

Biopolitics of Breeding

An Investigation into Herbicide-Resistant
Foxtail Millet in China

Pei Jiang | pj344@cam.ac.uk
Department of Geography
University of Cambridge





Foxtail Millet

also known as *Guzi* [谷子], *Su* [粟] or *Ji* [稷]

Binomial name: *Setaria italica*

**Power dynamics of
seed commodification
and conservation**

- Biopower: ‘an explosion of numerous and diverse techniques for achieving the subjugation of bodies and the control of populations’ (Foucault, 1978, p.140).
- Biopolitics: the politics of governmentality of life, through the human body, ‘to ensure, sustain, and multiply life, to put this life in order’ (Foucault, 1978, p.136).
- More-than-human life.
- Biopolitics of breeding: a series of strategies and mechanisms that govern crops and seeds through the ‘technologies of control’.

Biopower

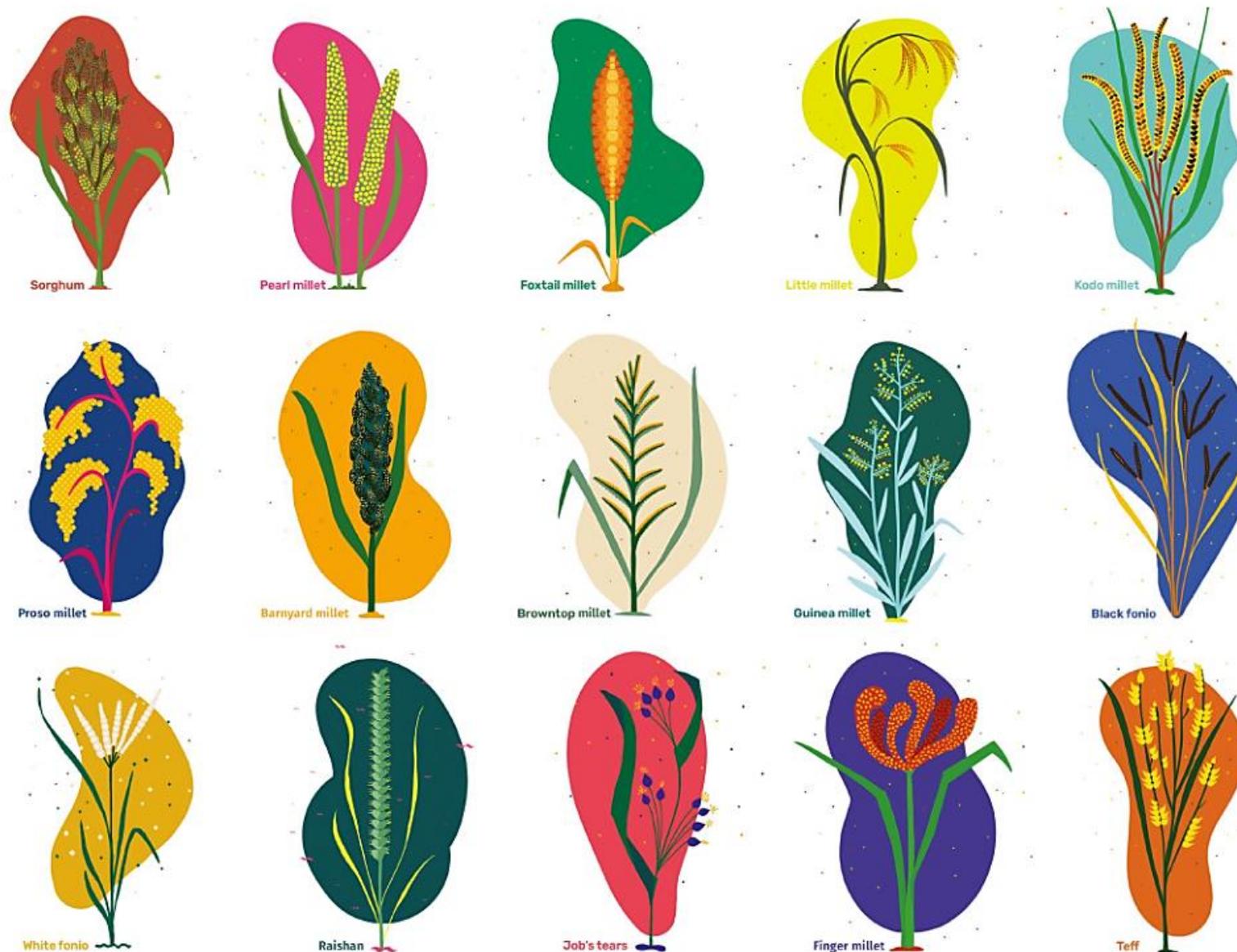
&

Biopolitics

Millets

Millets encompass a diverse group of **cereals** including pearl, proso, foxtail, barnyard, little, kodo, browntop, finger and Guinea millets as well as fonio, sorghum (or great millet) and teff (FAO 2022).

