16. PRESENT SITUATION AND PROBLEMS ON ENVIRONMENTAL PROTECTION AND CONSOLIDATION IN JAPAN

Kunio ISHIMARU*

Statistical Transition of Animal Husbandry in Japan

For centuries the Japanese farmers have raised cattle, horses, and poultry on their farms, either for food or labor, and utilized the animal excretions (wastes) as soil fertilizer.

In recent years, changes in the Japanese diet has resulted in the increased demand for meat products.

To supply the ever-increasing demand for meat, farmers have endeavored to increase their stocks at an unprecedented pace.

Table 1. Statistical transition of Milk Cow production in Japan

Year	The number of milk cow farm (×1, 000) (A)	The number of milk cow (×1, 000) (B)	B/A	Milk production (×1, 000 ton)
1962	416	1, 002	2. 4	2, 437
1963	419	1, 142	2. 7	2, 761
1964	402	1, 238	3. 1	3, 020
1965	382	1, 289	3. 4	3, 221
1966	361	1, 310	3. 6	3, 409
1967	347	1, 376	4. 0	3, 566
1968	337	1, 489	4. 4	4, 016
1969	324	1, 663	5. 1	4, 509
1970	308	1, 804	5. 9	4, 761
1971	278	1, 856	6. 7	4, 820
1972	243	1, 819	7. 5	4, 936

Table 2. 1972 Milk cow distribution in Japan

	Milk cows per farm						
	1-9	10-19	20-29	30-49	50	Calf	Total
The number of milk cow farms (×1, 000)	151	32	7	2	0. 5	50	243
The number of milk cows (×1, 000)	781	578	242	91	48	79	1, 819

* Professor, Chemistry Laboratory, Tokyo University of Agriculture, Japan.

(Beef cattle)

Table 3. Statistical transition of beef cattle in Japan

Year	The number of beef cattle farm (×1, 000) (A)	The number of beef cattle (×1, 000) (B)	B/A	The number of beef (×1, 000)
1962	1, 879	2, 337	1. 2	555
1963	1, 803	2, 337	1. 3	701
1964	1, 673	2, 208	1. 3	810
1965	1, 435	1, 886	1. 3	668
1966	1, 163	1, 577	1. 4	459
1967	1, 066	1, 522	1. 5	373
1968	1, 027	1, 666	1. 6	350
1969	950	1, 795	1. 9	454
1970	902	1, 789	2. 0	540
1971	797	1, 759	2. 2	—
1972	673	1, 749	2. 6	—

Table 4. 1972 Beef cattle distribution in Japan

	Beef cattles per farm					
	1～9	10～19	20～29	30～49	50	Total
The number of cattle farms (×1, 000)	656	10	4	2	1. 5	673
The number of cattle (×1, 000)	1, 276	139	92	87	115	1, 749

(Hog)

Table 5. Statistical transition of swine in Japan

Year	The number of hog farms (×1, 000) (A)	The number of hogs (×1, 000) (B)	B/A	The number of pork (×1, 000)
1962	1, 025	4, 033	3. 9	6, 244
1963	803	3, 296	4. 1	5, 386
1964	711	3, 461	4. 9	5, 700
1965	702	3, 976	5. 7	6, 785
1966	714	5, 158	7. 2	9, 410
1967	650	5, 975	9. 2	10, 329
1968	531	5, 535	10. 4	9, 546
1969	416	5, 429	11. 8	9, 172
1970	445	6, 335	14. 3	11, 467
1971	398	6, 904	17. 3	—
1972	340	6, 985	20. 6	—

Table 6. 1972 Swine distribution in Japan

	Hogs per farm						
	1∼9	10∼29	30∼49	50∼99	>100	Breed stock	Total
The number of hog farms (×1, 000)	134	36	12	11	11	136	340
The number of hogs (×1, 000)	510	719	544	860	2, 673	1, 679	6, 985

(**Hen**)

