Livestock in South-Eastern China

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Abstract

This paper describes the five important roles of the pig in a Chinese household, first as a garbage disposal plant to eat everything that humans do not want. Its wastes make it a power station providing biogas energy which can be converted into electricity, and then a fertilizer factory to supply nutrients to both water for polyculture of fish and macrophytes, and soil for multicropping of grains, vegetables, fruits and flowers. It also contributes to a feed mill, as the crop and processing residues are used as livestock feeds, and is finally a meat producing plant. These 5 useful functions make the pig a very special part in the life style of Chinese rural society, as it recycles all its wastes and residues most effectively and efficiently while contributing to its economic and social development in a sustainable manner. Following the same economic, ecologic and social principles, the integrated farming system has evolved, enhancing the farming and agroindustrial activities of every farm family to meet the needs of a modern society by providing the renewable means of production such as energy, fertilizers and livestock feeds.

KEY WORDS: Integrated farming system, China, pig, livestock, recycling, feed

Introduction

This paper deals with livestock production, using crop and processing residues from integrated farming systems as feeds, in the southern part of Pearl River delta, province of Guangdong in South-Eastern China, which lies in the subtropics with year-round agricultural production

where water is made available in polyculture fish ponds that have been in operation for many centuries. It covers 800 km2 of low-lying land and, before the modernization craze, had a population of 1,2 million people who were the most productive farmers in China, and probably the whole world, based on productivity per unit surface and human or artificial energy input, because of its most efficient waste recycling processes in an integrated livestock-fish-plant system.

Land Tenure

In the past, the whole region was divided into big properties owned by warlords or mandarins, and every property was sub-divided into small family farms on a share-cropping basis. The land tenure system did not change much despite changes in land ownership, private or state -- even during the Commune era, the family farm became the production unit and the village became the production brigade. But the farming system underwent dramatic changes, depending on the ingenuity of the farmers to make the most of their small plot of land and water, not only for survival but also to cope with the increasing population.

Farming System

Until the recent past, the usual livestock was 2-3 pigs per family behind the residence, raised not so much for meat production but as scavengers to eat anything that humans did not eat. They usually provided the meat for various festivals for families which were close relatives. Their wastes were taken daily to the field and used as raw fertilizers for the fish ponds to produce various plankton as fish feeds, and the only supplement was fast growing elephant grass grown on the edges of the ponds to feed the grass carp or other herbivorous fish.

The human faeces were retained in brick-lined pits in the courtyard and taken regularly in covered containers to the field and composted with coarser crop residues before being used to condition the plant beds -- the less coarse ones were used to supplement the pig feed. The human urine was always separated in a covered fired-clay jar used by males, and the females used chamber pots which were then emptied into the same jar. The fermented urine was used as fertilizer for vegetables which

represented 80-90% of the human diet. The rest was provided by fish, duck eggs and bean or bean products. Ducks, also scavengers, were reserved for visitors or as festival fare.

No external input was provided for the livestock, fish or plants. Any surplus produce from the farm was preserved by the farm family without any input from outside, and nothing was burnt or thrown away. In fact, the whole life style was based on cycles and recycles.

Agro-industry

The most important export items, besides food and drink products which included sauces, pastes and other condiments, were silk and silk products. Mulberry bushes grown on half the dykes provided the leaves to feed the silkworms, and the silkworm excreta and feed residues were used to fertilize the fish ponds or feed the fish. The nutrient-rich pond water was used to irrigate and fertilize the mulberry bushes and other crops which occupied the other half of the dyke, and the pond mud was removed once a year, after harvesting the fish, to enrich the soil on the dykes.

Fish residues were also used to supplement the pig diet. Surplus fish was salted, then dried or canned, as export items. Surplus pork and ducks are marinated in soya sauce and air dried, and then exported in jars and later on in cans. Surplus duck eggs were salted or covered with clay and rice straw for preservation, and exported. Most crop residues, which could not be used as livestock feeds, were used for culture of mushrooms which were dried and exported, with the residues then used as feed or compost.

All these preservation and value-added activities were done at family farm level, and provided employment for all members of the family which became well-off by any standards. As a matter of fact, the productivity in that part of Guangdong province was so enormous that even if the whole of China was closed to the outside world for nearly 3 decades, this province was allowed to hold two Canton Fairs yearly, each lasting one whole month, to trade with visitors from various parts of the world. There was never any interruption, and they are still being held now.

When China opened up to the outside world in the early eighties, such strategies allowed many families to become the first 10,000 yuan

farmers, when the salary of a university professor were less that 2,000 yuan yearly. After the recent agro-chemical invasion of Chinese agriculture in many coastal provinces, such strategies are proving useful again ...

Modern Farming

Such a philosophy has not changed much even with modernization, despite the special economic zones with foreign investments and technologies, and the agro-chemical invasion of Chinese agriculture in recent years. It is true that much harm has been done to the environment by the new industries and the increase in chemical fertilizer and fossil fuel uses, especially coal, but the Government has reacted effectively because of the solid farming foundations based on such a philosophy.