Millets can grow on **poor soils** with **little inputs**, are **resistant** or tolerant to many crop diseases and pests and can survive adverse climatic conditions (FAO 2022).



Note: Illustrations of millets are extracted from the *International Year of Millets 2023: Communication handbook and toolkit* (FAO 2022).

Table 1. The comparison of common crops in North China.

Crops	Thousand kernel weight	Water requirement for germination (water/kernel weight)	Transpiration coefficient
Foxtail millet	2.2-4g	26%	142-271
Maize	180-500g	48%	368
Wheat	23-58g	45%	513
Sorghum	20-34g	40%	322

Data source: Millet Database (China National GeneBank 2015); The status of new millet varieties in dryland farming (Tian et al., 2000). Table drawn by the author.

*Transpiration coefficient refers to the ratio of the transpired amount of water to the dry matter production. The dry matter of a plant consists of all its constituents excluding water. The transpiration coefficient relates to the efficiency of water use by plants. The higher the value of the transpiration coefficient, the less efficient the use of water.

Table 2. The comparison of nutrients facts.

Crops	Protein (g)	Carbohydrates (g)	Fat (g)	Crude fibre (g)	Mineral matter (g)	Energy (kcal)
Foxtail millet	12.3	60.9	4.3	8.0	3.3	351
Rice	7.9	76.0	2.7	1.0	1.3	362
Wheat	11.6	71.0	2.0	2.0	1.6	348

Data source: Foxtail millet: Properties, processing, health benefits, and uses (N. Sharma and Niranjana 2018). Table adapted by the author.

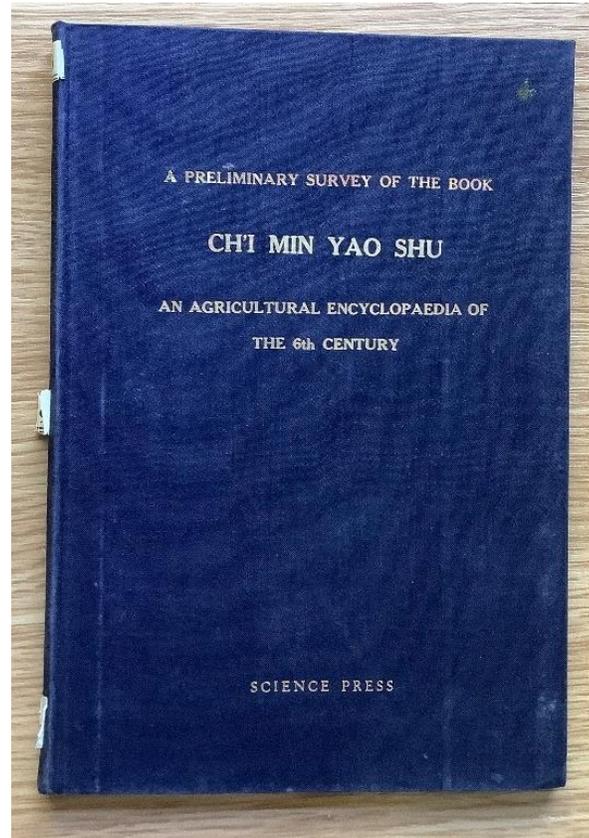
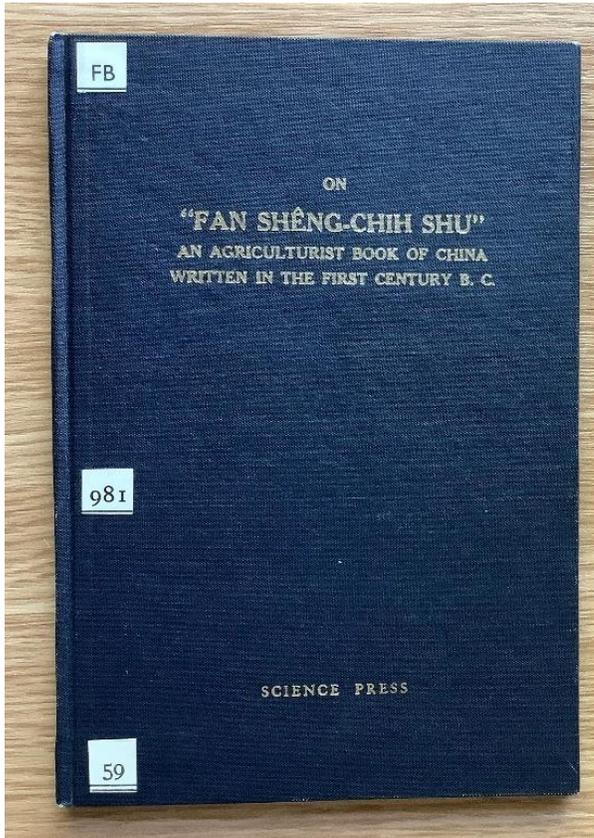
Cultural History of Millet Cultivation

