AGRICULTURE MANAGEMENT: HISTORIC, GEOGRAPHIC AND SOCIAL PERSPECTIVES

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Summary

When human beings recognized that hunting and gathering were fragile and unstable ways to obtain the food and other fundamental materials for their life, they began to try to domesticate wild plants and animals. Crop plants were each domesticated in a specific region—rice was domesticated in southern China and wheat in the Near East—and they spread to surrounding areas, forming a regional civilization basing on the specific crops. Around 10,000 years ago, the domestication of major livestock animals—sheep, goats and cattle—was also initiated. For a long period through the Medieval era, region-specific crops were cultivated with traditional practices which were inherited without evident technical innovation. However, with rapid growth of population in the late Medieval, technical innovation began in agriculture. The first innovation took place in the development of new cropping systems. The two course rotation system which had been practiced in Europe through the Medieval period after the Roman era, was developed to the three course rotation system, and later the improved three course rotation, or ley farming system.

In the modern era, with enormous and increasing population growth since the Industrial Revolution at the end of eighteenth century, agriculture progressed into the age of science. The sciences of plant nutrition and genetics, in particular, contributed greatly to improvement of agricultural productivity. Development of irrigation system,

exploitation of new agricultural machines and introduction of new agricultural practices for soil management and pest control, contributed to the remarkable increase of agricultural production. Establishment of research institutes and universities strongly supported the progress of agricultural research and education.In the twentieth century, particularly after the World War II, the world's population increase became very serious, particularly in the developing countries. Fortunately, to date, humanity has succeeded in avoiding worldwide hunger by igniting a peaceful agricultural revolution in wheat and rice―this is called the Green Revolution. The basic concept of the Green Revolution, and of modern agriculture in general, was "high input―high return". The principle was that farmers should obtain a high yield of crops with high input of materials, such as chemical fertilizer, agricultural chemicals and water for irrigation. The ultimate result of this concept was environmental pollution and shortage of natural resources. Today, the policy for agricultural production is shifting from "High input―high return" to "Low input sustainable agriculture (LISA)".

Human beings have successfully become armed with a powerful weapon―biotechnology ―to solve the problems of agriculture. Commercial cultivation of genetically modified crop varieties was widely initiated in the mid 1990s in cotton, maize, soybean and rapeseed. Worldwide, by 2000, more than 50 million hectares had been planted with transgenic crop varieties, mostly in USA. There are many difficulties for agriculture in the future, such as how to secure food production under global warming and climate change, how to perform sustainable agriculture with high productivity, how to efficiently manage primary crop production between cereals and animal feed.

1. Introduction—Domestication of Wild Plants and Animals

Food supply in the Paleolithic Age: As overviewed in *The Management of Natural Resources in Satisfying the Needs of Human Life*, hunting of animals and gathering of plants were two basic ways of obtaining food throughout the Paleolithic (Old Stone) Age. Jack Harlan has investigated the food source of the San, an African indigenous race who, even today, obtain their food from hunting and gathering, estimating that 60-70% of their food is from wild plants, and the remaining 30-40% from wild animals. He also reported that the native people of North America have about 1100 species, and Australian aborigines about 500 species of wild plants that they can utilize for food, beverage and medicines. These figures might indicate that the survival of human beings has been dependent on the large number of species of wild plants and animals that could be used through the era of hunting and gathering.

Domestication of the plants: After a long era of hunting and gathering through human history, people recognized that hunting and gathering were fragile and unstable ways of obtaining food, and they began to domesticate wild plants and animals. In the process of domestication many plant traits were changed, such as:

1. Increase of the parts of a plant with higher nutritional value and better taste; the most important trait of domesticated plants is high yielding performance with high nutritional value and good taste. Cereal and pulse crops bearing a large number of grains were selected in their domestication process, resulting in a

high yielding and good quality plant population. Even after domestication, this continued to be the most important trait in individual selection by farmers and breeders.

2. Reduced grain shattering; Wild plants are endowed with the feature of efficient spread of seeds; this is an essential trait in wild plants, which survive and maintain the species by dispersal of seeds as widely as possible. Domesticated plants, on the other hand, need no shattering trait as a survival mechanism. Along with loss of the shattering habit, awns and strong hairs on the grains of some cereals, which are useful for establishment of fallen seeds, also disappeared.

3. Reduction of dormancy. Wild plants have the habit of strong dormancy which allows the seeds to survive in unfavorable environments such as low temperature and drought. However, in domesticated plants, seeds are sown by human beings in the most favorable season for germination and growth, so that strong dormancy became unnecessary in domesticated plants.

4. Uniformity of timing of flowering and grain ripening; Uniformity of flowering and grain ripening is an essential trait of domesticated plants, increasing the efficiency of the harvest.

