Present Status of Incoming and Outgoing Phosphorus in Japan

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Introduction

1) Reasons for taking up phosphorus

Any element or any matter, coming out of the underground of the earth, the sea, or of the atmosphere, returns to these places after giving some influence on human activity. During the process of this cycle, elements or matters are affecting the natural or social environment through their translocation in terms of both time and space. Consumption of an exceedingly great quantity of a certain matter by human beings causes a partial over-flowing of the matter during the cycling, which results in the environmental pollution. When the quantity overflown exceeds the limit of the natural capacity of purification by diffusion, photochemical smog, eutrophication of water systems, or red tide, to take some examples, are caused.

The present report deals with phosphorus

Table 1. Phosphorus in essential elements for plant growth

element		dry weight basis %	element		dry weight basis %
Carbon	C	49	Magnesium	Mg	0.05～0.7
Oxygen	O	43	Chlorine	Cl	0.01～0.03
Hydrogen	H	6	Iron	Fe	0.001～0.15
Nitrogen	N	1～3	Manganese	Mn	0.0005～0.15
Potassium	K	0.3～6.0	Zinc	Zn	0.0003～0.015
Calcium	Ca	0.1～3.5	Copper	Cu	0.0003～0.0075
Sulphur	S	0.05～1.5	Boron	B	0.0003～0.0075
Phosphorus	P	0.05～1.0	Molybdenum	Mo	trace

Table 2. Import of rock phosphate (M.T)

1939	1,192,379	1950	1,005,787	1961	2,110,375
1940	1,110,188	1951	1,108,956	1962	1,890,733
1941	794,429	1952	939,391	1963	2,058,328
1942	578,329	1953	1,052,622	1964	2,344,566
1943	461,324	1954	1,386,285	1965	2,396,632
1944	187,000	1955	1,646,841	1966	2,467,486
1945	35,000	1956	1,680,730	1967	2,648,163
1946	195,035	1957	1,557,669	1968	3,412,157
1947	1,128,837	1958	1,509,122	1969	2,920,318
1948	419,045	1959	1,684,246	1970	3,008,390
1949	339,134	1960	2,022,559	1971	2,874,277

Table 3. Land area and population of Japan (1971)

a.	Total area	37,208 (1,000 ha)
b.	Arable land	4,826 (1,000 ha)
c.	Horticultural land	620 (1,000 ha)
d.	Grass land	950 (1,000 ha)
e.	Forest land	25,688 (1,000 ha)
f.	Others	5,124 (1,000 ha)
g.	Total population	104,929 (×1,000)
h.	Agricultural population	21,564 (×1,000)

Table 4. Energy consumption in Japan (1971)

a. Population	104,929 (×1,000)
b. General national productivity	609,113 ($\times 10^8$)
c. Consumption of total energy	297,385 ($\times 10^{10}$ Kcal)
d. Consumption of energy per capita	2,834 ($\times 10^7$ Kcal)

in relation to environmental pollution from the following reasons.

1) Phosphorus is an essential element for every organism and one of the three primary plant nutrients. (Table 1)
2) Japan must import almost all the phosphorus needed to meet the industrial demand. (Table 2)
3) Phosphorus is widely utilized as a raw material to make various products, or in the industrial process.
4) It is less fluid or less diffusive as an element.
5) When discharged into hydrosphere, it becomes a causal material of eutrophication.
6) Its complete removal from waste water is difficult.

Besides, Japan is selected as fit for the present investigation from the reasons below.

1) Japan is a country surrounded by the sea and can be regarded as a kind of closed system.
2) Land area, especially of the arable land is very small and its population density is high. (Table 3)
3) Industrial production and energy consumption is large. (Table 4)
4) Agriculture is highly intensive in this country.
5) Reliable statistics are easily obtainable in various fields.

2) Importance of phosphorus

Phosphorus, a basic component of protoplasm, is an essential element for the growth, health, and reproduction of every plant and animal. Its importance in life process is the same as nitrogen, hydrogen, oxygen, carbon and sulphur. Phosphorus and phosphate as raw materials in making various products in Japan are of rock phosphate origin in most cases. Other phosphorus-containing materials imported, like iron ore, coal, feed-stuff, food, and organic manure, are not imported for the purpose of obtaining phosphorus except the case of organic manure.