- *Five Grains*, also known as *Wugu* [五谷], are five farmed crops that were all important in ancient China. The identity of the *Five Grains* has varied over time, with the most common grouping being ‘**rice, broomcorn millet, foxtail millet, wheat, and soybean**’;
- Refers to all crops now.
- **The worship of foxtail millet**
- *Ji shen* [稷神], the deity of *Five Grains*;
- *Ji shen* is frequently mentioned alongside *She shen* [社神], the tutelary deity of the state.
- Chinese people later used *She Ji* [社稷] to refer to the state.



Picture 1. ‘Four colours millet’.
Picture by the author.

Cultural History of Millet Cultivation



Fan Sheng Zhi Shu

- written in Western Han dynasty (202 BC-9 AD)
- the first book that record foxtail millet;
- the China's first agricultural book written by an individual;
- the earliest agricultural work around the world.

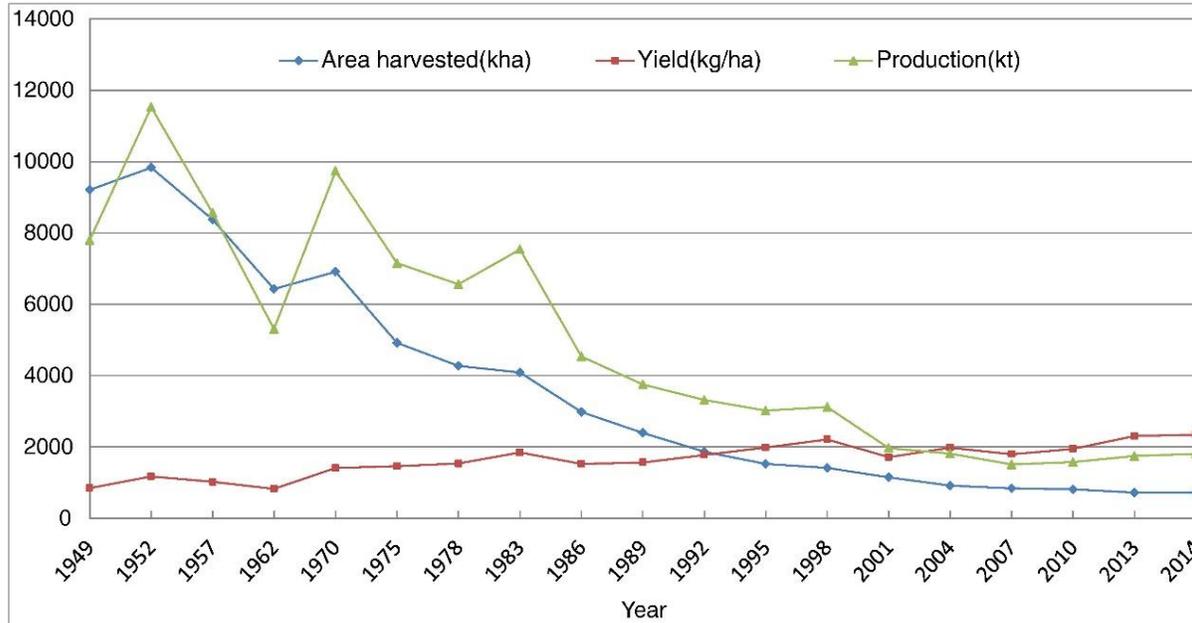
Qi Min Yao Shu

- Composed by Sixie Jia, a Northern Wei Dynasty official, in the 530s-540s;
- the best-preserved and most comprehensive Chinese classic dedicated solely to agriculture;
- includes 86 millet varieties, ranging from drought-resistant and water-resistant types to wind-resistant and pest-resistant varieties.

Picture 2. *Fan Sheng Zhi Shu* (left) and *Qi Min Yao Shu* (right).
Picture by the author.