Table 7. Statistical transition of hen in Japan

Year	The number of hen farms (×10, 000) (A)	The number of hens (×10, 000) (B)	B/A	The number of products (×1, 000, 000, 000)
1962	381	8, 486	22	146
1963	372	9, 180	25	153
1964	349	10, 677	30	129
1965	323	11, 422	35	186
1966	375	10, 910	40	187
1967	249	11, 925	48	233
1968	218	13, 263	55	247
1969	193	14, 919	77	279
1970	170	16, 076	94	300
1971	137	16, 271	118	311
1972	105	15, 452	147	—

Table 8. 1972 Hen distribution in Japan

	Hens per farm						
	1∼99	100∼499	500∼499	1, 000∼ 5, 000	75, 000	Chicks	Total
The number of hen farms (×10, 000)	96. 9	3. 9	1. 3	2. 0	0. 4	0. 8	105
The number of hens (×10, 000)	889	839	925	4, 269	5, 211	—	12, 133

(**Broiler**)

Table 9. Statistical transition of broiler in Japan

Year	The number of broiler farms (A)	The number of broiler (1, 000) (B)	B/A	The production of broilers (×1, 000 ton)
1964	21, 100	1, 317	617	74
1965	20, 490	1, 828	892	89
1966	19, 160	2, 192	1, 144	137
1967	18, 600	3, 137	1, 686	177
1968	17, 540	3, 474	1, 980	211
1969	17, 360	4, 109	2, 367	277
1970	17, 630	5, 374	3, 049	354
1971	17, 740	6, 311	3, 558	401
1972	15, 259	6, 792	4, 451	—

Table 10. 1972 Broiler distribution in Japan

	Broiler per farm				
	1～4, 999	5, 000～ 9, 999	10, 000～ 50, 000	>50, 000	Total
The number of broiler farms	4, 963	3, 814	7, 965	1, 039	17, 781
The number of broiler products (×10, 000)	1, 308	2, 846	17, 215	11, 521	32, 890

Table 11. Distribution volume of milk cows and farms from 1970 to 1972

The number of milk cow per one farm	Number of cows				Number of cow farms			
	1971	(%)	1972	(%)	1971	(%)	1972	(%)
1 ～ 9	900, 900	51. 1	780, 600	45. 0	181, 600	82. 3	151, 000	78. 3
10 ～ 19	554, 900	31. 5	578, 500	33. 2	30, 900	13. 9	21, 800	16. 5
20 ～ 29	206, 600	11. 7	242, 400	13. 9	6, 600	3. 0	7, 800	4. 0
30 ～ 49	62, 100	3. 5	91, 200	5. 2	1, 300	0. 6	1, 900	1. 0
>50	39, 100	2. 2	47, 700	2. 7	350	0. 2	450	0. 2
(Total)	1, 763, 600	100	1, 740, 400	100	220. 750	100	192, 950	100
Calf	92, 500	—	78, 800	—	58, 600	—	49, 800	—
Total	1, 856, 100	—	1, 819, 200	—	279, 350	—	242, 750	—

Table 12. Distribution volume of hogs and farms from 1971 to 1972

The number of hogs per farm	Number of hogs				Number of hog farms			
	1971	(%)	1972	(%)	1971	(%)	1972	(%)
1 ～ 9	706, 700	13. 5	492, 200	8. 6	174, 880	69. 6	110, 580	61. 4
10 ～ 99	2, 221, 800	42. 5	2, 035, 300	35. 4	66, 640	26. 5	57, 638	32. 0
100 ～ 299	1, 298, 000	24. 8	1, 608, 100	28. 1	7, 961	3. 2	9, 412	5. 2
300 ～ 499	429, 900	8. 2	616, 000	10. 7	1, 144	0. 4	1, 552	0. 9
500 ～ 999	306, 500	5. 8	406, 000	7. 1	456	0. 2	587	0. 3
>1, 000	273, 100	5. 2	581, 300	10. 1	159	0. 1	280	0. 2
(Total)	5, 236, 000	100	5, 739, 000	100	251, 240	100	180, 050	100
Breeding pig	1, 668, 000	—	1, 751, 000	—	147, 100	—	141, 000	—
Total	6, 904, 000	—	7, 490, 000	—	398, 340	—	321, 050	—