Generally speaking, the tendency in the world is that about 90% of the phosphorus and phosphate of rock phosphate origin is consumed as fertilizer, and the remaining 10% only is being utilized as materials for the production of phosphorus compounds other than fertilizer. In Japan, however, the percentage of the phosphorus and phosphate consumption for producing various phosphorus compounds except fertilizer is as high as 30%, which is a special case in the world tendency.

It is universally recognized that fertilizer is essential for the sufficient supply of food to the increasing world population; during the past twenty years from 1950 to 1970 fertilizer consumption in the world has increased four times and this tendency will still continue in future. However, despite the well-recognized importantce of fertilizer application for the agricultural production increase, the time has come that some conclusion must be drawn concerning the relation of heavy fertilizer dressing in many regions of the world to their environment on the basis of facts found so far.

In Japan also, a large amount of fertilizer has been consumed for a long time, especially since 1951. High doses of fertilizer had been necessary for sufficient food supply coping with the population increase. Combined with a high population density and a large amount of agricultural products in the country, not only fertilizers applied but also rapidly increasing amount of organic wastes from the farm products have now begun to exceed the limited of the natural purifying capacity.

As to the industrial wastes, the balance between phosphoric products, accounting for nearly 30% of the total industrial products, and recovery of the used products is supposed to have a far larger impact upon the environment than the phosphate in fertilizers which translocates in the soil.

From the above-mentioned circumstance it may well be affirmed that to gain a quantitative knowledge of the balance of incoming and outgoing phosphorus as accurately as possible will present a basis to clarify where the problem lies and how to meet the situation. At the present stage, however, it is inevitable that presently available techniques of phosphorus analysis are sometimes unable to offer satisfactory data when handling various wastes, and especially outgoing phosphate. (Table 5)

Present status of phosphorus incoming to Japan

As there is practically no phosphorus resources in Japan, almost all of the raw materials of phosphorus are imported. The form of phosphorus or its compounds coming into Japan varies very widely. When roughly classified, they can be divided into two, that is, 1) those imported as the main source of phosphorus, and 2) those which come into Japan along with other materials regardless of their uses. For instance, among those which belong to the first category, phosphate rocks and fertilizers imported in the form of ammonium phosphate and bone meal are the typical examples, and those of the second group are represented by foods and feedstuffs, fishery products, iron ore, coal, and timbers. When the incoming phosphorus is classified by quantity, phosphate rocks, feedstuffs, iron ore, and coal rank high.

The present status of the incoming phosphorus is as follows:

1) Phosphate rock

Phosphate rock is produced at various parts of the world, and therefore Japan imports it from several countries separately. (Table 6) The import has been gradually increasing as the high analysis component fertilizer is newly developed and becomes popular.

Components of phosphate rock differ according to the deposits from which it comes as shown in Table 7. Generally, the main component is fluoro apatite, $Ca_{10}F_2(PO_4)_6$.

2) Fishery catch

The recent fish catch in Japan is about 10%

Table 5. Analytical methods for phosphate and their errors incured

Methods	Phosphorus concentration μ/l	No. of laboratories employed	Relative error %
Molybdo-vanado phosphate method	100	45	21.6
	600	43	10.8
	7,000	44	5.4
Stannous-chloride method	100	45	28.7
	600	44	8.0
	7,000	45	4.3
Ascorbic acid method	100	3	10.0
	600	3	4.4
	7,000	3	4.1

of the total catch in the world. The phosphorus content in the fish products is shown in Table 8. Regardless of the changes in the kinds of fish recently caught, the total amount of phosphorus derived from fishery products has been showing an upward tendency. The

Table 6. Import of rock phosphate in Japan

(1,000 M.T)

	1971	1972
Florida	1,797	2,054
Morocco	463	464
Jordan	—	150
Togo	84	82
Senegal	98	94
Israel	37	30
Nauru	148	107
Others	7	22
Total	2,729	3,003

Table 7. Rock phosphate components

(%)

	Sources			
	Florida	Morocco	Sahara	Cora
BPL	77	80	80	86
P_2O_5	35.30	36.71	36.60	39.38
CaO	50.00	52.53	51.90	51.11
F	3.85	3.81	3.93	2.35
Fe_2O_3	1.02	0.30	0.14	0.54
Al_2O_3	1.01	0.52	0.35	0.55
SiO_2	3.15	1.41	4.52	2.79
CO_2	2.80	2.05	1.83	0
SO_3	0.75	0.53	0.44	0
Cl	0	0.03	0.04	0.01
Na_2O	0.41	0.15	0.24	0.57
K_2O	0.08	0.05	0.14	0.44
MgO	0.22	0.06	0.06	0.05
Organic matter (+Crystallic water)	2.25	1.63	0.71	0.20