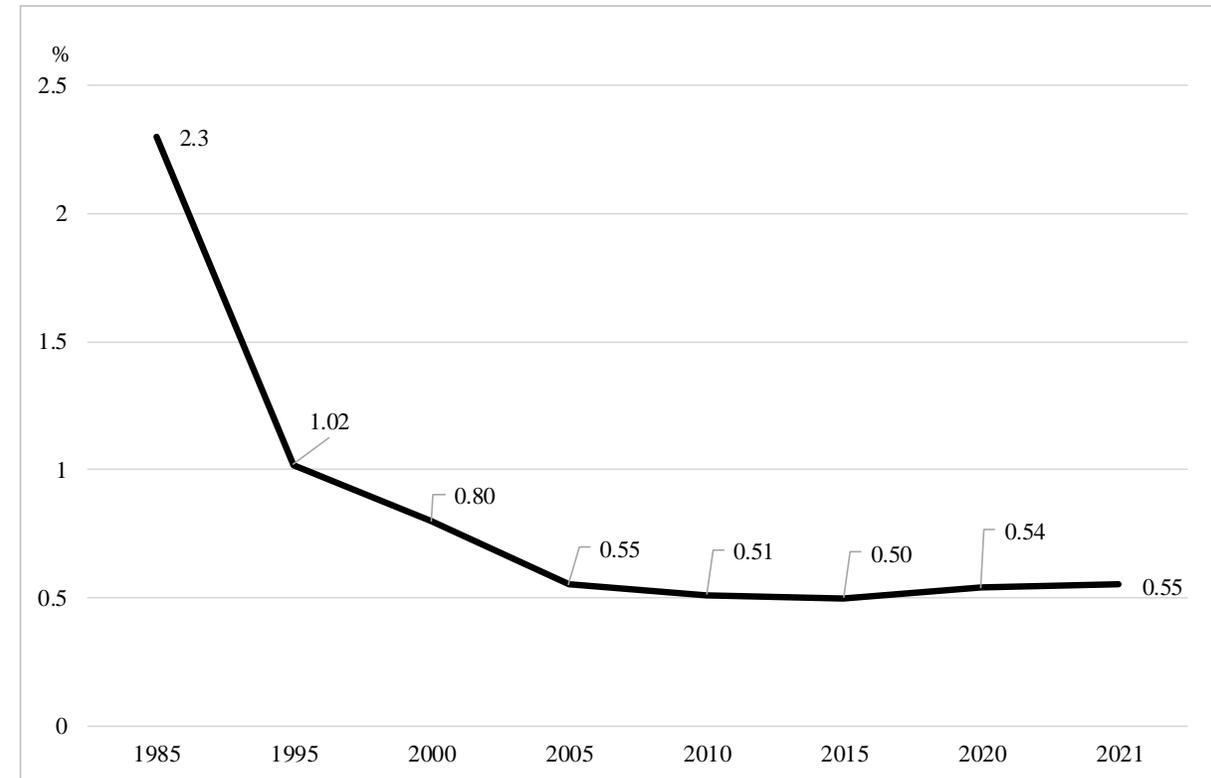
Millet Cultivation in China

Figure 1. Cultivation area, yield, and production of foxtail millet in China, 1949–2014.