5. Change from perennial to annual. Perennial plants cannot be grown in regions where the winter is too cold for the growth of plants. Furthermore, perennial plants are generally low yielding due to aging of the plants. For these reasons, in the domestication of wild plants, a change from perennial to annual life form took place, and cultivated plants were spread to cooler climatic regions.

The domestication of each crop species followed its own geographic path. A Russian botanist N.I. Vavilov (1887-1943) explored various parts of the world to investigate the extent of variation of morphological and physiological traits within each crop species. After precise analysis, he reached the conclusion that the region holding the largest variation of a certain trait within a crop species is the place of origin of the crop. He presented eight regions as the original sites of various crop species (see Table 1).

Region	**Crop**	**Scientific name**
1. Northern China;	Common millet	Panicum miliaceum L
	Barnyard millet	Echinochloa frumeetacea Link
	Soybean	*Glycine max* (L.) Merr.
	Adzuki bean	Vigna angularis
	Chinese cabbage	*Brassica campestrzs* (L) (pekinensis group)
	Pears	*Pyrus* spp.
	Chestnuts	Castanea spp.
	Apricot	*Prunus. armetsiaca* L.
	Persimmons	*Diospyros* spp.
	Ginseng	*Panax ginseng* C.A.Mey
	Japanese lacquer tree	*Rhus verniciflua* Stokes
2. Southern China – Southeast Asia – Northern	Rice	*Oryza sativa* L.
	Buckwheat	*Fagopyrum esculentum* Moench

India	Eggplant	*Solanum melongena* L.
	Yam	(*Dioscorea* spp.)
	Hemp	Cannabis sativa L.
	Ginger	*Zingiber officinale* Rosc.
	Jute	*Corchorus capsularis* L.
	Pepper	*Piper nigrum* L.
	Tea	*Camellia sinensis* (L.) O.Kuntze
	Indigo tree	*Indigofera tinctoria* L.
	Orange	*Citrus* spp. (aurantium)
	Citron	*Citrus medica* L.
3. Central Asia	Broad bean	*Vicia faba* L.
	Chick pea	*Cicer arietinum* L.
	Lentil	*Lens culinaris* Medik
	Leaf mustard	*Brassica juncea* (L.) Czern. et Coss
	Flax	*Linum usitatissimum* L.
	Cotton	*Gossypium spp.*
	Onion	*Allium cepa* L.
	Garlic	*Allium sativum* L.
	Spinach	*Spinacia oleracea* L.
	Radish	*Raphanus sativus* L.
	Pistachio	*Pistacia vera* L.
	Almond	*Prunus amygdalus* Batsch
	Peach (common)	*Prupzus persica* Batsch var. vulgaris Maxim.
	Grapes	*Vitis spp*
4. The Near East	Wheat	*Triticum aestivum* L.
	Barley	*Hordeum vulgare* L.
	Rye	*Secale cereale* L.
	Oats	*Avena sativa* L.
	Alfalfa	*Medicago sativa* L.
	Melon	*Cucumis melo* L.
	Carrot	*Daucus carota* L.
	Lettuce	*Lactuca sativa* L.
	Fig	*Ficus carica* L.
	Apple	*Malus spp.*
	Safflower	*Carthamus tinctorius* L.
	Cherry	*Prunus avium* L.
	Date palm	*Phoenix dactylifera* L.
5. Mediterranean	Pea	*Pisum sativum* L.
	Rape	*Brassica napus* L.
	Cabbage	*Brassica oleracea* L.
	Turnip	*Brassica campestris* L.
	Sugarbeets	*Beta vulgaris* L.
	Asparagus	
	Pacelli	
	Celerie	
	Laurel	*Laurus nobilis* L.
	Hop	*Humulus lupulus* L.
	Olive	*Olea europaea* L.
	White clover	*Trifolium repens* L.
6. West Africa and Abyssinia	Teff	*Eragrostis abyssinica* (Jacq.) Link
	Sorghum	*Sorghum bicolor* (L.) Moench
	Pearl millet	*Pennisetum americanum* (L.) K.Schum
	Coffee	*Coffea* spp.

	Okura	*Abelmoschus esculentus* (L.) Moench
	Watermelon	*Citrullus lanatus* (Thunb.)Matsum. et nakai
	Oil palm	*Elaeis guineensis* Jacq.
	Sesame	*Sesamum indicum* L.
	Finger millet	*Eleusine coracana* (L.) Gaertn
7. Central America	Maize	*Zea mays* L.
	Sweet potato	*Ipomoea batatas* Lam.
	Common bean	*Phaseolus vulgaris* L.
	Pumpkin	*Cucurbita maxima* Duch.
	Cotton	*Gossypium* spp.
	Cacao	*Theobroma cacao* L.
	Papaya	*Carica papaya* L.
	Avocado	*Persea americana* Mill.
	Cashew nut	*Anacardium occidentale* L.
8. South America	Potato	*Solanum tuberosum* L.
	Tobacco	*Nicotiana tabacum* L.
	Tomato	*Lycopersicon esculentum* Mill.
	Chili	*Capsicum annuum* L.
	Groundnut	*Arachys hypogaea* L.
	Strawberry	*Fragaria x ananassa* Duch.
	Pineapple	*Ananas comosus* Merr.
	Cassava	*Manihot esculenta* Crantz
	Para rubber	*Hevea brasiliensis* (HBK) Mull.-Arg

