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**Consumption and Utilization of Natural Foods
by the Common Hamster ***

[With 6 Tables & 1 Fig.]

The food preference of hamsters, *Cricetus cricetus* (Linnaeus, 1758), was investigated in summer and autumn by the method of stomach analysis. In summer green parts of wheat, rape and clover, as well as seeds of poppy and invertebrates, dominate in the food of hamsters. In autumn hamsters eat mainly clover, potatoe tubers, invertebrates and wheat corn. Moreover, consumption and utilization of concentrated foods (seeds of oat, wheat, corn, and *Vicia faba minor*), and bulky foods (green wheat, beetroot, alfalfa) was determined. The digested energy ranged from 56 to 91%, and metabolizable energy from 50 to 79%, and was higher for concentrated foods. On the basis of the obtained results an attempt was made to estimate the effect of hamsters on plantations.

I. INTRODUCTION

In order to determine the energy flow on the basis of feeding experiments it is essential to know the quality and quantity of consumed food, as well as the amount of energy assimilated by the animal and that dissipated from the organism to the ecosystem. This study was aimed at the determination of food preference of hamsters *Cricetus cricetus* (Linnaeus, 1758), and also estimation of consumption and utilization of natural foods by these animals.

Hamster is a hibernating and for this reason the period of its winter sleep has been mainly studied hitherto (Kayser, 1971); moreover, some authors investigated the biology and ecology of this species (Karaseva & Shilayeva, 1965; Erdakov, 1972; Mohr *et al.*, 1973). Hamster is one of the bigger rodents occurring in Poland; its range includes central and southern part of the country. As the predominantly herbivorous animal accumulating winter food reserves it can cause losses in the field crops.

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II. MATERIAL AND METHODS

The studies on the diet composition by analysis of stomach content and on the consumption and food utilization were carried out on hamsters trapped in the Vistula valley some 80 km east of Krakow.

The analysis of stomach contents was carried out microscopically following the method of Williams (1955, 1962), Holišova (1959, 1965) and Drożdż (1966). From each stomach usually 6 preparations were made, and additionally some control preparations were obtained from the most commonly cultivated plants in order to identify fragments of epiderm and starch in hamster stomach. The slides were analyzed under magnification 500X.

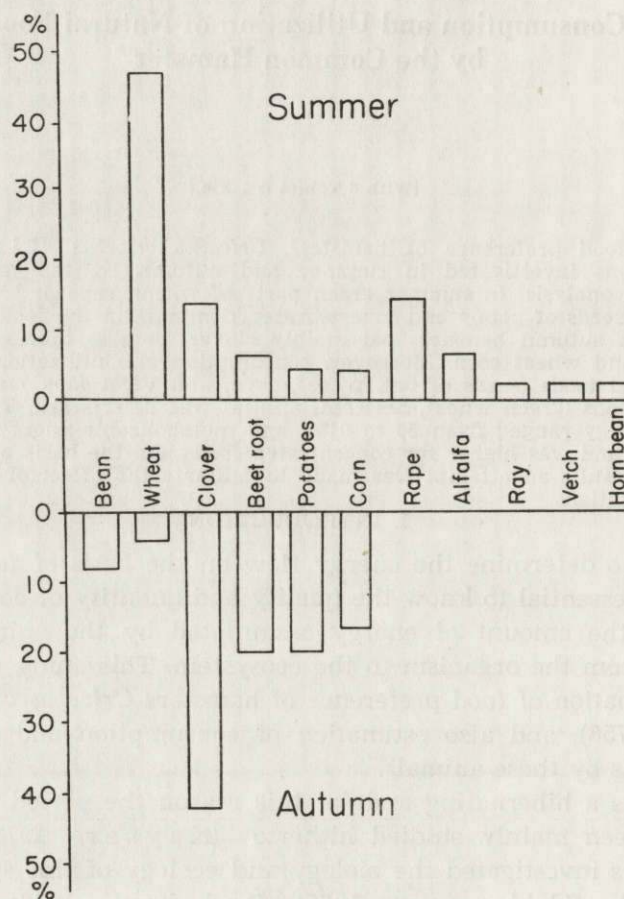


Fig. 1. Percentage distribution of hamsters trapped in different plantations.

For the studies of food composition 100 stomachs were used, including 75 organs from the animals trapped in summer 1972 (June, July) and 25 organs from the animals trapped in autumn 1972 (October, November) in various plantations (Fig. 1).

Consumption, digestibility and assimilation of 7 natural foods were investigated in the total number of 35 animals. In each experiment 4 to 7 animals were used.