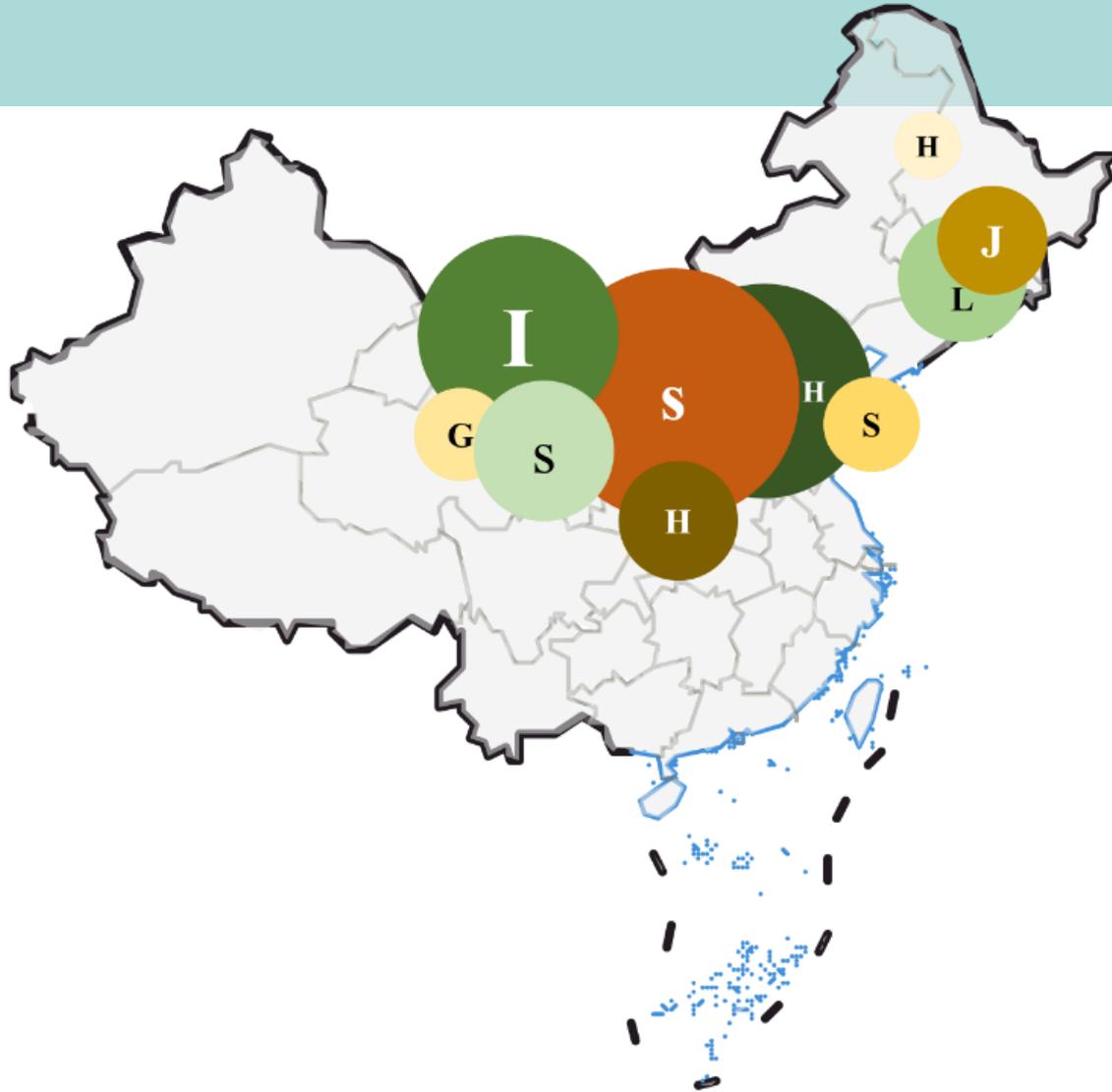
Note: This figure is provided at ‘Production and genetic improvement of minor cereals in China’ (Diao 2017, 105).

Figure 2. The proportion of millet cultivation in China’s overall crop cultivation.



Note: This figure was created by the author using data collected from ‘Spatiotemporal variation and regional advantages of foxtail millet production in recent 30 years in China’ (J. Liu et al. 2019) and China Statistical Yearbook 2022. <http://www.stats.gov.cn/sj/ndsj/2022/indexeh.htm>.

Millet Cultivation in China



Provinces	Growing area (million mu)
Heilongjiang	0.15
Gansu	0.18
Shandong	0.27
Jilin	0.53
Henan	0.54
Shaanxi	0.94
Liaoning	0.95
Inner Mongolia	2.06
Hebei	2.47
Shanxi	3.09

Note: Capital letters in coloured circle correspond to the initial letters of the provinces. Adapted by the author from the map provided at the following link: <https://db.cngb.org/millet/milletknowledge>

Map 1. Top 10 largest provinces by millet cultivation area in China (2012).

Map 2. Field sites.



Field Sites

Aohan

- Centre of origin of foxtail millet.
- Globally Important Agricultural Heritage Systems (GIAHS), 2012, FAO.



Picture 3. Carbonised millet grains.

Note: These grains were discovered in Xinglonggou, now on display at the Foxtail Museum of China. Picture by the author.

Picture 4. An aerial map of Henggouzi village, Aohan. Credited to Qiubi.



Aohan

Population: 448,712
Households: 170,998
Total area: 8,294 km²
Arable land: 3.8 million mu
Arable land per capita: 8.47 mu
(nationwide: 1.36 mu)

The national seventh population census (conducted between 1st November and 10th December 2020).

Picture 5. Millet cultivation in Aohan. Picture by the author.





Map 3. A map of Hainan Province, China.

Note: The author shaded the areas in green to highlight the main breeding sites in Hainan Province. Adapted from the map provided at the following link: <https://www.travelchinaguide.com/images/map/hainan/hainan.gif>.

