Areal Analysis of the Milch Cow Keeping in Japan**

— Some Problems on Circular Structures —

Ken-ichi TANABE*

I. Undeveloped Circular Structures of City-milkshed.

Since the theory of H. v. Thünen was made public, there have been many studies of the circular patterns of agricultural management-systems in compliance with the distance from a consumptive city. The agricultural system with milch cow keeping, as one of the circular structures, is naturally situated in the inner zone in contact with the city as its city-milk-supply area and in the outer zone distant from it as its raw-milk-supply area. However, the farms keeping milch cows in Japan do not constitute such a simple arrangement. It is a matter of course that there is a clear difference between the theoretical circular structures and the geographical pattern because of the diverse nature of geographical environment. But the agriculture of Japan did not adopt milch cows originally,⁽¹⁾ so it is unable to discuss the distortion of arrangement of milch-cow-keeping regions only from the view-point of geographical environment.

For instance, Tōkyō has been supplied its market milk from the area from all over the Kantō Region to a part of the Chūbu Region.⁽²⁾ But in Chiba Prefecture which is the nearest one to Tōkyō, its whole production of milk is consumed more than 60% as raw milk, therefore the prefecture belongs to the group of raw-milk-producing prefectures. In Kanagawa, Gunma, Saitama and Ibaragi Prefectures the raw milk percentages are 48–38%⁽³⁾. That is to say, the milch cow keeping within the milkshed of Tōkyō can not be recognized to coincide with that of the city-milk-supply area as a circular structure. The milk which is produced in Nagano Prefecture, the Chūbu Region, is transported to Tōkyō for its market-milk supply during summer, but in the other seasons the milk is almost consumed as raw milk. The amount of city milk consumed in the prefecture is very little (about 14.3% in 1952) and is treated by the small factory of the dairy association near each city. And the consumption of raw milk is made by the other dairy manufacturing factories managed upon the capital from Tōkyō. Those manu-

*Assistant Professor of Geography, Faculty of Science, Tōhoku University.

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(1) Author's 7th Report (1953), p. 2.

(2) *ibid.* (1): p. 7 & Fig. 4.

(3) *ibid.* (1): pp. 5~6 & Fig. 3.

facturing factories are not those which are equipped simply enough to consume the rest of the milk within a city-milkshed, but the Matsumoto Factory (Morinaga Milk Industries Co.) is the largest one in Japan in scale and the Ueda Factory (Meiji Milk Products Co.) was also enlarged in Oct. 1954 to the scale comparable to that of the former, and the Nagano and the Hiraga Factories compare favourably with the large-scale factories in the Tōhoku Region.⁽⁴⁾ However, the fact that liquid milk is sent to Tōkyō from such factories whose object is to deal

Fig. 1 Distribution of dairy manufacturing factories in Nagano Prefecture (left), annual amount of gathering milk and city-milk-producing ratio of these factories (right) and index map (middle).

The index map shows the site of Nagano Prefecture, the M_1 and M_2 milch-cow-keeping regions in Tōhoku Districts, and the estimated potential circles of city-milk-supply area of Tōkyō and Sendai. The Taishin Factory which is near the Matsumoto Factory has not any data, so it is not shown in the right map. The Oosawa Factory which is near the Ueda Factory is likely a gathering station, that is, it supplies the whole milk gathered by it to a dairy factory in Gunma Prefecture. The Matsumoto Factory gathers the milk from its own milkshed and its branch factory M_1 . And it usually supplies a little amount of city-milk to Matsumoto City. The (S) Factory, which was near the southern part of Nagano Prefecture, moved to the east-side of its milkshed and changed its name with the enlargement of its scale and capital. This process is clearly shown in the curve of the Fuso Factory in the right map.

(4) *ibid* (1): pp. 11~14.

with raw milk, — even some of them and even only in summer, means that the milch-cow-keeping area to response the demand of Tôkyô is not enough developed in the vast zone — the potential circular zone of market-milk supply — where some portions of Kanagawa, Gumma, Saitama, Ibaragi, Tochigi and Chiba Prefectures are contained, although it is thought to result from the seasonal fluctuation of the amount of demand for market milk in Tôkyô, from another point of view.

