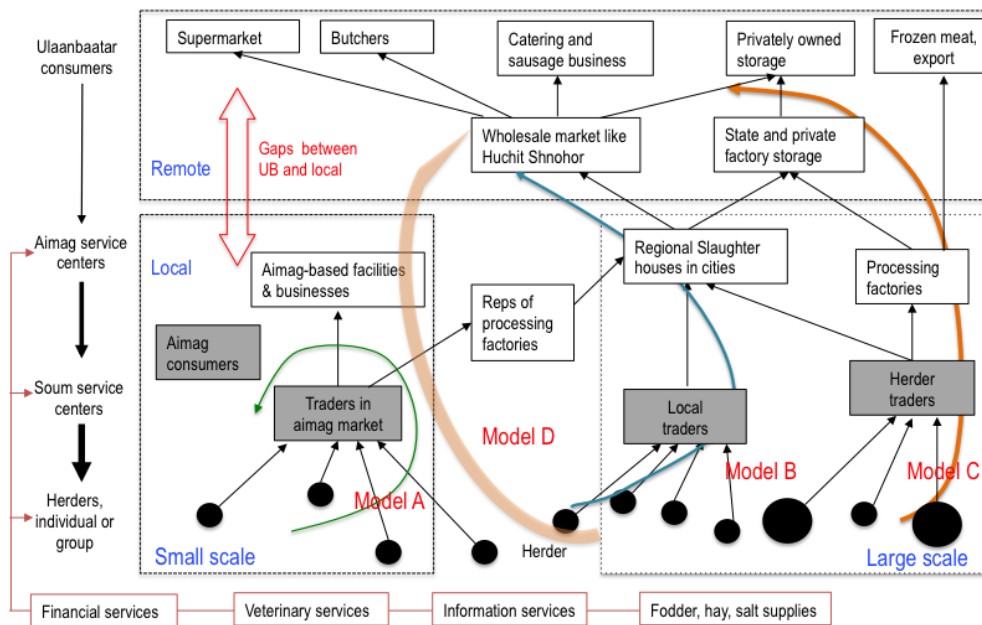


Figure 1. Agent-Based Network for Meat Distribution

Table 1. Comparison of Meat Distribution Models

Model	A	B	C	D
Feature	Local markets	Cooperation with wholesalers	Working with large-scale herders	Enhancement of local centers (soums, aimags)
Merit	Local production, local consumption	Low investment	Independent transport by herders	Development of attractive aimag/soum centers
Demerit	Low economic development	No improvement	Large gaps between poor and rich	No established business model
Policy & Strategy	Culture preservation	Market economy	Meat supply to UB first	Decentralization from UB
Cleanliness/ Hygiene	Not easy to maintain	Not easy to maintain	Easy to improve	Well-controlled
Greenness/Low CO₂ emissions	Very low	Low	High	Well-controlled
Resiliency	Vulnerable	Vulnerable	Vulnerable	Resilient

Infrastructure required for Model D:

- ❶ Veterinary services -> ❷ Grassland management (ex-ante, during, and ex-post dzuds) -> ❸ Collective program

Shared information and communication

One significant problem currently in Mongolia is the lack of data and communications among governmental departments, providers, and consumers. Fortunately, the Mongolian government initiated the National “Mongolia Livestock” registration system in 2010 (Resolution based on the Law of Great Khural of Mongolia, Article 43 and clause 43.1), by which 40% of animals are tagged with a bar code and registered to a central database in pilot aimags. Only tagged animals are certified to be marketed or exported. The system is even designated to connect with the Mongolian Agriculture Commodity Exchange (MACE). With this registration and market information, the potential of livestock across the country could be activated, and the meat market would be expected to prosper in the near future.

Empowerment of local governments, herders, and communities

Mongolian herders maintain tight ties through informal networks, as 31% of livestock is owned by non-herders (Ichinkhorloo and Thrift, 2015). In rural area two to twelve households move, live, and work together in a herding management unit called a *khot ail*. A number of *khot ails* settled together around a small water source is known as a *neg usnihan* (meaning “users of the same water”). The population within a given area neighboring a *neg usnihan* with similar herding management practices constitutes a *neg nutgiinhan* (meaning “people of the same area”). This *khot ail*→*neg usnihan*→*neg nutgiinhan* structure (Nyamsamba, 2000) constitutes a community-based social network. In the process of urbanization, rural areas are faced with problems related to aging. The sustainable management of pasturelands and livestock will largely depend on the revitalization of these informal connections. The agent-based model aims to enhance the capacity of local centers with communities by developing the capacity of capital assets. By using modern modes of communication, information can be delivered to agents easily. Market information of MACE or that of the local market, as well as knowledge of grassland management and breeding animals, could be shared in a manner similar to that of the service that has delivered weekly weather information via short message service (SMS) to herders (Suvdantsetseg et al., 2015).

CONCLUSIONS

This paper proposed an agent-based network of livestock production and meat distribution in Mongolia. This proposed model defines herders, merchants, governments, and wholesalers as agents with intelligent and physical capacity. The main difference of this model from conventional ones is its ability to empower *soum/aimag* centers through the rational management of freezing stock in addition to livestock and forage stock. By introducing freezing meat storage as the third food industrial infrastructure, the agent-based network can overcome the vulnerability of the food chains from livestock production to meat distribution and create opportunities to local communities. The implementation of this network is expected to reduce long-distance transportation, enhance market value of meat, and thrive herders' life. This idea shares the direction of the New Soum Center Project of the Mongolian Government, by perspective of food security. We argue that freezing meat stock must be planned, introduced, and maintained as the important food industrial infrastructure of the country with livestock and forage stock of pastureland together.

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