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THE INFLUENCE OF FARMING AND FEEDING PRACTICES ON Cs^{137} AND Sr^{90} CONCENTRATION IN FODDER, MILK AND EXCRETA

By

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Measurements of Cs^{137} and Sr^{90} in Norwegian milk since 1956 have revealed significant variations from district to district (2, 5, 6).

The deposition of Cs^{137} and Sr^{90} on the ground also varies from one district to another, and is approximately proportional to precipitation (3, 4). The concentration of Cs^{137} and Sr^{90} in milk, however, is not proportional to precipitation (2). The uptake in milk therefore also depends on other factors such as fodder composition and methods of cultivating the grazing fields. Milk from districts with low precipitation but unworked grazing fields has been found to have a higher concentration of radioactive material than milk from districts with high precipitation but well worked grazing fields. It seemed important then, to look for the same tendency under extreme conditions, i. e. in districts with high precipitation and extensive grazing and feeding conditions. Such extreme conditions exist in certain districts of Western Norway.

Investigations on uptake of Cs^{137} and Sr^{90} in milk in such a district were initiated in the fall of 1963 (11) and have been continued during the years 1963—1966.

The present communication presents results and conclusions from this study.

MATERIAL

The sampling has taken place in a district on the west coast of Norway, where the mean annual precipitation is about 3000 mm. A number of farms have been visited in order to collect samples and to study the farming and feeding practices. The first samples were taken in the autumn of 1963 from farms A and G—N. Since then samples from farm A have been collected and measured about once a month. Other samples were taken in the autumn of 1966 from farm A—H. The samples consisted of milk, fodder and animal excreta. Furthermore, soil samples were also taken to determine the activity of Cs^{137} in the top layer of the ground. The samples were taken within areas not worked for the last 10 years.

RESULTS AND DISCUSSION

Farming practices in Norway are not uniform, even within limited localities, and in the district in question extensively as well as rather intensively worked farms can be found. The farms under investigation have been classified according to farming

Farm	Number of cows	Fodder used			Soil treatment		Classifying marks
		Hay	Silage	Concentrates	Commercial fertilizer	Ploughing	
A	3	+	(+)	(+)	−	−	×
B	3	+	+	−	−	(+)	× ×
C	1	+	−	−	−	−	×
D	6	+	+	+	+	+	× × ×
E	1	+	−	−	−	−	×
F	3	+	−	+	+	+	× × ×
G	7	+	+	+	+	+	× × ×
H	3	−	+	+	−	÷	× ×

Figure 1. Classifying factors for farms investigated in 1966.

and feeding methods (Fig. 1). This classification is to some extent subjective, but there is a wide gap between the most extreme categories. The farms have been divided into three classes and allotted one, two or three marks, one mark symbolizing the most extensive way of farming. Fig. 1 shows factors of importance in the classification in 1966. The farms investigated in 1963 were given values in the same way.

In Fig. 2 are given measured values of Cs^{137} in milk from different farms. The samples have been arranged in order of

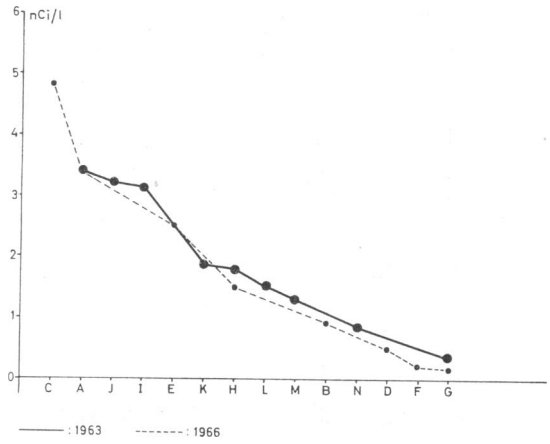

Figure 2. Distribution of farms arranged according to the content of Cs^{137} in milk.

decreasing values. Farms A, G and H were investigated both in 1963 (11) and 1966 (13). As can be seen from Fig. 3, there is a remarkable difference in the content of radionuclides in milk from the farms concerned. The average ratio between the three