The investigations were carried out using both bulky foods (beetroot, alfalfa, green wheat) and concentrated foods (oat, wheat, corn and *Vicia faba minor*). Hamsters employed in the experiments were kept singly in metabolic cages (Drożdż, 1968).

Five-day experiments were carried out at ambient temperature of $20^{\circ}\text{C}\pm 2^{\circ}\text{C}$ and at 12-hour light rhythm. Quantitatively collected faeces and non-consumed food were dried in an oven at 60°C while urine acidified with 1% H_2SO_4 was stored in a refrigerator at $+4^{\circ}$ (Drożdż, 1968).

The caloric value of food and faeces was determined in a calorimetric bomb (Górecki, 1965), while the caloric value of urine was determined with the method of Nijkamp (1965). The obtained figures were evaluated by Student's *t*-test.

III. RESULTS

1. Analysis of Stomach Contents

Macroscopic analysis of stomach contents showed the existence of such elements as roots, parts of stems, seeds, invertebrate animals and muscles of vertebrates. Altogether macroscopic parts of plants and animals were found in 53 cases out of 100 analyzed stomachs. The seeds of poppy and invertebrates occurred most often — in 41.5% of stomachs.

The presence of starch in the analyzed stomachs is strictly correlated with the type of actually cultivated plants. In summer the most fre-

Table 1

Foods identified in hamster stomachs by the analysis of starch granules in summer. Values indicate percentage.

Foods	Summer	Autumn	Annual mean
Seeds			
Wheat	75.5	16.7	60.6
Potatoes	3.8	44.4	14.1
Corn	13.1	22.2	15.5
Oats	3.8	5.6	4.2
Alfalfa	3.8	—	2.8
Beans	—	11.1	2.8

Table 2

Green parts of plants consumed by hamsters. Values indicate percentage.

Foods	Summer	Autumn	Annual mean
Wheat	31.6	15.0	27.5
Clover	16.0	25.0	18.1
Rape	16.1	—	13.4
Beet	11.5	12.5	11.7
Potatoes	3.9	22.5	8.2
Corn	6.1	12.5	7.6
Alfalfa	9.2	—	7.6
Oats	—	—	2.9
Beans	—	5.0	—
Others	5.6	7.5	3.0

quently was found wheat starch (75.5% of stomachs) followed by corn starch. Also some starch from potatoes, oat and alfalfa seeds were detected (Table 1). On the other hand, in autumn dominated potatoe starch (44.4%) and corn starch, while starch from wheat, beans and alfalfa was less abundant (Table 1). After summarizing the above data it appears that wheat starch dominated in the diet of hamster during the whole vegetation period as found in 60.6% of stomachs, while starch of corn

and potatoe occurred in approximately 14.5% of stomachs on the average (Table 1).

The results of microscopic analyses indicate that hamsters consume green parts of almost all cultivated plants. However, the type of food is strictly correlated with the season (Table 2). In summer epidermis of wheat was found most often in the stomachs of hamsters (31.6%), followed by rape and clover (16% each). Further place were occupied by beetroot, alfalfa, corn and potatoe. The epidermis of oat, *Vicia faba minor* and rye were found only occasionally. In autumn dominated clover and potatoes (24% on the average) followed by green parts of wheat, beetroot and corn (Table 2). Employing the analysis of epidermis 11 plant species commonly occurring in cultivated fields and consumed by ham-

Table 3

Foods consumed by hamsters (in percent).

Foods	Summer	Autumn	Annual mean
Seeds			
Wheat	17.7	5.0	15.2
Poppy	9.7	—	7.8
Corn	3.1	6.7	3.6
Greens			
Wheat	18.1	10.0	16.5
Clover	9.3	16.8	10.9
Rape	9.7	—	8.0
Beet	6.6	8.3	7.0
Potatoes	—	15.0	5.2
Corn	3.5	8.3	4.5
Alfalfa	5.3	—	4.5
Invertebrates	6.2	13.4	7.7
Vertebrates	—	3.3	1.2
Others	10.8	10.2	7.9

sters were identified. Wheat and clover, as well as rape and beetroot dominated during all the year (Table 2).

Estimating the composition of hamster's food by all the employed methods clearly indicates significant differences between summer and autumn. In summer green parts of wheat dominate (18.1%) and are followed by wheat grain (17.7%), as well as by green parts of rape and clover, and seeds of poppy. The food in this period also includes beetroot, invertebrates and green alfalfa. In autumn clover is the most often consumed food (16.8% of stomachs) followed by potatoes, invertebrate animals and green wheat (Table 3).