Through the ages in Japan, fish was the prime source of protein. With the prohibitive increase of inshore fishing areas due to increase in contamination by toxic substances, and compounded by the restriction and limitations imposed on deep-sea fishing by international treaty, the demand for meat products has increased drastically. To cope and to resolve this situation, the Ministry of Agriculture and Forestry have proposed a program for the scheduled development of livestock farming as follows;

Production goal of livestock in Japan by 1982.

Milk cow	3,080,000
Beef cattle	3,346,000
Pig	16,662,000

Chicken	194,018,000
Broiler	135,635,000

Percentage goal for livestock of self-sufficiency acquirement in Japan by 1982.

Milk	88～ 97%
Beef	83～ 94%
Egg	95～100%

Presently there are 5,261,000 Japanese farms engaged in livestock breeding. Thus in order to accomplish the above goal by 1982, all that each farm, presently engaged must breed more than one cow/cattle, more than three pig/hog and more than sixty poultry.

Japanese Pollution Controls

In Japan, The Basic Law Environmental Pollution Control (Enacted 1967, Law No. 132) regulates air pollution, water pollution, soil pollution, noises, osillation, land subsidence, mold and offensive odors. Among these seven pollution the ones in which animal husbandry are involved are offensive odors and water pollution. Pollutions caused by Japanese animal husbandry have rapidly accelerated since 1965.

Offensive Odor Control Law (Enacted 1971, Law No. 91)

Japan is the first country in the world where offensive odors have been regulated. The present law requires that the following five kinds of odors must be below the following concentration around the emitting source of the offensive odor.

Table 13. Control standard applied to odor

Odor* Intensity	Ammonia	Methyl mercaptan	Hydrogen sulfide	Methyl sulfide	Trimethyl amine
2. 5	1 ppm	0. 002 ppm	0. 02 ppm	0. 01 ppm	0. 005 ppm
3	2 〃	0. 004 〃	0. 06 〃	0. 05 〃	0. 02 〃
3. 5	5 〃	0. 01 〃	0. 2 〃	0. 2 〃	0. 07 〃

* 0: No ordor
1: Very faint
2: Definite
3: Easily noticeable
4: Strong
5: Very strong

These regulations are strictly enforced for animal husbandry, and we must install the anti-pollution apparatus before or by 1975.

Water Pollution Control Law (Enacted 1970, Law No. 138)

Water Pollution Control Law requires that the purity of water in the streams of Japan must comply with the respective levels designated as criteria for the usages prescribed.

In order to attain the quality shown in Table 14, the respective standards have been required of drainages from factories and works.

Table 14. Control standard applied to water**

	River						Lake				Sea		
Class	AA	A	B	C	D	E	AA	A	B	C	A	B	C
pH	6. 5–8. 5	6. 5–8. 5	6. 5–8. 5	6. 5–8. 5	6. 0–8. 5	6. 0–8. 5	6. 5–8. 5	6. 5–8. 5	6. 5–8. 5	6. 0–8. 5	7. 8–8. 3	7. 8–8. 3	7. 0–8. 3
BOD (ppm)	<1	<2	<3	<5	<8	<10	<1	<3	<5	<8	—	—	—
COD (ppm)	—	—	—	—	—	—	—	—	—	—	<2	<3	<8
SS (ppm)	<25	<25	<25	<50	<100	—	<1	<5	<15	—	—	—	—
DO (ppm)	>7. 5	>7. 5	>5	>2	>2	>2	>7. 5	>7. 5	>5	>2	>7. 5	>5	>2
Coli. (100 ml)	<50	<1, 000	<5, 000	—	—	—	<50	<1, 000	—	—	<1, 000	—	—