Table 9. Catch of various fishes (1971)

Total	8,021 (1,000 M.T)
Herring	100
Sardine	496
Horse mackerel	1,254
Pacific saury	190
Yellow tail	110
Skin jack	192
Tuna marlin	360
Salmon	153
Flounder plaice	348
Pollack	2,803
Shark	44
Pacific porgy	30
Shell	534
Cuttle fish	483
Help	152
Fish farming	
Fish	62,913 (M.T)
Shell	38,280
Others	744
Sea weeds	340,806
Inland water fishery	
Trout	102,992 (M.T)
Shell	36,056
Others	6,780
Whales	125,000 (M.T)

Table 8. Total fish catch and their P contents in Japan (1971)

	Catch weight (1,000 M.T)	P (%)	Amount of P (M.T)
Total	9,909		1,555,481
Marine fishery	9,758		
Fishery	9,149		
Aquaculture	609		
Fish	7,913	1.8	142,434
Shell	498	0.6	2,988
Others	760	0.75	5,700
Sea weeds	586	0.28	1,641
Inland water fishery	151	1.8	2,718

Table 10. Import & export of feedstuffs (1971)

Feedstuff	Import (1,000 M.T)	Export (M.T)
Forage crop	464.1	103
Lucerne meal	398.3	—
Brans etc.	361.4	1
Brans	250.5	—
Oil cake	279.4	7,242
Soybean cake	38.9	7,017
Peanut oil cake	122.0	225
Meat meal・Fish meal	108.3	37,879
Fish meal	21.7	37,724
Feather meal	27.7	—
Offal・Formula feed	156.6	213,675
Beet pulp・Bagasse	49.8	—
Vitamine additive	3.9	—
Pet food	9.8	33,005
Beet pulp pellet	84.7	140
Corn (Maize)	3,401.4	—
Rye	146.3	—
Oats	189.7	—
Milo・Grain sorghum	3,798.1	—

amount in 1971 reached as much as 155,000 tons. Beside this, statistics on whales are given in Table 9.

3) *Feedstuff*

High economic growth rate and a rising tendency of the national income brought about the improvement of people's diet with an increased intake of animal protein such as eggs, dairy products and meats. In a country like Japan where the self-sufficiency of food is hardly attained, unless a large quantity of feed for livestock and poultry is imported, it naturally becomes necessary to import livestock products themselves. Recently the import of feedstuffs is sharply increasing above all. Table 10 shows the kinds of imported feeds in 1971.

4) *Food*

It is said that to maintain the present level of diet of the Japanese without importing any food, additional 8,500,000 ha of agricultural land would be needed in the country. The recent import of foods excluding feeds is seen in Table 11.

Table 11. Import & export foods (1971)

Foods	Import (M.T)	Export (M.T)
Rice	13,000	966,000
Wheat	3,357,000	—
Wheat flour	—	32,000
Barley	121,000	—
Corn (Maize)	1,606,000	—
Soybean	3,212,000	—
Buckwheat	38,813	—
Millet	29,019	—
Grain sorghum	12,000	—
Small rice bean	38,982	—
Field bean	19,256	—
Pea	40,016	—
Kidney bean	59,966	—
Red bean	11,599	—
Green gram	39,651	—
Peanut	52,382	—
Citrus fruit	82,000	—
Banana	989,000	—
Sugar	3,894,000	—
Cacao bean	39,000	—
Oil crop seed	4,442,000	—
Beef	41,572	992 (Beef, Mutton, Pork, Chicken, Horse fresh)
Mutton	130,072	
Pork	27,204	
Chicken	27,162	
Horse fresh	37,147	
Modified milk powder	—	11,247
Skim milk	50,663	—
Curd cheese	35,896	—
Eggs	35,233	300
Butter	—	1,115
Sausage	—	695
Canned meat	—	549
Animal fat	256,886	7,760

5) *Iron ore and coal as industrial raw materials*

Since 1960 steel production in Japan has remarkably increased with the rapid growth of her economy. Keeping pace with the tendency, imports of iron ore and coal have increased. (Table 12) In general, phosphorus content in iron ore ranges from 0.03% to