As the farmers became better-off, they increased the size of their livestock, with the pens built on the dykes next to the fish pond. In 1985, 3,000 hectares of integrated farms were added in 3 regions of the province, with bigger ponds and more livestock. Some additional feeds were used but they were limited to corn, peanut and soya cakes after oil extraction, and created some pollution due to non-consumed feed residues. However, it was the livestock wastes which became a limiting factor for the ponds because of oxygen consumption by the organic content of the increased raw wastes.

That was when I became a volunteer at the Academy of Sciences in Guangdong province, and I advocated the use of digester and shallow basins to pretreat the livestock wastes not only to solve this oxygen problem but also to increase substantially the number of livestock in the system for economic benefits, which I have been doing since 1969 at the South Pacific Commission in New Caledonia, and later on at United Nations ESCAP in Thailand. It took us nearly 4 years to put together an Integrated Farming proposal for consideration by DANIDA, but the Tiananmen incident shelved it, and I left China to continue my work in Vietnam and other places until the United Nations University came up with the ZERI programme, and I was the only one they could find to implement it.

Integrated Farming System

If we are trying to help the poorest of the poor farmers in the third world, with limited land and monetary resources, there is no way they can grow fodder to feed their livestock, and they have to depend on residues from their food and raw material crops for local utilisation first, with any surplus for export. All available crop and processing residues, with simple physical processing and requiring no complex equipment or microbial processing taking advantage of the warm climatic conditions, should be used as livestock feeds. If required, they can be enhanced with solar and/or biogas energy produced on site. Use of fossil and other imported fuels can never be economic, and are NOT used as a recurrent input.

Only an integrated system of livestock, fish and crop with the wastes and residues of ALL three operations being used as feeds for livestock and fish, and as fertilizers for fish and crop cultures, can be viable economically, ecologically and socially -- see Annex I. All the processes involved can remain biotechnological, using simple locally-built structures and no external input , as the system produces the essential means of production such as feeds for livestock and fish production, fertilizers for fish and crop culture, and energy for domestic and farm uses. As the farming activities increase, keeping the same economic and ecologic principles, the integrated farm will become totally self-sufficient in feeds, fertilizers and energy for an agro-industrial complex which can become a prosperous enterprise.

A thorough analysis of all the processes involved will convince any biotechnologist that such achievements are feasible, as shown below. The most surprising feature is that they work best in the wet tropics, where water is available year-round, and marginal lands such as marshes are the best and cheapest sites for integrated farming systems.

Processes Involved

1. *Digestion* of livestock wastes up to 60% reduction in biochemical oxygen demand (BOD) in a digester which can be a simple plastic bag or a self-built brick tank with a domed roof that is made airtight with liquid barriers, while producing biogas fuel.

China is the most advanced country with digester technologies, with sizes ranging from 5 to 2,000 cubic metres, supplying cooking gas to millions of households and meeting the energy needs of huge farms or agroindustries. The biggest power station run on biogas has a capacity of 1.5 Megawatt.

2. *Oxidation* of digested effluent for a further BOD reduction of 30%, or of washwater, with algal growth in shallow basins to produce the needed oxygen naturally. The algae can also be produced, using solar or wind energy to move the liquid, for sale to manufacturers of health foods or cosmetic products. The effectiveness and efficiency of oxidation can also be enhanced in deeper ponds with contact oxidation media, resulting in substantial reduction of the space required. Some cheaper versions of oxidation consist of earth channels, where various kinds of macrophytes are grown as livestock feeds while producing oxygen, to partially treat raw livestock wastes before they flow into fish ponds.

China and other countries such as Cuba and Mexico produce algae for commercial purposes, with or without livestock waste treatment.

3. *Polishing* of the 90% treated effluent by dilution and aeration after it enters the deep fish ponds for polyculture of various kinds of fish feeding at different trophic levels. Such ponds are clean with prolific growth of various plankton in the water, and grass on the edges of the pond, to feed ALL the fish, which are not under stress even if the yield is very high compared with other forms of aquaculture worldwide, using artificial feeds.

Unfortunately, in most places of China, raw livestock wastes are used to fertilize polyculture fish ponds, but things are changing as more digesters are introduced.

4. *Aquaponic* culture of cereals, fruits and flowers on the edges of the pond and on half the pond surface using bamboo or plastic floats, with nylon netting below to protect the roots, to control eutrophication caused by excess nutrients from the bigger size of the livestock, without interfering with the fish polyculture.

For China, the economic implication is enormous when it is considered that there is twice as much water surface than land in an integrated farm. This breakthrough is also very meaningful from the environmental point of view, as China is losing more and more land to industry, urbanisation and highway communication -- half the huge water surface from the multitude of fish ponds, reservoirs and lakes are now available for food culture!

5. *Macrophyte* culture of useful chlorella, spirulina, azolla, lemna, pistia and even water hyacinth as livestock feed in shallow channels which distribute the nutrient-rich pond water to the fields for irrigation. The macrophytes are first used as substrate to grow mushroom to break down the ligno-cellulose and make the residue more digestible and even more palatable for the livestock, which eat more to grow faster and produce better wastes for the system.

This important strategy, which also uses all the available crop and processing residues, is widely practised in China, which produces over 50% of the world's mushroom output, using simple structures and methods in the backyards of most farmers in the south.