On the other hand, concerning the milkshed of Sendai which has a population of one-twelfth of Tôkyô, there was a narrow circular zone of its city-milk-supply area in old days (about 50 years ago). In the zone milch cows were kept by the distributors whose object was the production and supply of city milk. But, even in 1949 when the consumption of milk was controlled, the liquid-milk production in that zone was not enough to the amount of milk-consumption in Sendai. Therefore those distributors filled up the lack by buying the milk from the milch-cow-keeping farms which lay on the remote site from Sendai and had not the object to produce the city milk. This fact means that the old circular milkshed was destroyed owing to the retreat of the restriction of distance due to the improvement of the condition of communication, and a wide circular milkshed becomes possible to come into existence, and that the farmers are able to change their purpose for the production of city milk with the advance of the demand of city milk, when they have kept milch cows and been engaged in the production of raw milk since the early age. That is, the latter is profitable than the former, so the dairy manufacturing factories at Ishinomori (60 km north of Sendai) and Tajiri (40 km north of Sendai) were forced to suspend their work as a result of the diminution of raw milk supply. Since the dissolution of the control of city-milk demand, the demand of Sendai has heavily been promoted. The new factory established by a new dairy association has come to supply overwhelmingly much liquid milk than that of the former city-milk distributors. The milk gathering area of this factory is very wide, that is 120 km from north to south. And the members of this association are mostly the farmers possessing newly kept milch cows and have intended the supply of city milk from the outset.

In short, the potential city-milk-supply area become wide compared with the population of Sendai which consumes liquid milk, therefore within that area farmers are possible to keep milch cows at any place without any consideration of distance from Sendai. Consequently milch cow keeping is able to concentrate in the several places favoured by the environments. But, now, in actuality such concentration cannot be seen and no area dominates on milch cow keeping. That is, one reason of the aspect of such a wide-spread milch cow keeping is that it was started unconsciously and without any consideration of geographical environment,

urged by the boom of "dairy farming"⁽⁵⁾ in Japan.

In other words, the first example shows the under-differentiation and under-development of city-milk-supply circle and the second example the under-

Fig. 2 Milkshed of Sendai in 1954.

In Miyagi Prefecture dairy manufacturing factories are not located except one, Tsuya Factory, at present. So this prefecture is an interesting area as a vacant ground in the midst of the raw-milk-supply prefectures. Milch cow keeping has been started by the city-milk distributors in the suburbs of Sendai since early times (about 70 years ago). Now there are seventeen distributors, but most of them have been included in its new residential area.

(5) *ibid* (1) : p. 1.

differentiation of milch-cow-keeping area. The facts make the author think that the forces of the traditional agricultural system of Japan which did not experience milch cow keeping in former times are so strong that some of the geographical environments — physical, social and economic — are ignored.

II. Milch-Cow-Keeping Region and Site of Dairy Factory in Tōhoku Districts

The Tōhoku Districts, except Miyagi Prefecture, belong to the raw-milk-supply zone to the demand of dairy products in Tōkyō.⁽⁶⁾ The regions keeping milch cows in the districts were already shown with the aid of the numbers of milch cows in 1951 and 1953,⁽⁷⁾ and the ratio of the milch-cow-keeping farmers to the whole farmers (the milch-cow-keeping ratio) in 1954.⁽⁸⁾ And the dairy manufacturing factories and their milk-gathering area were described in 1953.⁽⁹⁾ From these articles, it is known that the only five factories are placed within the milch-cow-keeping regions, the other factories in the area having low ratios of milch-cow-keeping farmers. Namely, in the M_1 milch-cow-keeping region (the northeastern part of the Yonezawa Basin) is situated the Takahata Factory of Nihon Milk Manufacturing Co.; in the M_3 milch-cow-keeping region (the northern Kitakami Mountain Land) exist the Iwaizumi Factory of Meiji Milk Products Co. and the Kuzumaki Factory of Moriyama Co.; in the M_4 region (the southern part of the dissected tableland of San-nohe) is the Herai Factory of Herai Dairy Association, and near the M_2 region (the southern part of Kitakami Mountain Land) the Takekoma Factory of Meiji Milk Products Co.. On the other hand, the other chief factories — the Fukushima, Ishikawa and Morioka Factories of Morinaga Milk Industries Co., the Kaminoyama and Shinjō Factories of Meiji Milk Products Co., and the Hanamaki, Aozasa and Ichinoseki Factories of Snow-Brand Milk Products Co. have no relation to the above milch-cow-keeping regions. These outer factories had to have the vast milk-gathering areas because of the dispersion of milch-cow-keeping farmers, and with the rise of milch cow keeping, to divide the gathering areas by the construction of another factory in the area. The process of the segmentation has recently occurred and the mother factories are generally the lately established ones.⁽¹⁰⁾ On the contrary, the factories which stand in the area whose

(6) *ibid* (1): pp. 5~6 & Fig. 8.