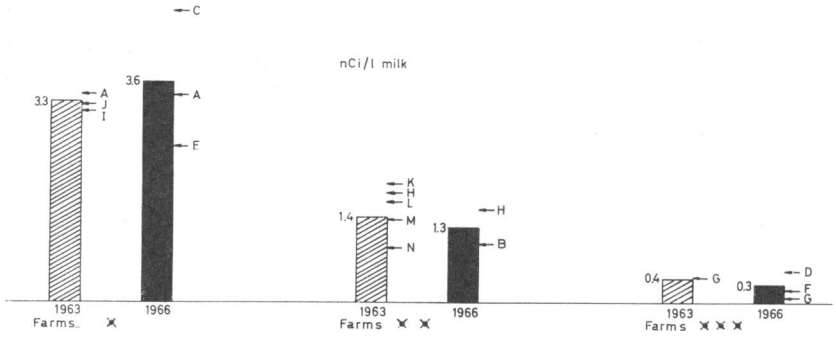

Figure 3. Average values for Cs^{137} in milk samples taken from various farms in 1963 and 1966. The farms have been grouped according to farming practices (Fig. 1). The arrows indicate the values for individual samples.

groups is found to be 1:3.5:10, and the results strongly indicate a correlation between farming practices and Cs^{137} concentration in milk. This is in agreement with later pasturing experiments made in USA (8).

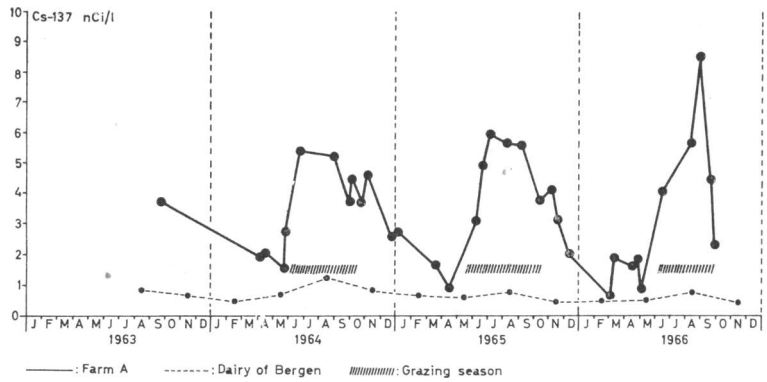

Figure 4. Content of Cs^{137} in milk.

In Fig. 4 the concentration of Cs^{137} in milk from farm A during the period December 1963—November 1966 is shown (1, 7, 9, 11, 12, 13). There is a marked seasonal variation, the highest values being found in the summer period June—September. This variation is a result of a change in the fodder composition. During the summer period the fodder requirement of the milking-cows is mainly met by grazing the meadows and fields. The relatively heavy precipitation at this season results in a marked increase in the direct contamination of the fodder consumed. Another factor of importance is the slow growth of the grass in those fields, compared to the better cultivated ones supplying the winter fodder, and the fact that the animals have to graze a wide area to meet their energy requirement. During winter time hay is the main fodder with some addition of silage and concentrates containing a considerably lower percentage of radionuclides than hay. During the spring farmer A also has to supplement the fodder with hay grown in other districts. This "imported" hay usually has a lower content of nuclides than his own, resulting from the drier climate and more intensive farming.

In Fig. 4 the values of Cs^{137} in milk from farm A are compared to the values of samples taken at the Dairy of Bergen, which receives milk from a wide area of the west coast. There seems to be a certain correlation between the two curves, even though the seasonal variation in the values of the dairy milk is rather small. The average ratio between the farm milk and the dairy milk in summer is 8 while the corresponding ratio for the winter season is 2.