6. *Aeroponic & Multicropping* cultures of various vegetables and fruits on the dykes using the pond water to irrigate and fertilize them, have enabled farmers to increase food production without the use of chemical fertilizers or pesticides for centuries. It is certainly a much acceptable and more practical way of using livestock wastes to fertilize crops, instead of the big mess created and intensive labour required to handle organic wastes around the world.

China has increased its use of agrochemicals from practically nothing to 21.5 million tons in 1994, and is determined to reverse this disastrous situation with the new Chinese Ecological Agriculture (CEA) programme, implemented in ALL provinces. I cannot see the newly affluent farmers replacing the convenience of purchased fertilizers or pesticides with the messy handling of organic wastes as they did in the past. So the only solution to the chemical problem is for China to adopt the integrated farming system, which is only receiving lip service at the

moment in most places.

7. *Processing* of produce for preservation and/or value added is the best way to prevent spoilage of valuable foods, and the simple processes at village level are well known, especially in Asia, without using complex processes and fossil-fuel operating equipment. In modern times, much bigger agroindustrial factories are required, but still maintaining the same economic and ecological principles.

China has demonstrated a few outstanding examples of stand-alone farms and factories which produce their own energy and fertilizers for big agro-industrial enterprises, with the crop and processing wastes used as livestock feeds, with and without further physical and/or microbial processing. The government should make such practices mandatory for all enterprises.

8. *Marketing* of produce and goods in some parts of Asia is quite impressive even in the rural areas where vegetables and meat are sold fresh, and fish and poultry are sold live. The government has a very important role to play by providing facilities for the farmers to sell their surplus crops at a fixed price to government stations, where the crops are processed for local and export trade.

China has such "import and export corporations" which are beneficial to the farmers, who are certain of a fixed price for any produce they cannot sell on the local market, and for the government which is assured of having the surplus crops for processing and export to maintain a healthy balance of payments for many decades.

Some concrete examples can be supplied to participants on request.

Annex I: Goals of Integrated Farming Systems

The goals of integrating livestock, fish and crop are described as follows:

1. Economic

The universally known problems of commercial farming in the developing world are the prohibitive costs of external inputs, such as feed for livestock and fish, fertilizer for crops, and energy for processing, while most wastes and residues are left to pollute and even degrade the environment when they should be recycled as useful resources. These problems are compounded with imported technologies which are inappropriate, costly and inefficient due to the wrong systems used and which do not take full advantage of local climatic and environmental conditions to make the processes more effective and less costly.

The Integrated Farming System demonstrates that the only way for commercial farming to be viable economically is to recycle all wastes and residues as means of production for maximum productivity at lowest costs. There is no other way for most developing countries without fossil fuel, mineral and other mining resources. They should capitalize on their sunny and hot climate for optimum microbial processes for recycling all their wastes and residues as fuel, fertilizer and feed to produce food, fibre and raw materials for economic development.

2. Ecological

For centuries, most developing countries have followed ecological principles for subsistence and self-sufficiency from their lush forests and rich aquatic life. The same principles can be used to meet the requirements of a modern society, instead of adopting systems that have been designed for other climatic and environmental conditions, requiring imported and costly input such as fossil fuels, agrochemicals and complex equipment, and can never be economic in most of the third world.

Some developing countries were even forced to accept polluting industries to locate in their poor communities to provide lowly paid jobs, without any provision for environmental pollution control or even workers' safety. There are enough horrible examples in some countries to

make the concerned leaders stop such disastrous development strategies, and adopt more appropriate systems.

The Integrated Farming System shows that modern scientific knowledge and technological innovations can improve all the farming and agro-industrial processes involved without upsetting the ecological equilibrium, and provides a new concept of development that can prevent environmental degradation while benefiting both investors and communities concerned, with production of foods and renewable raw materials first.

3. Social

Past development in the third world depended heavily on the strategies of the administrative powers, which used the land, people and natural resources to meet the material and industrial needs of the metropolitan nations. This development used huge areas of prime lands for livestock ranches and monocultural plantations for primary produce for export, very often at the expense of local food production. It is unbelievable that such development still continues in most countries of the third world today, and it is not surprising that they remain poor or even become poorer.

In the past, there were also many man-made cultural constraints on reutilisation of wastes in many parts of the world, with many official bodies making things worse by arbitrary laws and regulations. They resulted in many human settlements living in squalor because the wastes were not disposed of properly. Many changes have occurred in recent years when the powers that be, including all the religious bodies, began to realize that the only way to solve such problems is to recycle the wastes as economic resources.

The Integrated Farming System demonstrates that the developing countries can have more viable agro-industries, with their wastes used as inputs in surrounding integrated farms, while solving the waste and pollution problems effectively and efficiently and making local enterprises highly rewarding in a healthier environment. So both industrialists and farmers benefit socially and environmentally from such collaboration. One additional aspect, which should not be overlooked, is

the establishment of self-employment for the individual farm family with relatively small area of land and low investment which can be recovered within a couple of years, with the prospect of its members becoming entrepreneurs as the integrated farm expands.