Table 12. Incoming phosphorus contained in iron ore and coal imported (1971)

	Import (1,000 M.T)	P (%)	Amount of P (1,000 M.T)
Iron ore	114,951	0.05	57
Coal	46,979	0.03	14

(c.f)

Iron ore	P %	Coal	P %
Magnetite	0.01~0.05	Australia	0.002~0.069
Hematite	0.06~0.16	South Yakutsk	0.015~0.04
Total mean	0.05	Total mean	0.03

1.0%, and it is presently standardized to be lower than 0.05%. If the phosphorus content in iron ore is taken as 0.05% on an average of varying contents, the total amount of phosphorus contained in the imported iron ore is estimated to be 57×10^3 tons in 1970.

Similarly the phosphorus content in coal ranges from 0.01% to 0.05% depending on its kind. If calculated on the bases of an averaged 0.03%, phosphorus content in the coal imported in 1971 amounts to 14×10^3 tons in total.

6) Other materials imported

Even their phosphorus content is small, those materials which are imported in large quantity must be taken into account in estimating the total amount of incoming phosphorus. But, this has not been done, because lack of reliable data on phosphorus contents in those materials.

7) Precipitation (rain and snow)

Data on the phosphorus content in rain and snow in Japan are less as compared to those of nitrogen compounds. Besides, due to its low concentrations and consequently due to large errors occurring in chemical analysis, accurate figures are not yet available at every region of the country, but they are roughly estimated to lie between 0.1 and 0.2ppm as seen in Table 13. The large figures occasionally found in the table seem to have resulted from combustion of coal or oil, or derived from phosphorus particles spread together with dust from factories, or H_3P which has been formed under the very strong reducing condition in soils, volatilized and oxidized in the air.

Table 13. P content of rain water

0.14~0.16 ppm	(Low & Armitage[1])	
(c.f)		
0.10~4.36 kg/km^2/day	Ube city,	1972
0.06~0.35	〃	1973
0.38~5.51	〃	1974
0.13~0.21	〃	1974
	(Ukita & Nakanishi)[2]	

Present trend of phosphorus outgoing from Japan

If looked from the global standpoint, about one-eight of the mined phosphorus in the world is believed to be flowing into the ocean.

1) Course of phosphorus outgoing

The outgoing course of phosphorus in Japan varies depending on the kind of materials. If its final stage is classified upon the hypothesis that there exists a state of equilibrium, there are 1) the one which flows directly into the ocean, 2) the one which remains in the soil including mud at the bottom of the inland waters (rivers, lakes and marshes), 3) and the one which volatilizes in the air, though it is very small in quantity.

The phosphorus of the second group remaining in the soil, sometimes becomes soluble as the environment changes, and is leached out. The volatilized phosphorus, which belongs to the third group, dissolves in rain or snow, flowing into the ocean at the final stage.

There is another group of phosphorus which takes a completely different course; the export of phosphorus as phosphorus-containing materials or products.

2) Items exported from Japan

The kinds and quantities of phosphorus-containing materials produced for export are listed in Table 14.

Table 14. Export percentage of phosphorus compounds (1971)

Material	Production (M. T)	% exported
Yellow phosphorus	2, 314	2. 0
Red phosphorus	1, 555	6. 5
Phosphoric acid	69, 786	6. 2
Phosphorus pentoxide	1, 475	3. 1
Sodium phosphate	8, 545	8. 0
Calcium phosphate	16, 000	1. 3
Sodium tripoly-phosphate	159, 300	5. 1
Phosphorus tri-chloride	3, 866	5. 6
Phosphorus penta-chloride	42	5. 8
Phosphorus oxychloride	5, 863	0. 5
Phosphorus penta-sulphide	2, 936	0. 3
Potassium phosphate	1, 666	1. 0
Ammonium phosphate	5, 355	10. 0
Sodium poly-phosphate Fertilizer	4, 541	5. 0
Super phosphate	707, 740	7. 6
Calcined phosphate	105, 022	6. 9
Fused magnesium phosphate	404, 128	0. 6
Mixed fertilizer	656, 696	7. 0
Compound fertilizer	4, 230, 041	11. 0
Double super phosphate	71, 064	11. 3