Table 1. Origin of crop plants

The number of crop plants which have been cultivated in the whole history of agriculture, is predicted to reach about 2300. About 900 of these are food or edible crops, about 1000 are industrial crops and the remaining 400 or so are forage and manure crops. Most of the crop plants were domesticated in the early stage of agricultural history, but some of them were domesticated just a few centuries ago.

Domestication of wild animals: It is believed that the domestication of major livestock animals—sheep, goats and cattle—was initiated around 10 000 years ago when agriculture started. The domestication of other important grazing animals, such as buffaloes, horses, asses and camels, is considered to date back to only about 5000 years ago. Since then, domesticated animals have played a very important role in the lives of human beings. They provided them with various basic matters for their life, such as meat and milk for food, skin and wool for clothes, urine and feces for the fertilizer or fuel, and physical power for draft and packing. They functioned as a tool for family savings and economic security in the failure of crop production due to natural calamities. They have also played other roles in human culture—for exhibitions and shows, religion and ceremony, fighting and racing, pets and recreation, etc.

Initiation of agriculture: Agriculture with domesticated plants and livestock is supposed to have started about 10 000 years ago. We might say that a time span of 10 000 years is very short, just 2% of the time since the appearance of our oldest hominid ancestors. The remaining 98% of human history was the era of hunting and gathering.

Crop plants domesticated in a certain specific region, spread to surrounding areas, and became traditional crops adapted to local environmental and social conditions. The traditional crops were cultivated through the Medieval era for a long period without remarkable innovation of technology, and crop yield is supposed to have stayed at a low level.

The world population is believed to have been only 50 million around 2000 BC. It increased gradually through the Roman era and Medieval age, attaining approximately 500 million around 1500 AD. If the annual rate of population increase during these 3500 years is calculated, it is only 130 000 per year (see Figure1). The population growth was so low that there was no great need for technical innovation, and human beings could cope with population growth just by development of new arable land—by hewing the forest.

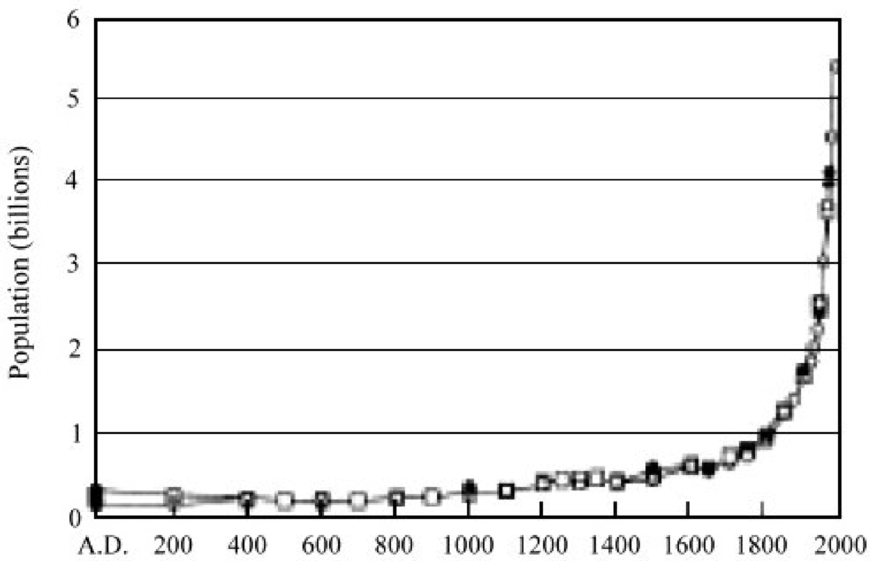

Figure 1. Trend of population increase in the past 2000 years
Source: L.T. Evans, 1998.

In *Food Crop Production*, progress of agriculture will be reviewed historically, particularly after the Medieval era when racing of population growth and food production began to markedly increase.

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Biographical sketch

Ryuichi Ishii was born in 1940 in Beijing, China, with Japanese nationality. After he graduated from the Department of Agricultural Biology of The University of Tokyo, he started his scientific career as a Research Assistant in the Laboratory of Crop Science of The University of Tokyo. He was promoted to Associate Professor in 1979, and Professor in 1987. His research interest was the relationship between photosynthesis and yield in various crop plant species. He retired from The University of Tokyo in 2001, and now is working in Nihon University as a professor of crop science. He has served as President of the Crop Science Society of Japan, and in 2000 he was appointed as a member of the Science Council of Japan.