** Water Pollution Control Standard
pH : Hydrogen ion concentration
BOD : Biochemical oxygen demand
COD : Chemical oxygen demand
SS : Suspended substance
DO : Disolved oxygen
Coli. : Number of colitis germ
Oil : n-Hexan dissoluble substances

Table 15. Water pollution control standards applied to domestic animal waste water

		Daily average	Maximum
pH	River	—	5. 8–8. 6
	Lake, Sea	—	5–9
BOD	(ppm)	120	160
COD	(ppm)	120	160
SS	(ppm)	150	200
Coli.	(1 m*l*)	3, 000	—

Pollution and Animal Waste Problem in Japan

Table 16. Pollution by animal waste in Japan

Animal	Water pollution	Water pollution ordor vermin	Oder vermin	Misc	Total
Cow	163	76	448	12	669
Cattle	82	57	131	2	272
Hog	525	436	1, 111	24	2, 096
Poultry	72	53	1, 262	23	1, 410
The others	1	1	16	2	20
Total	843	623	2, 968	63	4, 497

Table 17. Countermeasure proposals and resolution of the pollution problem by animal waste in Japan (Department of Agriculture and Forestry-1970)

Animal	Installation of treatment equipment	Recommenda-tion of waste treatment method	Temporary transfer of farming site	Consultation and arbitration	Misc	Total
Cow	34	504	12	27	116	669
Cattle	3	184	17	4	64	272
Hog	82	1, 652	119	51	192	2, 096
Poultry	37	963	104	51	255	1, 410
The others	—	16	2	1	1	20
Total	156	3, 319	260	134	628	4, 497

Measures for Offensive Odor Control

The areas from where offensive odors are emitted on a farm are from the barns and from the treatment equipment used for the disposal of animal waste.

A. Closure of Barn

The odor may be contained if all the openings are closed or sealed. Then the odor enclosed in the barn may be deodorized by one of the several methods available.

B. Dilution of Odor

This is the method of diluting a large amount of odor with odorless air, whereby, the odor concentration is diluted but the absolute amount of the odor remains constant.

However, the fact that odor has a chemical characteristic that it can still be smelled even when subjected to large degree of dilution must be carefully considered.

In certain cases, some odor's intensity may appear unabated even when 90% of the offensive odor has been eliminated.

C. Masking

This method involves the use of another scent, perfume, to "mask" the offensive odor. Through the use of a perfume which is selected to treat the particular offensive odor, the original unpleasant odor is "masked" and may not be smelled although the absolute amount of the offensive odor remained constant.

D. Rinse

Most odors are water soluble.

Thus deodorization is possible by channeling the odor through a smoke duct or tower, and then film-spraying with water.

This is an effective and inexpensive method of treating odor. However, the disadvantage is the treatment problem of the resulting by-product, the odor-rinsed contaminated water.

E. Chemical Treatment

It has been determined possible to treat offensive odors with the use of certain chemicals and compounds.

For example, a complete deodorization reaction is that of ammonia added to sulfuric acid resulting in the formation of ammonium sulfate.

With the end-product in mind, the proper chemical compound may be selected to treat offensive odors.

F. Oxidation

Another method of treating odor is through oxidation with the use of ozone and chloride of lime.

The oxidizing apparatus require special design and operation, since the oxidizing agent is a powerful reactive chemical compound.

G. Absorption

The method of eliminating odors by absorption has been used since ancient times.

The odor can be absorbed with the use of active carbon, zeolite or ion exchange resin.

H. Thermal Decomposition

This is a method of decomposing the component of offensive odors into odorless substances by exposure to high temperature.

For example, ammonia can be decomposed into nitrogen and hydrogen in a second when exposed to a temperature of 650°C.

With the use of a similar process, the odor may be eliminated by reburning the odor emitted from the heating drier.

The disadvantage of this method is the fact that a large amount of fuel is required in the process.

I. Microorganism Treatment—Biological Method

Under this method of deodorization, the offensive smelling substance is placed on a microorganism growth culture.