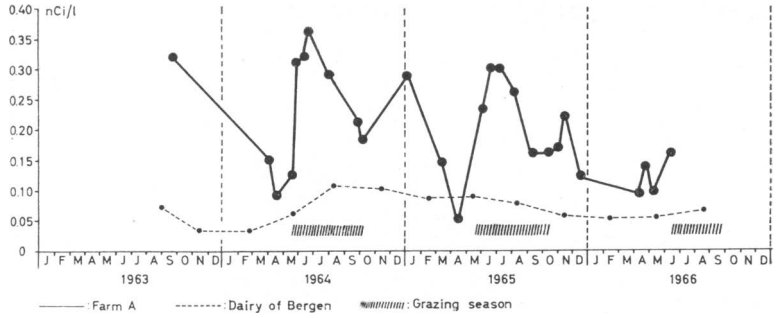

Figure 5. Content of Sr^{90} in milk.

Similar results of measurements of Sr^{90} in milk from farm A and from the Dairy of Bergen during the same period are shown in Fig. 5. The same seasonal variations are apparent, though somewhat more indistinctly. The average ratios between the two milk supplying sources are 1.3 for the winter and 3.4 for the summer season.

This wide difference between farm A and the Dairy of Bergen should be noticed. It points to the fact that farms of the one-mark group play an absolutely inferior part in the production of dairy milk.

In Figs. 6 and 7 are plotted values of Cs^{137} resulting from measurements of hay, urine and faeces at farm A during the

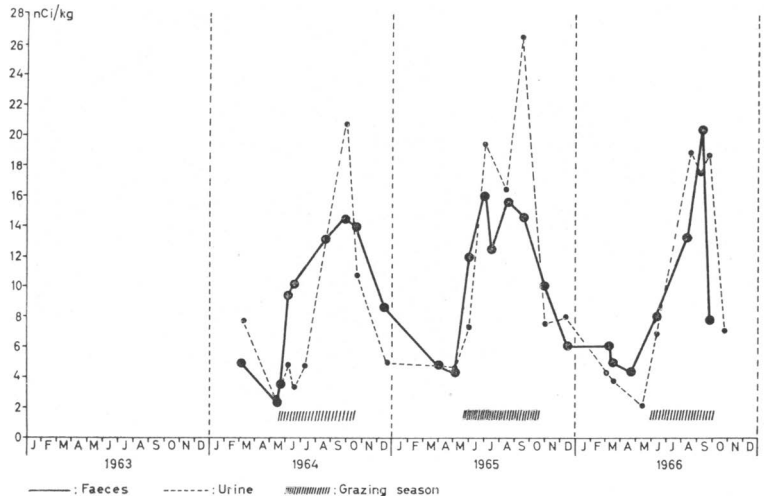

Figure 6. Content of Cs^{137} in animal excreta from farm A.

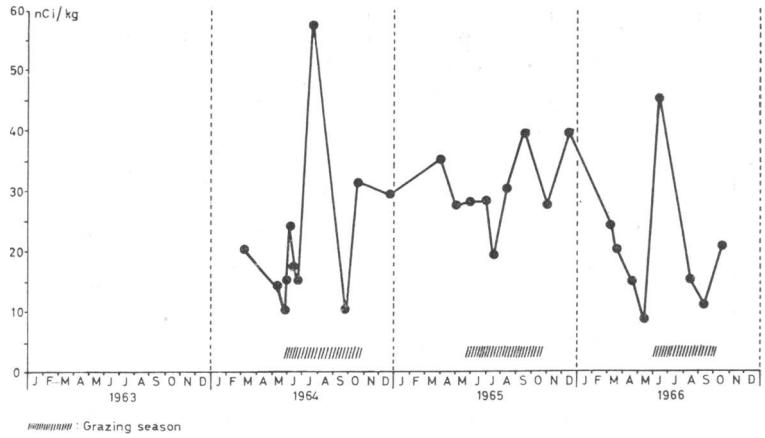

Figure 7. Content of Cs^{137} in hay from farm A.

period 1963—1966. The seasonal variations in the milk activity evident in Fig. 4, also appear for food and excreta, giving typical peaks in the curves of excreta during the summer months. It will be seen that the curve for Cs^{137} in hay does not give such typical variations as do the curves for excreta. It would seem reasonable to suppose that the true curves for the fodder consumed should correspond rather closely to those of urine and faeces. It is interesting, too, that the content of Cs^{137} varies with a factor of 4 within the same winter season. Most probably this variation should be attributed to the taking of samples, representing old and newly harvested hay and hay of different qualities. For instance the sample giving the extreme value of 57 nCi/kg in 1964 was noticed to be of extremely bad quality.