(7) Author's 6th Report (1951): pp. 13~15 & Fig. 3; *ibid*. (1): pp. 4~5 & Fig. 2.

(8) Author's 9th Report (1954): pp. 106~108 & Special Map.

(9) *ibid*. (1): p. 8 & Fig. 5, pp. 9~16.

(10) *ibid*. (1): p. 12 Fig. 8, p. 13, Fig. 9 & pp. 14~16.

R. Kaneda described in 1954 that the Ishikawa Factory of Morinaga Milk Industries Co. was established in the southern part of milk gathering area of the Fukushima Factory. This segmentation was suggested in Author's 7th report, and another segmentation which was suggested in the same report has lately appeared.... The Hanamaki Factory captured the southern part of the milk-gathering area of the Morioka Factory in 1953.

milch-cow-keeping ratio is more than 50 % were established in comparatively early times⁽¹¹⁾ and the scale of factories has been enlarged with the development of milch cow keeping, although in those days the circumstances did not allow the factories to have a large-scale equipment and the topography prevented some of them from gathering the milk from a broad area. From these phenomena, it is confirmed again that milch cow keeping and its region have an indivisible relation to a dairy manufacturing factory⁽¹²⁾ and it is thought that the region, where the milch cows have been kept since early days, has kept holding domination in keeping-ratio, because the milch cow keeping was taken in the old agricultural system of Japan only ninety years ago. That is, the author thinks that time element exerts a strong action on milch cow keeping⁽¹³⁾ than geographical environment. Then, why were milch cows kept earlier in such a region?

The author thinks that it was due not so much to the geographical environments of the region as to the mere voluntary choice. This thought is proved by the facts that within the milkshed of a large-scale factory established later there are the parts where the ratio of milch-cow-keeping farms is rising up rapidly at present.⁽¹⁴⁾

III. Circular Structure within Milch-Cow-Keeping Region

When milch cow keeping begins in an area which has never experienced it, the first keeping begins as a point. That is, the milch cow keeping is often begun by a person — an enlightened person or an influential person or a diligent farmer — for an endeavour to get out from the old traditional agricultural system.⁽¹⁵⁾⁽¹⁶⁾ These persons exist in every area, but a person voluntarily becomes the starting point of milch cow keeping, and it is difficult to recognize that his appearance is inevitable. And then the milch cow keeping gradually develops from such

(11) The Takahata Factory was established in 1914; the factories Kuzumaki and Iwazumi in 1930.

(12) *ibid.* (1) pp. 7~3 & p. 17.

(13) The differentiation of livestock regions was discussed in his 9th report according to the characters of topography, but the effect is not a direct one except the horse-keeping regions in mountainous land.

(14) For instance, the northeastern piano of Iwate Volcano 20km north of Morioka and the reclaimed land at San-nôkai 15km south of Morioka in the milkshed of the Morioka Factory.

(15) The condition of Hokkaidô is different from that of Tôhoku. That is, the milch cow keeping in Hokkaidô is led by the Authority and the agriculture in that area has no tradition.

(16) Although there are the processes of changing horses for cattle, and afterwards cattle for milch cows (the 8th report and 9th report), milch cow keeping is different from horse or cattle keeping in the position occupying in agricultural management.

an origin, and a dairy factory is invited to the point. An advancement of the milch cow keeping goes speedily following the establishment of the factory, and a milch-cow-keeping area is formed in such a process.