3) Fixation of phosphorus in the soil

When phosphorus compounds get into soil, they usually do not stay in their original form, but undergo complex reaction with soil constituents. If ion of phosphoric acid contacts with acidic soil, which is widely distributed in Japan, generally two kinds of reaction are succesively induced. The first reaction is anion exchange absorption of soil colloid, and it completes in a very short time. The second one takes place in a very long period of time; namely, substitution of OH-radical in the clay mineral for phosphoric radical, isomorphous substitution of SiO_4^{---} for PO_4^{---}, and thereafter it reacts upon Ca·Fe·Al to form slightly soluble compounds. These reactions are called fixation of phosphoric acid. In the cases of Japanese soils, reaction on Fe·Al is dominant. In calcareous soil or alkaline soil, fixation with Ca takes place mainly, producing $Ca_3(PO_4)_2$ at first and then $Ca_{10}(OH)_2(PO_4)_6$ or $Ca_{10}F_2(PO_4)_6$. When reacted on Fe or Al, it is considered that Variscite $Al(OH)_2H_2PO_4$ or Strengite $Fe(OH)_2H_2PO_4$ is produced. Generally speaking, pH in the soil plays an essential role in the fixation of phosphoric acid. In acidic soil solubility of soil phosphoric acid is smallest at the pH level of 3 to 4. In calcareous soil it becomes smallest at pH 7 to 8, and if pH gets lower than this level, the solubility increases very rapidly. For this reason, irrespective of the kinds of soil, the soil pH level most suitable for phosphoric acid absorption by crop plants ranges from 5.5 to 6.5. In the regions where acidic soil is dominantly distributed as in Japan, application of lime seems to be effective for efficient utilization of phosphoric acid in the soil.

4) Loss of phosphorus from the soil

Phosphorus content in the soil normally ranges from 0.022 to 0.083%, and phosphorus concentration in soil solution is said to be 4 ppb under non-fertilized condition. However, as mentioned in the foregoing section, these figures widely vary depending on the history of fertilizer application, pH of the soil and/or other various properties of the soil. In the same way, leaching out of phosphorus from the soil cannot be discussed in a generalized way, as it differs with precipitation, soil temperature, land gradient, and kind of cover-plants in the area. In fact a wide range of figures is seen in the data obtained in various lysimeter experiments and field tests. If normal cases only are taken up, however, the average amount of phosphorus run off can be regarded as 0.2 kg/ha to 2 kg/ha/year in P_2O_5 either in Japan or other countries.

Table 15. Phosphorus outflow from industrial waste

Product	P (kg)	Base
Bread, Cake	0.085	product 1 t
Starch	0.19	raw material 1 t
Sugar refining	0.2	do
Beet sugar	0.023	do
Bean jam	0.086	do
Bleached candy	1.17	do
Beer	0.0182	product 1 kl
Alcohol from sweet potato	0.336	raw material 1 t
Alcohol from corn	3.6	do
'Miso'	0.16	product 1 t
Soy	0.02	1 kl
Sodium glutaminate	1.9	1 t
Antibiotic	0.06	1 kg
Fruit processing orange	0.05	raw material 1 t
Fruit processing peach	0.46	do
Fruit processing tomato	0.15	do
Seed oil	0.0013	product 1 kl
Butchery	0.0055	a pig
Meat processing	0.51	product 1 t
Milk	0.035	do
Canned fish paste	1.2	do
Boiled fish paste	0.667	raw material 1 t
Leather	0.66	raw hide 1 t
Hair washing	1.3	wool 1 pound
Viscose	0.33	product 1 t
Sulfide pulp	0.006	raw pulp 1 t
Kraft pulp	0.004	do
Chemical pulp-Na	0.013	do
Chemical pulp-NH_3	0.03	do

5) Deposit of phosphorus in Japan

The total amount of phosporic acid applied to the entire cultivated land in Japan during the past seventy years starting from 1903, when the amount of applied phosphoric acid became known for the first time, to 1972, is 20,277,000 tons in P_2O_5. If the maximum figure of loss, 2 kg/ha/yr, shown above is used for the calculation, the total loss during the seventy years would be:

2 kg×5, 700, 000 ha×70 years=798, 000 tons

If the availability of phosphorus by crop plants is estimated to be 30%,

20, 277, 000 t×(1−0. 30)=14, 194, 000 tons
14, 194, 000 t−798, 000 t=13, 396, 000 tons
13, 396, 000 t÷5, 700, 000 ha=2. 35 t/ha

As the weight of cultivated soil of 20 cm depth per 1 ha is approximately 2,000 tons, the content of residual phosphorus would be about 1,200 ppm.