Care must be taken with temperature since microbiological activity is affected by change in temperature. The optimum temperature of 10°–30°C must be maintained to obtain effective results from microorganisms.

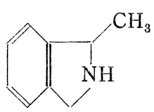
J. Soil Treatment

Another which utilizes microorganisms for treatment in the soil has been developed in Japan and is now widely used.

The odor is passed into the soil through the porous holes of the buried pipe where the odor is absorbed by the damp soil.

The absorbed odor is decomposed by the soil microorganisms and the odorless gas is released to the surface.

Table 18. Odor substances

Sulfide-compound	H_2S	Hydrogen sulfide
Thioethers (R—S—R¹)	$(CH_3)_2S$ $(C_2H_5)_2S$ $(C_3H_7)_2S$ $(C_6H_5)_2S$	Dimethyl thioether Diethyl thioether Dipropyl thioether Diphenyl thioether
Mercaptans ($C_nH_{2n+1}\cdot SH$)	C_2H_5SH $(CH_3)_2CH\cdot SH$	Ethylmercaptan Dimethylmercaptan
Ammoniums	NH_3 $(NH_4)_2S$	Ammonia Ammonium sulfide
Amines	$C_3H_7CONH_2$ $C_2H_5NH_2$ CH_3NH_2 $(C_2H_5)_2NH$ $(C_2H_5)_3N$	Aceto amide Ethyl amine Methyl amine Diethyl amine Triethyl amine
Alcohols	C_4H_9OH $C_5H_{11}OH$	Butyl alcohol Amyl alcohol
Aldehydes	$H\cdot CHO$ CH_3CHO C_2H_5CHO C_3H_7CHO	Form aldehyde Aceto aldehyde Propion aldehyde Butyl aldehyde
Fatty acids	$H\cdot COOH$ CH_3COOH C_2H_5COOH C_3H_7COOH C_4H_9COOH	Formic acid Acetic acid Propionic acid Butyric acid Valeric acid
Phenols	C_6H_5OH C_6H_5SH	Phenol Thiophenol
Indols		Skatols

Treatment Process of Animal Waste

Unit load of pollution substances of various animals.

Unit load (g/one animal/day)

=Waste volume (l/one animal/day) × Concentration (mg/l)

Table 19. BOD load of various animals

Animals		Weight of waste	Concentration	Load
Cow	Faeces	25 (kg/one animal/day)	24, 000 (ppm)	600 (g/day)
	Urine	5 〃	4, 000 〃	20 〃
	Mixed	30 〃	20, 000 〃	(600) 〃
Hog	Faeces	3 〃	61, 000 〃	183 〃
	Urine	3 〃	5, 000 〃	15 〃
	Mixed	6 〃	33, 000 〃	(200) 〃
Horse	Faeces	30 〃	5, 000 〃	150 〃
	Urine	10 〃	6, 000 〃	60 〃
	Mixed	40 〃	5, 000 〃	(200) 〃
Human	Night-soil	1. 3 〃	13, 000 〃	(17) 〃

Table 20. SS load of various animals

Animals		Weight of waste	Concentration	Load
Cow	Faeces	3 (kg/one animal/day)	223, 000 (ppm)	669 (g/day)
	Urine	3 〃	4, 500 〃	14 〃
	Mixed	6 〃	117, 000 〃	(700) 〃
Hog	Faeces	25 〃	120, 000 〃	3, 000 〃
	Urine	5 〃	5, 000 〃	25 〃
	Mixed	30 〃	100, 000 〃	(3, 000) 〃
Horse	Faeces	30 〃	200, 000 〃	6, 000 〃
	Urine	10 〃	5, 000 〃	50 〃
	Mixed	40 〃	150, 000 〃	(6, 000) 〃