If a geographical environment is uniform, the advancement of milch cow keeping shows a concentric zoning from the origin as its centre, and the dairy factory is situated at its centre. Then, the milk-gathering area is expanded with the addition of milch-cow-keeping farmers to the surrounding area and the factory is also increased in equipment with the increasing amount of gathering milk. But this circulatory process does not continue endlessly. The limitation is as follows: (A) When the transportation cost of milk is charged to the farmers keeping milch cows, the limit of milk-supply area to a factory is the place where a favourableness of milch cow keeping in the agricultural management becomes lower in proportion to the distance from the factory, until at last it is completely lost. The milch-cow-keeping region covers

Fig. 3 Relation of carriage (yen/kan) to distance in milkshed of Takahata Factory

as far as such places. (B) When the transportation cost is paid by a factory, as it is pooled, the price of milk is not related to the distance and is the same to the farmers whether they live near or distant from the factory. Therefore when the profit of the factory is equal to that of the factory in the case of A, the limit of milk-gathering is the range as wide as that of the case A.⁽¹⁷⁾ (C) When the increase of the equipment of a factory ceases, the enlargement of a milkshed and milch-cow-keeping area runs against a deadrock at the time when the capacity of the equipment balances to the production of milk of the area. The range formed at this time is a limit in appearance only. But this limit shifts inward at the time when the density of milch cow keeping in the area becomes higher, and shifts outward when the density becomes lower. However, the limitation of outward shifting is the same in the cases of A and B.

An economic concentric zoning is found, within the area limited as above, by the carriage charge of milk, or the rate of profit on a farmer or a factory.⁽¹⁸⁾

(17) The broad milk-gathering area of the outer large-scale factory is maintained by diminution of the profit of a factory or by the sacrifice of the profit of farmers. But probably the former may be an actual one as the process of segmentation of the milk-gathering area has been usually seen.

(18) Namely the vast range is only an apparent limit of a milch-cow-keeping region. It is found by allotting the profit of factory to farms.

But it does not show the zoning represented by a circular structure of the expansion of a milch-cow-keeping region. The author takes up five elements showing the circular structure with the expansion of the zone. They are as follows :

- (i) The time that a milch cow keeping begins among farmers
- (ii) The rate of milch-cow-keeping farmers to whole farmers
- (iii) The number of cows of excellent breed
- (iv) The average production of milk of a cow
- (v) The amount of fat contained in milk

These five elements, under the supposition that the geographical environment of a milch-cow-keeping area is uniform, also show the circular structures of the expansion as well as the economic concentric zoning. That is, (i) the time that milch cow keeping has begun forms a circular structure as the function of the time of propagation. (ii) Its meaning will be self-evident. (iii) The farmers having kept milch cows since early times exchange the cows with excellent cows by the profit that had been got within those years. (iv) Excellent cows produce a large amount of milk and (v) its milk contains more fat. So several concentric structures are formed by each element.

Nevertheless, in actual land each element shows a considerably different distribution of its own. As was already mentioned, it is an voluntary phenomenon that milch cows were kept by farmers in early times, even though they took account of the geographical environment to some degree. While, an excellent milch cow gives plenty of milk containing more fat, but such nature is effected by its forage and the techniques of mangement. The latter raises a problem whether agriculture lays stress on the milch cow keeping or not. Therefore, here appear the effects of geographical environment. In the case of the ratio of milch cow keeping it is the same. As the milch cow keeping increases in the competition to other agricultural managements⁽¹⁹⁾, the difference of geographical environments causes the transformation of a circular structure.

Next let the author try to analyse by using five elements the areal structure of the region where the milch cow keeping predominates now.

M₁ Milch-Cow-Keeping Region (Northeastern Part of Yonezawa Basin⁽²⁰⁾)

In 1882 a private city-milk distributor kept milch cows at Takahata, and the farmers began to keep cattle (mixed-breed shorthorn) as milch cows in about 1892 and Holstein has been introduced since 1900. In 1914 a dairy manufacturing factory was established at Nijjuku as a private company, and in 1919 it became

(19) The author discussed the relation between the milch cow keeping and the management scale of farms in his 8th report, pp. 7~9, & 9th report, pp. 101~104.

(20) It is clearly seen in this basin what he described in the Shinjō Basin in the 8th report.

Figure 4 shows the annual total amount of milk gathered by the Takahata Factory and that of parting. In

the factory enlarged its equipment. And Miyauchi₍₂₇₎ and Inukawa₍₂₂₎ were added in 1940~1943. During this time the capacity of the equipment has been made larger every year since 1941. In 1945 Kanayama₍₂₉₎, Komatsu₍₂₁₎ and Yoshino₍₃₁₎ joined in the numbers of the milk-gathering area. The amount

(21) He described a general relation between the milch cows kept by farmers and those by distributors in 7th report, *ibid.* (1), pp. 2~3.