Southern seed breeding

(also known as *Nanfan* [南繁] in Chinese)

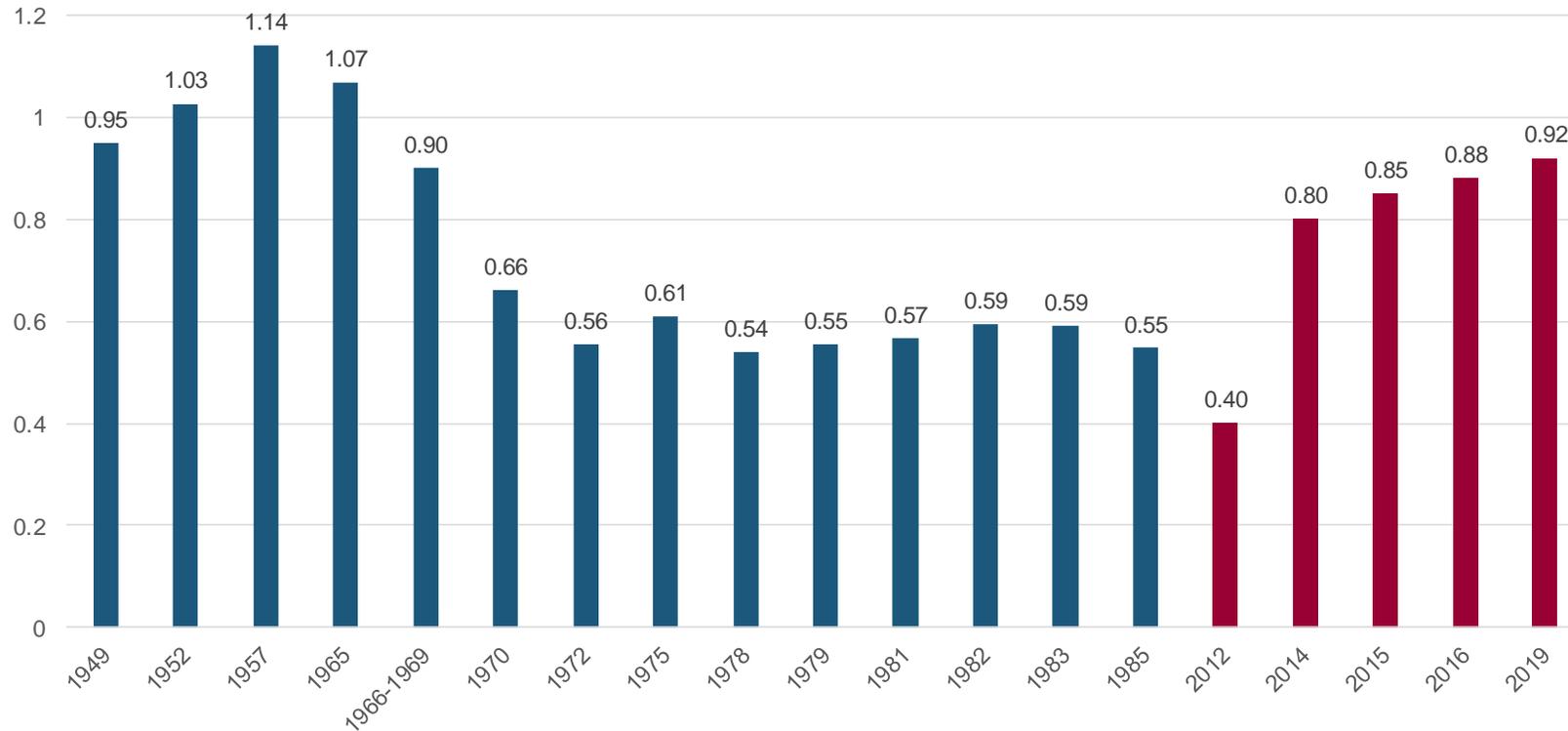
- Tropical climate: a distinct rainy season from June to October, followed by a dry season from November to the next May.
- The primary areas for southern seed cultivation in Hainan include places such as Lingshui Li Autonomous County, Sanya City, and Ledong Li Autonomous County, all situated along the 18-degree north latitude from east to west (Map 3).

Picture 6. Nanbin Farm in Sanya City. Picture by the author.



Millet Cultivation in Aohan

Figure 3. The area planted with millet in Aohan (million mu).



In the past decade:

- The millet average unit yields have doubled (from about 200kg to about 400kg).
- The millet growing area has doubled (Figure 3).

Note: Mu (Chinese: 亩), Chinese unit of land measurement. One mu equals to about 667 square meters.

Source: General History of Aohan Banner (1991), Conservation and Development Practices in Aohan Dryland Farming System of Inner Mongolia Autonomous Region (2020), news and reports from Aohan's government portal website.

The Drivers of Expansion



- *Guidelines on the Structural Adjustment of Maize in the Sickle-like Curve (2015)*

‘...by 2020, the area of maize cultivation in the Sickle-like Curve region should be reduced (by more than 50) to 100 million mu’ .

- *Circulation of Rural Land (2003)*

land transfers; individuals or companies are empowered to acquire extensive and centralised land for production.

Map 4. The Sickle-like Curves in China

Note: Adapted by the author from the map provided at the following link:
<https://m.news.cntv.cn/2016/04/11/ARTINdku8KoLjQ9I5QRwyMLF160411.shtml>.