The summarized data on the food constituents consumed by hamsters during the whole year indicate that the diet is dominated by green wheat and its grain found in 16.5% of stomachs. Further places are oc-

cupied by clover, rape, poppy seeds, invertebrates and beetroots (found in seven to ten per cent of stomachs). Seeds of grass, rape and oat were observed in very few cases only (1 to 1.7% of stomachs) while the presence of green parts of rye, bean and seeds of alfalfa and bean, as well as muscles of vertebrate animals was below 1% (Table 3 — others).

2. Consumption and Utilization of Foods

Studies on the consumption, digestibility and assimilation were carried out on natural bulky and concentrated foods. Hence the examined food showed considerable differences in the content of water and in caloric values. These values ranged from 3.519 kcal/g dry weight for corn to 4.510 kcal/g dry weight for alfalfa (Table 4). Daily food requirement depended on the type of food, its caloric value and body weight of the animal (Table 4).

The animals fed with bulky food consumed the highest amount of alfalfa — 61.42 kcal/day, and the lowest energy intake was observed during consumption of green wheat — 15.17 kcal. Among concentrated foods the animals consumed the highest amount of wheat and the lowest amount of corn (Table 4).

Statistically highly significant differences occurred between green wheat and corn in comparison with all the remaining foods ($P < 0.001$).

Losses of energy with feces and urine expressed as per cent of consumed energy amount to 1.3 — 5.6% for urine, while for feces the corresponding values are much higher and range from 8.5 to 44%, depending on the diet. Among bulky foods the losses of energy with feces show a considerable dispersal from ca 15% for beetroot to approximately 44% for alfalfa (Table 5). The energy losses with urine show much smaller differences and range from 4.6% for beetroot to 5.6% for alfalfa (Table 6). Lower values of energy losses were obtained when feeding the animals with concentrated foods. The combined mean values of energy losses with feces and urine amount to 34.5% for bulky foods and 12.9% for concentrated foods. The coefficients of digestibility of bulky foods differ considerably: from 85.1% (beetroot) to 55.9% (alfalfa). Smaller differences in the values of digestible energy are evident in case of concentrated foods. The grain of oats shows the highest digestible energy (91.3%), while slightly lower values were found for *Vicia faba minor* and wheat. The lowest digestibility was found for corn (80.3%). Despite these differences the coefficients of digestibility of concentrated foods are higher than those of bulky foods (Table 5).

The values of assimilation were estimated only for four selected foods (Table 6). In animals fed with concentrated foods the assimilation is high-

Table 4
Consumption of different foods by the common hamster.

Foods	Foods, kcal/g	No. of animals	Body wt., g \pm SD	C.V., %	Consumption				
					g dry wt/animal day	kcal/animal day	C.V., %		
Beetroot	4.119	5	397.6 \pm 129.0	32	9.95	40.98 \pm 13.42	33	0.11	85.5
Alfalfa	4.510	4	224.9 \pm 66.5	29	13.62	61.39 \pm 13.91	22	0.28	192.9
Green wheat	4.289	7	369.6 \pm 82.0	23	3.55	15.17 \pm 2.25	14	0.04	32.0
Seeds, Oat	4.417	5	403.4 \pm 74.0	18	11.85	52.36 \pm 6.33	13	0.13	103.5
Wheat	3.926	5	383.6 \pm 110.1	29	13.99	54.90 \pm 17.41	31	0.14	112.9
Horn bean	3.590	5	449.2 \pm 115.2	26	12.35	44.30 \pm 8.91	20	0.09	80.9
Corn	3.519	4	311.0 \pm 60.0	19	7.09	24.60 \pm 9.20	9	0.08	59.0

Table 5
Digestibility of bulky and concentrated food by the common hamster.

Foods	Faeces, % of energy intake	%	Digested energy	
			kcal/animal day \pm SD	C.V., %
Beetroot	14.88	85.12	35.16 \pm 13.40	38
Alfalfa	43.95	55.97	34.37 \pm 6.65	19
Green wheat	27.75	72.21	10.96 \pm 2.62	24
Seeds, Oat	8.53	91.31	47.81 \pm 6.61	10
Wheat	11.56	88.43	49.44 \pm 15.90	32
Horn bean	9.23	90.69	41.00 \pm 8.63	21
Corn	26.79	80.28	18.95 \pm 8.21	43

Table 6
Metabolizable energy of foods eaten by hamsters.