Fig. 5 Progression of milch-cow-keeping ratio

of milk gathered from Wada and Akayu especially increased and approached to that gathered by the old core. In 1945 the total amount of milk reached the maximum. The rate of increasing in the amount of milk from the core is smaller than that of the total amount. And the amount of milk from the core was brought to a stationary state. On the contrary a heavy increasing rate is shown in the part which began to keep milch cows later than the core. Therefore, the amount of milk from the core has decreased in percentage against the total amount of milk gathered by the factory.

In July, 1947, a small factory was started at Miyauchi by a dairy association, and pirated the northern part of the milkshed of the Takahata Factory with the result that the amount of milk gathered by the Takahata Factory diminished. The Miyauchi Factory has no statistical data, — not even the datum of the annual amount of gathered milk. If the total amount of the milk gathered from the area is added to the curve in Figure 4, the curve is expected to continue an increasing trend. As a substitute for it, the addition of the members of this association shows the increasing phase observed in Figure 7. The main body of the milk-

Fig. 6 Distribution of milch-cow-keeping ratio and 80% and 90% areas of Takahata's gathering milk.

gathering area of the Miyauchi Factory consists of Yoshino⁽²¹⁾, Miyauchi⁽²⁷⁾, Okigô⁽²⁵⁾ and Ringô⁽²⁴⁾. The eastern part (Nakagawa⁽³⁰⁾) of the milkshed at the first stage in 1947 was captured by the Kaminoyama Factory⁽²²⁾ and the southeastern part became included in the milkshed of the Takahata Factory.

In Nukanome and Kameoka several farmers have begun to supply the liquid

Fig. 7 Annual change of members of Miyauchi Dairy Association

milk to Yonezawa with the increasing of the city-milk demand since 1945 without supplying raw milk to the Takahata Factory. So the curve of the amount of milk gathered by the Takahata Factory declines.

Under such conditions the Takahata Factory supplemented the milk by gathering from the outward of the Miyauchi milkshed. Therefore the rate of the amount of milk of the old core has come up again nearly to that of the first stage. (Fig. 6₁₉₄₈)

The milk-gathering routes in the Takahata milkshed and the distribution of milch cows are shown in the Figure 8 at the present of June 15th, 1953. And the

(22) *ibid.* (1): p. 11 & 15

rate of the excellent cows⁽²³⁾ is in Figure 9. According to these figures, the factory is located in the communication centre in the chief milk-gathering area, and more milch cows are clearly observed to be kept in Niijuku, Takahata, Yashiro near the mountain land, forming a core of the milk-gathering area. But in the rate of excellent cows a belt of its high value is seen from the eastern mountainous parts to the western low basin. The villages which keep a few cows but have a high rate of excellent ones have almost kept milch cows since early days and in these villages new addition of the milch-cow-keeping farmers is seldom seen. On the

contrary the villages which keep many cows but a few excellent ones mean that new milch-cow-keeping has been begun one after another. Moreover, the milch cow keeping has already reached the stage of saturation in the villages that have not only many cows but also many excellent ones.

The total amount of milk gathered by the Takahata Factory and

Fig. 8 Gathering routes of Takahata Factory and distribution of milch cows in each village.

its mean fat-ratio in the last several years is shown in Figure 10. The monthly mean fat-ratio gradually declines and the amount of milk irregularly fluctuates, therein the seasonal variation is not recognized. This fact tells the change of the marginal structure of the Takahata milkshed caused by the scramble for

(23) There are four kinds of registration; descent, preliminary, formal and special ones. He has counted the total of these registered cows, even though the meaning of those terms differs a little in each other.

a milk-gathering area between Takahata and Miyauchi since August, 1946. But the effect does not reach the core of the Takahata milkshed. In the core area the distribution of the mean-fat-ratio in each parting in Nov. 1952 and in June, 1953 is shown in Figure 11 and 12. These patterns in winter and in summer show a sharp contrast between them. In winter a wide area of high ratio is in the basin and the patches of it are scattered in the mountain; and in summer those patches show a much higher ratio and so does the side of mountain

land, while that of the basin comes down. These seasonal difference in the distribution of fat-ratio is the effect of the physical environment through the agricultural management of this area. This will be able to be nearly estimated from the next table.