The Drivers of Expansion



The screenshot shows the FAO GIAHS website interface. At the top left, there are logos for the Food and Agriculture Organization of the United Nations and the Globally Important Agricultural Heritage Systems. The main heading reads "GIAHS Globally Important Agricultural Heritage Systems". A navigation menu includes "Background", "Become a GIAHS", "GIAHS around the world", "News", and "Resources". The current page is titled "Aohan Dryland Farming System, China" under the "Regions" section. A small note indicates "GIAHS since 2012". The background features a stylized map of China with green and yellow regions.

- **Ecological
Civilisation**

- **GIAHS**

Source: <https://www.fao.org/giahs/giahsaroundtheworld/designated-sites/asia-and-the-pacific/aohan-dryland-farming-system/en/>

‘we now use more fertiliser and pesticide, **better seeds** than we used to, notably the invention of herbicide-resistant varieties and the usage of mulch, [and] therefore the yields and growing area expand.’

Research Question

- How do breeders design seeds to meet the needs of millet industry expansion as well as capital accumulation and profits?
- How do breeders wield biopower to control and manipulate breeding practices?

Weed Management

- Traditional long-term methods of weed management are too slow from the perspective of the productivist treadmill (Ward 1993).
- Faith in industry, such as the ‘centralisation of production, standardised mass commodities, and mechanisation’ (Scott 1998, 197), has become an agricultural principle.



Picture 7. A man-powered weeding tool.

Note: Peasants use this tool to remove millet seedlings and weeds that grow outside rows. However, for those growing in rows, peasants need thin out seedlings and weed by hand. Picture by the author.

Herbicide-resistant Millets

Table 3. Changes of varieties in Zhasaiyingzi village.

Phase	Main Landrace Planted	Main Cultivar Planted
Late 1950s - early 1980s	Xiaobaimi (Tuzizuixiaobaimi), Zhushagu, Dabaigu.	
Late 1980s - early 2000s		Zhaogu 1, Chigu 4, Chigu 5, Chigu 8.
Late 2000s	Huangjinmiao, Maomaogu.	Shanxi Red Millet.
2010s	Huangjinmiao, Maomaogu.	
2019-2021	Huangjinmiao, Maomaogu.	Jinmiao K1 (herbicide-resistant).

Source: The data was collected during fieldwork. Table and picture (right) by the author.



Picture 8. Jinmiao K1.

Herbicide-resistant Millets



Picture 9. A bag of Aogu 8000 seeds (herbicide-resistant variety).

Picture by the author.

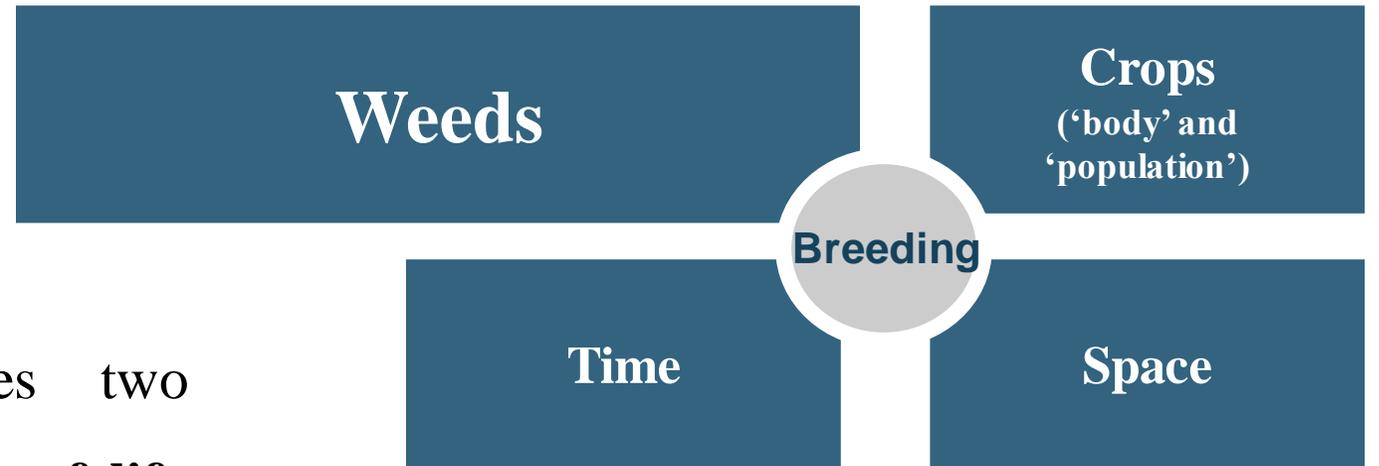
Aogu 8000 has a very strong capacity for adaptation to the environment in Aohan, which yields higher when it is grown in fertile and flat land. For the price of 100 RMB, you can purchase a bag of seeds of *Aogu 8000* (400g) and a bottle of herbicide sufficient for cultivating two mu of land. If you choose a regular variety, you need to hire someone to manually weed, incurring a cost of about 150-200 RMB per day.