If it is assumed that the availability by the principal crop is 30% and the one by the second crop is 20%:

20, 277, 000 t×(1−0. 50)=10, 138, 000 tons
10, 138, 000 t−798, 000 t=9, 340, 000 tons
9, 340, 000 t÷5, 700, 000 ha=1. 64 t/ha

Therefore, the content would be 820 ppm.

In other words, on the assumption that the acreage of the total arable land in Japan has been kept unchanged to be 5,700,000 ha, P_2O_5 content in the arable soil would be 800 to 1,200 ppm. As Black[3] pointed out, these figures suggest that Japanese soil may well be concluded as "rich in phosphoric acid."

6) Outgoing of phosphorus for industrial uses

Table 16. Phosphorus content of various sludges

Sludges	Range	Total P_2O_5	Number of samples
Food processing plant	max	3.87	
	min	1.71	15
	mean	2.95	
Medicine manufactory	max	3.39	
	min	1.05	6
	mean	2.25	
Pulp manufactory	max	3.08	
	min	1.26	3
	mean	2.37	
Chemical plant	max	4.39	
	min	0.79	6
	mean	2.69	
Night soil	max	10.13	
	min	7.40	3
	mean	9.00	
Sewer sludge	max	3.12	
	min	0.65	5
	mean	2.02	

Phosphorus compounds which are produced from phosphate rock for industrial uses finally flow, either through sewers, rivers and canals, or directly into the ocean, after being utilized. Ukita[2] reported that the flow-out ratio is as shown in Table 16. When phosphorus in the sewer is recovered at sewage plants, the recovery ratio is about 85 to 95%. The remaining phosphorus flows into the ocean at the last stage.

7) Phosphorus in various wastes and its outgoing

Wastes can be divided into the following three groups by their constituents and properties: 1) industrial wastes, 2) household wastes, and 3) livestock-poultry excrements.

1) Industrial wastes: Table 16 is a list showing kinds and amounts of phosphorus-containing industrial wastes (various sludge). Phosphorus in this category flows into the ocean through the process similar to the one contained in the industrial chemicals mentioned above.

2) Household wastes (urban waste): Almost all phosphorus in this group also goes into the ocean in the same way as in the case of industrial chemicals.

3) Livestock and poultry excrements: The number of livestock and poultry, amount of their excrements, and amount of phosphorus contained are presented in Table 17. Among them most of the excrements from cattle are recycled to cultivated lands or grasslands, and fawl droppings are applied as fertilizer to arable lands because of their high fertility. As to the excrement of hogs, it is mostly thrown to rivers and ocean.

8) Outgoing of other phosphorus-containing materials

Phosphorus contained in iron ore mostly translocates into the slag during the process of refinement in blast furnaces or converters, and, partly, it is volatilized in the air. The amounts of blast furnace slag and converter slag produced in 1971 were 22×10^6 tons and 6×10^6 tons respectively. Among them about 600,000 tons was pulverized and applied to arable lands as silicate fertilizer. The remainder was utilized in constructing piers and roads as building materials. Phosphorus in the slag used for the latter purpose is far less soluble than that in the slag used as fertilizer.

Remarks on the data

Some part of the statistical figures on phosphorus translocation is not so accurate due to the present unsatisfactory techniques in phos-

Table 17. Total livestock excrement and P_2O_5 content (1971)

Livestock	Number of heads ($\times10^3$)	Excrement weight (kg/day)	Total weight (estimate value) (1,000 M. T/year)	P_2O_5 Content %	P_2O_5 Total weight (1,000 M. T/year)
Milk cow	1,856	31	21,001	0.35	73.5
Beef cattle	1,759	31	19,031	0.35	66.6
Pig	6,904	6	15,120	0.20	30.2
Horse	190	15	1,040	0.35	3.6
Broiler	63,114	0.075	1,728	1.5	25.9
Hen	172,226	0.15	9,429	1.5	141.4
Total					341.2
Man	100 million (adult 70%, child 30%)	1.5	46,538	0.10	46.5
Grand total			113,887		387.7

phorus determination and lack of reliable information.

Statistics of the year, 1971, are utilized in the present report because that year is considered to be normal regarding the economic activity in Japan, as compared with 1972 or the following years when the supply and demand situation showed a somewhat different trend in the country due to the abnormal weather recorded in 1972 throughout the world and also due to the outcome of the oil crisis which became noticeable in that year.

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