In each village in the area that shows higher ratios in both winter and summer the number of silos per

Fig. 9 Change of fat-ratio and amount of gathering milk in Takahata Factory in the last two years.

Fig. 10 Distribution of ratio of excellent milch cows in milkshed of Takahata Factory.

Table 1.

Name of village	Number of keeping-stocks in each village					Number of extracted farms****
	Total (A)	Milch Cows Excellent (B)	Milked (C)	Cattle (for agricultural labour) (D)	Horses (E)	
Fukanuma*	41	35	25	16	0	8
Suji**	61	34	33	5	0	9

*Fukanuma is in the low basin. **Suji (contained Tazawa) is in the mountain land.

****The right half of this table shows some of the farms extracted 20% by random

milch cow is 0.8 to 0.97, but in the low basin it is 0.2 to 0.45. The low land Fukanuma-village has 13 silos and the mountain Suji-village has 49 silos. As the capacity⁽²⁴⁾ of silos has much variety, strictly speaking, they can not be compared in number. But the very construction of silos is a good index showing the place that milch cow keeping occupies in the agricultural management.

Fig. 11 Distribution of fat-ratio in winter in milkshed of Takahata Factory.

Fig. 12 Distribution of fat-ratio in summer in milkshed of Takahata Factory.

Mean scale of agricultural management of extracted farms								
Number of stocks					Paddy field	Managed Dry area field	Forage field	Number of silos
Milch cows (A')	(B')	(C')	Cattle (D')	Horses (E')				
1.25	1.25	0.25	0.5	0	11.7	2.91	0.375	0.13
1.33	0.78	0.11	0.11	0	5.5	5.61	2.46	1.12

***1"tan" equals to 9.91 "are".

sampling from the milch-cow-keeping farms in the northern half of the Yonezawa Basin.

M₃ Milch-Cow-Keeping Region (Northern Part of Kitakami Mountain Land)

The M₃ milch-cow-keeping region accompanying the Mix₁ and Mix₂ Regions covers the midst of the stock-keeping regions of C₁₀, S₉ and C₉⁽²⁵⁾. But in about 1887 both the milch-cow-keeping region and the S₉ sheep-keeping region did not germinate at all, and these stock-keeping regions were contained in the former cattle keeping connected-Region C₉₋₁₀. In the former C₉₋₁₀ region, historically speaking, the purpose in cattle keeping was transportation and since the Meiji Era it has begun to bear the character of breeding and at the same time the cattle of Japanese Breed have been replaced with those of Shorthorn Breed. The milch cow of Horstein Breed has been taken in near the centre of this region since 1891. But before a dairy factory was established at Iwaizumi in 1930 the purpose in stock-keeping was also breeding⁽²⁶⁾. Afterwards the M₃ milch-cow-keeping region was differentiated from the C₉₋₁₀ region. The reason of this differentiation can not be grasped from the angle of physical environment. The author thinks that social environment is a prevailing one, because in the C₉₋₁₀ region the powerful tenant system of livestock⁽²⁷⁾ exists and in addition the starting point of milch cow keeping is certainly one of the nodes of such feudal ligament. That is to say, the M₃ milch-cow-keeping region was formed by accident and the division of the C₉ and C₁₀ regions resulted in the appearance of the M₃ region. In consequence, the establishment of the Iwaizumi Factory was the object in using the potential milk-production in the milch-cow-breeding area. So it is a special case of the relation between a factory and a milch-cow-keeping area which is shown in the Takahata Factory and others. However, these historical conditions do not effect the later expansion of a milch-cow-keeping region.

In the uplift of the amount of milk gathered by the Iwaizumi Factory since 1929 there are several steps (Fig. 13). The first step till 1941 shows a declining curve because of the gradual diminution of the number of milch cows and the amount of milk-supply. There are two main reasons in the diminution. The one is that the idea became prevalent among the farmers that breeding calf with the skim-milk returned by the factory is not good, though the farmers changed their purpose in milch cow keeping from breeding to producing milk. The other is the fall of milk-price. Therefore the gathering area was not expanded but clearly

(24) hight ("shaku") × diameter ("shaku") :

6×4, 6×4.5, 6×5, 8×4, 8×5, 8×5.5, 8×6, 9×5, 10×4, 10×5, 10×6, 10×7, 10×9, 11×6, 12×5, 12×5.1, 12×6, 13×6, 13×7, 15×6. (1"shaku" equals to 0.303 "meter")

(25) *ibid.* (8) : pp. 106~108 & special map.