Table 21. Nitrogen load of various animals

Animals		Weight of waste	Concentration	Load
Hog	Faeces	3 (kg/one animal/day)	5, 000 (ppm)	15 (g/day)
	Urine	3 〃	8, 000 〃	24 〃
	Mixed	6 〃	6, 500 〃	(40) 〃
Cow	Faeces	25 〃	6, 000 〃	150 〃
	Urine	5 〃	8, 000 〃	40 〃
	Mixed	30 〃	6, 500 〃	(200) 〃

Table 22. Phosphor load of various animals

Animals		Weight of waste	Concentration	Load
Hog	Faeces	3 (kg/one animal/day)	8, 000 (ppm)	24 (kg/day)
	Urine	3 〃	400 〃	1 〃
	Mixed	6 〃	4, 000 〃	(25) 〃
Cow	Faeces	25 〃	2, 000 〃	50 〃
	Urine	5 〃	400 〃	2 〃
	Mixed	30 〃	1, 660 〃	(50) 〃

Before a treatment plant is constructed, the following conditions must be taken into consideration:

(Location factors)

a—Precautions in disposing of effluent
  to river (legal limits)
  to agricultural stream (N&P concentration)
  to farm land (N&P concentration)

b—Sources of water for dilution
  from river
  from city water
  from well water

c—Type of surround area
  in urban
  in rural

d—Size of available land
  for treatment plant of waste water
  for treatment plant of waste

e—Configuration of the ground
  Geological survey

f—Weather condition
  air temperature
  water temperature
  snow and freezing

(Cost)
  Plant building expense and treatment cost

(Treatment techniques)
  Machine, electronics, microbiology and chemistry.

Treatment Method of Animal Waste Water

Primary treatment method

Equipment need for above system

a—Strage tank
  volume $>4\ m^3/100$ HU (HU=Hog unit)
  depth $1\sim3$ m
  angle of bottom 60°
  Supplimental facilities, pump pit, agitater

b—Solid removed apparatus
  (1) Square type vibrator
    screen area$>1+(N-100/100)\times0.1\ m^2$

Table 23. Primary treatment

Animal waste	Washing piggery	Solid removal	Sedimentation	Simple digestion	Effluent (ppm)
Hog waste 6 kg	Fresh water 24.1				BOD 6,600 SS 24,000
	Waste water 30.1				BOD 5,300 SS 12,000
BOD 33,000 ppm (200 g)	BOD 6,600 ppm (200 g)	BOD remove 20% 5,300 ppm (160 g)	BOD remove 40% SS remove 40%		BOD 3,200 SS 7,200
SS 117,000 ppm (700 g)	SS 24,000 ppm (700 g)	SS remove 50% 12,000 ppm (350 g)		BOD remove 60% SS remove 60%	BOD 2,100 SS 4,800

(N—number of hog)

size of screen 50-méshes-(0.3 mm)

treatment capacity $>15\ m^3/m^2/hour$

(2) Round tray type vibrator

screen area $0.5+(N-100/100)/0.2\ m^2$

size of screen 50 meshes (0.3 mm)

treatment capacity $>10\ m^3/m^2/hour$

(3) Rotary screen

screen area $>1+(N-100/100)\times 1.5\ m^2$

size of screen 20~65 meshes

screen speed 40 r.p.m.

treatment capacity $>10\ m^3/hour$

c—Sedimentation tank and settling tank

(1) Sedimentation tank

volume $>12\ m^3/100$ HU

depth 1~3 m

supplimental facilities—flume block plate

sedimentation time one day

sedimentation solid removal every one month

(2) Settling tank

volume $>12\ m^3/100$ HU

depth 1~3 m

angle of bottom 60°

settling solid removal every two month

supplimental facilities—flume block plate

d—Simple digestion tank

semi-unaerobic digestion

volume $>30\ m^3/100$ HU

depth 1~3 m

angle of bottom 60°

supplimental facilities—flume block plate

e—Sterilized tank

volume $0.2\ m^3/100$ HU

sterilize by liquid chlorin or solid chloride

f—Transfer apparatus

(1) Pump

capacity of four times of one day average waste water volume

(2) Pipe

waste water 50 mmϕ

waste water containing solid 65 mmϕ

Secondary treatment method

Secondary treatment process connected with primary treatment process and effluent to comply with requirement of the law.