The price of seeds for regular varieties, such as *Changmaogu* and *Dajinmiao*, is only 15 to 20 RMB per bag (400g).

Aogu 8000: 50 RMB/mu
Regular varieties: 150-600 RMB/mu

The Governance of Life

- Weeds, waste of soil nutrition; weeding, a waste of human labour.
- Disciplining agriculture encompasses two political dimensions: **the classification of life** (e.g., unproductive for capital accumulation) and the subsequent utilisation of **different methods to control lives** based on their designated categories.



Space, time, and the bodies of seeds and plants, as well as the process of reproduction, become the focal points of precise governance and regulation for maximising investment returns.

The Introduction of Herbicide-resistant Gene

Hybridisation

- Herbicide-resistant genes were discovered in wild green foxtail populations;
- The creation of herbicide-resistant breeding materials: non-genetically modified distant hybridisation methods, 1993 & 2006;
- The first herbicide-resistant hybrid, *Zhangzagu 3*, 2005;
- The first herbicide-resistant variety grown in Aohan, *Jinmiao K1*, 2019;
- Hybridisation \neq hybrids

Hybridisation



Picture 10. The structure of a millet plant.

From left to right: foxtail millet plant (a), ear (b), spikelet (c), and flower (d). The author has adapted the images from the work of W. Zhang et al. (2021).



Picture 11. The blossoming of tiny white foxtail millet flowers.

Picture by the author.

Hybridisation

- ‘Accumulation by molecularisation’ (Nally 2011)
- Cells/Molecules: Mendel’s laws of heredity;
- Single flower;
- Individual plant (‘body’);
- Breeding materials (‘population’);

- Blossom periods;
- Southern seed breeding (*Nanfan* [南繁]).



Picture 12. Hybrid combinations that have borne fruits.

Southern Seed Breeding



Picture 13. Breeding field in Sanya.

Note: The spatial partitioning of varieties (breeding materials) is clearly visible. The white rectangular standing plaque has the variety number written on it.

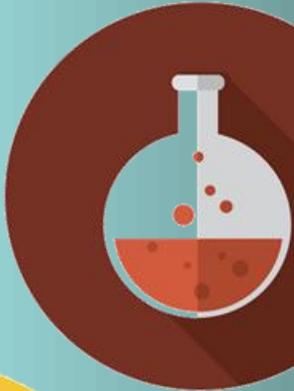
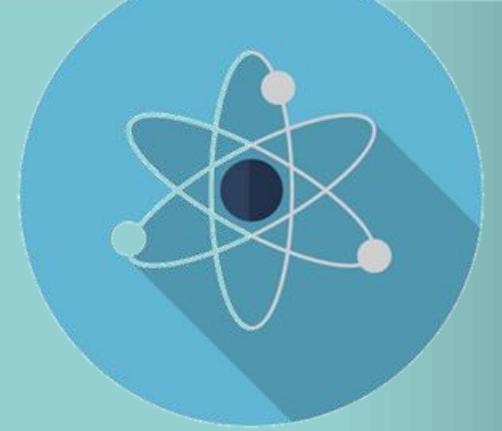
Picture by the author.

- December to (the next) May;
- accelerating breeding turnover time;
- *Nanfan* dismantles the barriers of vegetal temporalities to ‘the industrial capitalist time-space regime’ (Lawrence 2022, 631), which enables capital to break free from the constraints of time and space and circumvent the ‘limits to growth’ (Meadows, Randers, and Meadows 2004).

Conclusion

- New efforts to administer life: optimising and intensifying the life force (productive capacity) of the entire plant via breeding technologies.
- The reductionist nature of modern breeding: these practices dismantle the parent plant as a whole, anatomising the plant and reducing the organism to distinct ‘traits’.
- The biological barriers to capital accumulation have been eroded through the adoption of hybridisation.
- Crop bodies metamorphose into factories that generate economic value for seed companies, highlighting the complex interplay between biopower and plant breeding techniques for economic benefits.

Thank You!



This project is funded by:

Department of Geography, University of Cambridge - University Fieldwork Fund

Gonville and Caius College, University of Cambridge - Graduate Travel and Research Expense

The Henry Lester Trust

Great Britain-China Educational Trust - Chinese Students Award

Cambridge Political Economy Society Trust - Supplementary Funding

Thanks for the friendship and support from all participants in Aohan, Hainan, and Farmers' Seed Networks.