(26) Author's 2nd report pp. 560~577.

(27) Author's 5th report, p. 55 & 63.

diminished. Since 1942 the stepping curve of the amount of gathered milk generally responds to the fluctuation of the whole number of milch cows in Japan,⁽²⁸⁾ though the decline in the War time is not so remarkable in this dominant milch-cow-keeping area as that of the number in whole Japan. The equipments of the factory were added in 1938, 1942 and 1946, and at that time each step of the curve began.

Fig. 13 Yearly amount of milk gathered by Iwaizumi Factory

Fig. 14 Monthly amount of milk gathered by Kuzumaki Factory

(28) *ibid.* (1) : p. 8.

Fig. 15 Monthly mean of milk gathered daily by Iwaizumi Factory

Fig. 16 Change of monthly mean fat-ratio of Iwaizumi Factory

The Kuzumaki Factory stands at the northwest edge of the M_3 region and gathers its milk from the northwestern part of the region and the Mix_1 region to the northwest of the former region. It was established at the same time as the Iwaizumi Factory, but it started as a small private factory. In 1935 it became an associational factory, and then in 1939 it was run on the capital of Moriyama Co. and grew to be ranked among large-scale factories. The monthly total amount of gathered milk and the annual mean of the monthly total amount of milk since 1940 are shown in Figure 14. The curve does not show a decline after the War as that of the Iwaizumi (Fig. 15) shows. This is an evidence that the M_3 region has gradually been expanded toward the northwest. The graph (Fig. 16) shows the monthly-mean-fat-ratio in the whole milk in the Iwaizumi Factory. The curve gradually rises, though a little, with a slight seasonal change. This tendency suggests the increase of excellent cows or the development of management technique or the combination of both.

The variation of the monthly total amount of the milk gathered by the Kuzumaki Factory shows a tendency similar to the curve of the monthly-mean amount of the milk gathered daily by the Iwaizumi Factory. That is, the amount of the milk gathered by both is less in winter and more in summer. This seasonal variation reflects the amount of the excretion of a milch cow. Generally speaking, the excretion of milk has a tendency to diminish at higher temperatures, and not to be reduced so much at lower temperatures if forage supply is adequate.⁽²⁹⁾ And in general in summer the excretion of milk also increases sharply owing to the growth of green grasses.⁽³⁰⁾ It is clear that these phenomena are inconsistent with each other. However, the latter tendency is described only in the literatures of Japan and is certainly true so far as Japan is concerned. The production of milk in the M_3 region and its surrounding area is very much in summer. The author interprets this fact to be either because temperature is not so influential a condition as forage⁽³¹⁾ in regard to the effects on the excretion of milk, or because the amount of forage shows a great effect under the condition of low-level-management. Although it is a slight rise, the seasonal change of mean fat-ratio has been shown in Figure 16, that is, the maximum ratio being always seen in winter and the lower ones from spring till autumn. Then the distribution of mean fat-ratio by each village is shown in Figure 18 and 19. Between the mean-fat-ratio

Fig. 17 Rate of second-class milk and its distribution along routes gathering milk in Kuzumaki milkshed. (The rate is the amount of second-class milk/the total amount of milk gathered by its factory.)

(29) Douglas H. K. Lee & Ralph W. Phillips: p. 406 & 419.

(30) T. Miyawaki (1953), and others.

(31) The temperature condition gives a large effect to the milk being transported. As the example of the Kuzumaki Factory showed in Figure 17, in a hot season according to the distance from the factory a worse effect is given to the milk.

of the total amount of gathered milk in the Iwaizumi Factory in Nov. 1952 and that in June, 1953 the difference is only 0.1%, the one being 3.4% and the other 3.3%. Nevertheless the patterns of the areal distribution in both seasons are quite different as Figures 18 and 19 show. At first sight, in summer fat-ratios are elevated in the whole area but the areas showing high ratios in winter are not seen. Therefore, in spite of the general elevation of fat-ratios, the fat-ratio of the whole milk comes down in summer. This will be easily understood relating to the distribution of the number of milch cows of villages (Figure 20). That is, the two areas showing high ratios in winter are the core area keeping many milch cows. The western area found in fat-ratio coincides with the centre of the rate of excellent cows. The high rates from this centre elongate along the main valley and form patches and gradually decline in the margin of milch-cow-keeping area (Figure 21). This distribution nearly forms a circular structure.