(A) Active sludge process

Active sludge process is the most useful method and its flow sheet is shown in next figure.

Plant design for active sludge process

Aeration tank volume

BOD volume load 0.5~1.0 kg BOD/m^3/day

BOD sludge load 0.2~0.3 kg BOD/MLSS kg/day

Aeration

Oxygen transfer coefficient KLa>4

Aeration tank oxygen content >1 ppm

Sludge volume (30 min) SV_{30} 40~60

Mixed liquer suspended solid MLSS 4,000~6,000 ppm

Sludge volume index SVI 100~150

Final settling tank volume (retention time 4 hours)

=Influent volume (m^3/day)+Return sludge volume (m^3/day)×4/24

Return sludge volume 50~100% of influent volume

Treatment effect

	Influent (ppm)	Effluent (ppm)	remove (%)
BOD	1, 200	120	90
SS	3, 000	150	95

Excess sludge (kg)

=0.2~0.3×(removed BOD kg+removed SS kg)

(B) Trickling filtration process

Plant design for trickling filtration process

Tank volume

BOD volume load 1.0~1.5 kg BOD/m^3/day

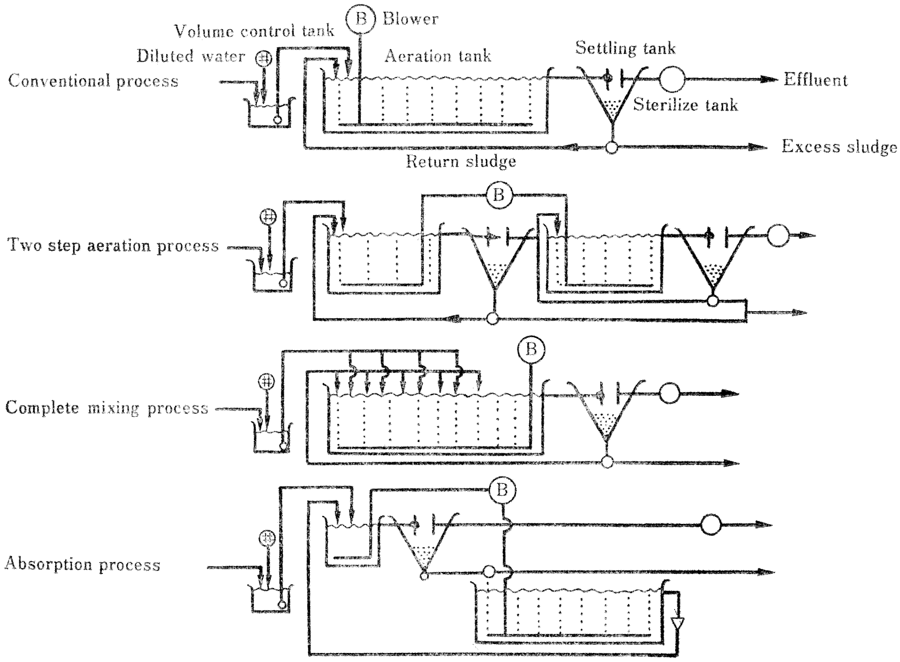
Waste water sprinkling load 10~20 m^3/m^2/day

Settling tank volume (retention time 4 hours)