The measurements of soil samples revealed an average value for Cs^{137} of 182 mCi/km^2, while the corresponding average value for Northern Norway is 100 mCi/km^2 (13). This difference is expected to be mainly due to higher precipitation on the west coast, but other factors may be of importance. There is reason to believe that local topography can be a determining factor, not only for the precipitation but also for the fallout (10).

A certain amount of precipitation along the coast can cause heavier contamination of the soil than the same amount inland (10). There is no great variation between the various groups of farms in the district as regards the content of Cs^{137} in soil.

This fact strongly supports the theory that farming and feeding practices are of great importance for the radionuclide contamination of the dairy products.

CONCLUSIONS

The investigations seem to prove that farming and feeding practices are of decisive importance for the uptake of radionuclides in animal products.

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SUMMARY

In a district on the west coast of Norway where the annual precipitation is about 3000 mm, the content of Cs^{137} in cows milk, fodder and excreta from 14 different farms have been measured during the period 1963—1966. The farms have been classified according to farming and feeding practices. There is strong correlation between extensive farming and high concentration of radionuclides. The average content of Cs^{137} in milk samples from the most extensively worked farms is about 3.5 nCi/l, while the corresponding value for the relatively well-worked farms is 0.4 nCi/l. Similar variations are found for Sr^{90}. The seasonal variation in the radionuclide content is large, the highest values being found during the grazing period.

ZUSAMMENFASSUNG

Die Bedeutung der landwirtschaftlichen Betriebsmethoden für Cs^{137} und Sr^{90} Konzentrationen in Futter, Milch und Ekskreten.

Man hat eine Untersuchung über die Konzentration von Cs^{137} in Milch, Futter und Ekskreten der Kühe vorgenommen.

Die Proben stammen aus 14 verschiedenen Bauernhöfen in einem Distrikt in West-Norwegen, wo der Niederschlag ungefähr 3000 mm jährlich beträgt. Die Höfe sind je nach den benutzten landwirtschaftlichen Betriebsmethoden in drei verschiedenen Gruppen eingeteilt. Die Resultate der ausgeführten Messungen zeigen deutlich, dass die primitivsten landwirtschaftlichen Methoden mit den höchsten Konzentrationen von Radionukleiden verbunden sind. Der durchschnittliche Inhalt von Cs^{137} in der von den primitivsten Höfen gelieferten Milch, beträgt etwa 3,5 nCi/l, während der entsprechenden Wert für die relativ gut geführten Landwirtschaftsbetrieb 0,4 nCi/l beträgt. Das-

selbe Verhältnis ist bei Sr^{90} nachgewiesen worden. Man hat festgestellt, dass während des Sommers die grössten Konzentrationen von Radionukleiden auftreten.

SAMMENDRAG

Fóring og driftsforms innflytelse på Cs^{137} og Sr^{90} konsentrasjonen i fór, melk og ekskreter.

Fra et distrikt på vestkysten av Norge har en målt Cs^{137} innholdet i melk, fór og ekskreter fra 14 gårdsbruk. Den årlige nedbøren er i dette området ca. 3000 mm. Gårdsbruka er klassifiserte etter fóring og driftsform. Det synes å være en nær sammenheng mellom ekstensiv drift og høge konsentrasjoner av radionuklider. Det gjennomsnittlige innhold av Cs^{137} i melk fra de mest ekstensivt drevne gårdene er omkring 3,5 nCi/l, mens de tilsvarende verdiene for godt drevne gårdsbruk ligger på 0,4 nCi/l.

Tilsvarende variasjoner er funnet for Sr^{90} innholdet. Den sesongmessige variasjon i radionuklidinnholdet er stor. De høgste verdiene er registrert i beiteperioden.

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