It is said from the view-point of the time of starting that the western core of fat-ratio which has many excellent cows is absolutely an old milch-cow-keeping area. And as the management-technique is good especially in winter, and the accommodation against winter is also good, the core becomes one of the highest fat-ratio areas. However in summer, forage is only green grass which is a rough one, so the fat-ratio comes down.

In the eastern fat-ratio core around the factory many milch cows have been kept but the rate of excellent cows is not so high. But in it the farmers are given an enough lead in milch cow keeping by the factory. Therefore in winter it shows high fat-ratios. However in summer under the forage condition the ratio declines more than that of the former core. In near future the core will form a new centre in the excellent-cow-keeping area.

The area, especially the northeastern part of the milk-gathering area, that has a lower rate of excellent cows has kept absolutely few number of excellent cows and shows a very low fat-ratio. Moreover, in the seasonal variation the fat-ratio in summer is 0.2 or 0.4% higher than that in winter. This variation is greater than that of the other areas. Accordingly, it shows clearly that the winter forage is very coarse, too. The area has lately entered the milk gathering area.

Generally in this region in summer time the amount of milk-production is much and its fat-ratio is higher, but at the two cores the fat-ratio is a little lower than that in winter. The author thinks that this fact is caused by the condition under which the management-technique of milch cow keeping is generally low except in the core areas.

Now, the milch-cow-keeping region can be divided into its core area and its marginal area from the results of the areal analysis through the five elements. Especially in the M_3 region the rate of excellent cows shows a typical circular

Fig. 18 Distribution of fat-ratio of Iwaizumi Factory. (winter)

Fig. 19 Distribution of fat-ratio of Iwaizumi Factory. (summer)

Fig. 20 Distribution of milch cows and milk-gathering routes in Iwaizumi milkshed.

Fig. 21 Distribution of ratio of excellent milch cows in Iwaizumi milkshed.

structure. Although the fat-ratio of milk and the milch-cow-keeping ratio are arranged to make concentric zones theoretically, yet in the present area they appear strongly on areal contrast and weakly on circular structure. The areal contrast is able to be understood as a transformation by the effect of physical conditions, however it is not a direct effect but an indirect one mainly through the management of milch cow keeping.

Then, these milch-cow-keeping regions, formed by the propagation around the starting point of a voluntary origin, have been maintained for a long time and extended gradually. This fact may suggest as a matter of course that in these areas there are some excellent characters in the physical, economic or social environments. But it is beside the purpose of this paper to refer to such characters.

IV. Summary and Conclusion

From the macroscopic view: (1) The zone of liquid milk production of a metropolitan city has not been completed yet, contrary to the expectation of its completeness under an economic condition, one of the geographical environments. Therefore the zone penetrates into the zone of raw milk production in summer when the demand of city milk rises. (2) The zones of the other cities are seen forming a small circle around each of them in the case of the cities inside the raw milk zone. And in a city outside the raw milk zone the city-milk-production circle has a vast area, whose width is equal to that of the metropolitan city. So, in the circle, the milch cows are kept very coarsely, despite of the existence of possibility to concentrate in a favourable area in geographical environment, physical and social. (3) The milch-cow-keeping region which is found in the circle of raw milk production was brought into being not because of its excellent geographical environment of any type, but because of the voluntary choice of a keeping area. Moreover the constitution of the region is greatly due to the early start of milch cow keeping.

These phenomena result from farmers' little selection of geographical environment due to the lack of their full acquaintance with agricultural system accompanying milch cows, as the agriculture of Japan did not keep milch cows originally, and from the less weeding action by geographical environment due to so short a period since cows began to be kept comparatively later.

In the microscopic view of milch-cow-keeping region: The circular expansion-structures of the region are distorted in the actual land, even though they are typically shown by the theoretical distribution of each index-element. The variety of physical environment reflects the distortion of the circular expansion-structures through the agricultural management, an economic one in the geographical environments, and it will be interesting to study the reflection from the view-point of

agricultural management.

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