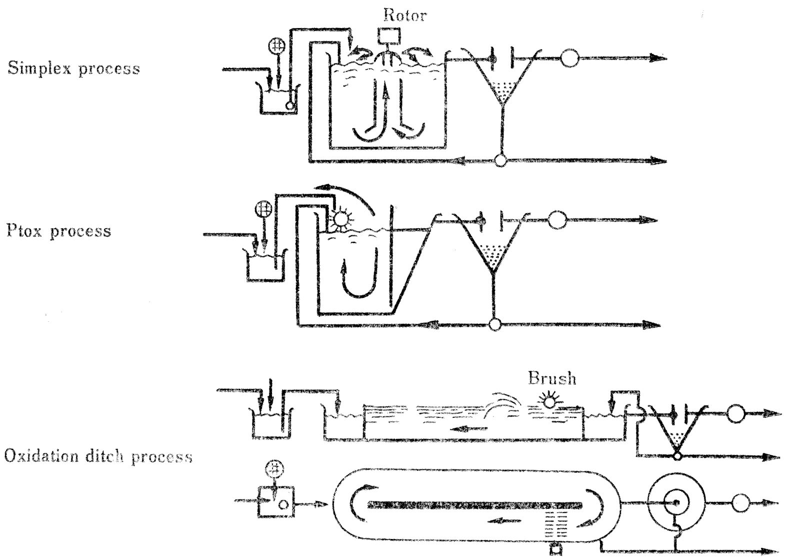
Treatment effect

	Influent (ppm)	Effluent (ppm)	remove (%)
BOD	800	120	85
SS	1, 500	150	90

Air diffusion aeration process



Mechanical aeration process



(C) Lagoons

Area

Lagoons (static) 6 kg BOD/m²/day

Oxidation pond (aeration) 18 kg BOD/m²/day

Don't culture float plant

Cost

(i) Plant building expense of Night-soil treatment
BOD 10,000~13,000 ppm (13~15 g/one man/day)
Excretion volume 1.0~1.3 l/one man/day
Building expense 15,000~20,000 yen/one man 100~130 yen/BOD g.
Effluent BOD 20~60 ppm

(ii) Plant building expense of hog waste treatment
BOD 33,000 ppm (200 g/HU/day)
Excretion volume 6.0 kg/HU/day
Building expense 10,000~15,000 yen/HU 50~75 yen/BOD g.
Effluent BOD 120 ppm

Animal Waste as Soil Fertilizer

There is an old Japanese proverb which states "Without livestock, no manure; Without manure, only barren soil; With barren soil, no agriculture".

Animal waste (manure) composition is rich in soil fertilization components.

Table 24.

Animal	Faeces			Urine		
	N (%)	P_2O_5 (%)	K_2O (%)	N (%)	P_2O_5 (%)	K_2O (%)
Hog	0. 5–0. 8	0. 15–1. 5	0. 4–0. 5	0. 3–0. 8	0. 1–0. 2	0. 2–1. 3
Cow	0. 3–0. 5	0. 2–0. 4	0. 1–0. 2	0. 6–0. 8	0. 1–0. 2	1. 4–1. 5
Horse	0. 4–0. 5	0. 3–0. 4	0. 2–0. 3	1. 0–1. 2	0. 1–0. 2	1. 3–1. 5
Poultry	1. 6–2. 0	1. 7–2. 0	0. 8–1. 3	—	—	—

The use of animal waste to enrich the soil is recommended as soil fertilization.

The recommended quantity of animal waste depends on the type of crops as follows:

Table 25. (unit ton/10a/year)

Animal	Pasture plant	Vegetables	Fruit tree	Mulberry	Tea plant	Paddy field
Hog	10	3–5	3–6	10	5	Few
Cow	15–20	5–10	5–10	20	10	2. 5
Horse	15–20	5–10	5–10	20	10	2. 5
Poultry	4	1–2	1–3	4	2	Few

The following conditions must be considered when animal waste is used as soil fertilizer:

1. Size of the farm
2. Quality and composition of the soil
3. Kind of crops
4. Form and decay-rate of the fertilizer
5. Collection and treatment
6. Transportation and distribution
7. Environmental and sanitation problems

In the years ahead, increase in the production of livestock is not only a certainty but mandatory to meet the requirement for more meat products.

However, in the process of solving the food problem, there lies an equally important problem of animal waste which require utmost attention since the solution will affect the lives of millions. The problem poses many positive and helpful possibilities to mankind and with the aid of human resource and ingenuity, it can be successfully resolved.