Foods	Urine, % of energy intake	%	Metabolizable energy	
			kcal/animal day \pm SD	C.V., %
Beetroot	4.6	79.52	31.74 \pm 9.60	30
Alfalfa	5.6	50.37	30.93 \pm 5.15	13
Seeds, Oat	4.4	86.90	45.50 \pm 7.12	15
Wheat	1.3	87.15	47.90 \pm 15.70	33

er than in those supplied with bulky foods and for wheat and oats it amounts to 87%, i.e. to 47 kcal/animal day on the average; for beetroot assimilation is ca 79% (32 kcal) and for alfalfa 50% (39 kcal). Statistically significant differences occur between alfalfa and wheat, between oat and wheat and beetroot, as well as between oat and alfalfa ($P < 0.002$).

IV. DISCUSSION

1. Consumption and Utilization of Foods

In relation to very variegated food utilized by free living hamsters the most commonly cultivated plants were employed in the feeding experiments as both bulky and concentrated foods (Surdacki, 1964, and these data). The type of food had no relation to the actual season. Despite this fact the hamsters well adapted themselves to the consumption of different foods in agreement with their considerable alimentary plasticity. In this respect hamster can be compared only with the bank vole (*Clethrionomys glareolus*) which during the year consumes equally willingly concentrated food under the form of seeds of trees and shrubs, and bulky foods under the form of herb layer plants (Drożdż, 1966).

Erdakov (1972) carrying feeding experiments on young hamsters (body weight 185.3 g) obtained higher values of consumption than those found in the present study (Table 4): they amounted to 79.4 kcal/animal day. On account of intensive growth the energy requirements of younger animals are higher than of adults, and this fact sufficiently explains the differences in the values obtained by Erdakov and by us.

Bulky foods are characterized by a low coefficient of digestibility which in hamsters ranged from ca 56% for alfalfa to ca 85% for beetroot. Bulky foods contain considerable amounts of fiber, which decreases the efficiency of digestion (Nehring, 1959; Nehring *et al.*, 1965; Davis & Golley, 1963). The low coefficient of digestibility of bulky foods is also related to a high content of water decreasing the caloric value of the consumed biomass.

In case of concentrated foods the digestible energy was found to be much higher and ranged between 80% for corn and 91% for oats. The low value of digestible energy of alfalfa — 55.9% is similar to that found for grass — 55.2% in *Arvicola terrestris* (Drożdż *et al.*, 1971). Similarly the value of green wheat amounts to 72.2% in hamster and 70.4% in *Microtus arvalis* (Drożdż, 1968). The values of digestible energy for oat are most close for hamster and other rodents: hamster 91.3%, common vole 92.3%, bank vole 89.1%, field mouse 90.4% (Drożdż, 1968). Lower utilization of bulky foods by hamsters is also indicated by the value of energy losses with faeces and urine, which amount on the average to 34.5%. On the other hand, corresponding losses for concen-

trated foods amount to 13% only. The mean assimilation value of examined bulky foods amounts to 65.4% and is only slightly different from the value of assimilation of green wheat in common vole — 65.2% (Drożdż, 1968), and from the mean assimilation value for *Arvicola terrestris* (Drożdż, *et al.*, 1971). Assimilation of bulky foods in hamsters amounts to 87%, while in common vole, bank vole and field mouse it ranges from 86 to 89.7% (Drożdż, 1968). The hamsters assimilated on the average approximately 39 kcal/animal day, hence the utilization of foods was considerably lower than in the experiments carried out by Erdakov (1972), in which the amount of metabolizable energy amounted to ca 63 kcal/animal day. This can be explained by employment in these experiments young, intensively growing animals.

2. The Effect of Hamsters on Plantations

In the Vistula valley, where the population of hamsters was investigated in spring and summer 1972 their density was 6 animals/ha. In autumn 1972 the number of hamsters doubled to the value of 13 animals/ha (Górecki, unpubl. data). At this density they can inflict some damages to agrocenoses. On the basis of the data obtained in the present study on the food preference, consumption and energy requirements the losses caused by hamsters were estimated. Such an attempt is of course not accurate as it based on incomplete data but it gives an approximation of losses caused in natural conditions by these rodents.

In the period of activity, corresponding to spring and summer, *i.e.* during 6 months one hamster consumes mainly green parts of plants taking up in this period jointly ca 11,000 kcal. When assuming the presence of only 6 hamsters/ha it was calculated that they consume 9 million kcal, *i.e.* barely 0.05% losses in the total biomass of cultivated fields.

In autumn the losses caused by hamsters are much higher due to storing grain. According to various authors food reserves accumulated by these rodents range from a dozen or so to a few dozens of kilograms. Feriancova-Masarova & Hanák (1965) reported that the reserves of a hamster are around 15 kg, while according to Walker (1964) they may amount to 90 kg of grain. Taking into account the fact that the latter figure corresponds probably to maximum values it was assumed that the mean food reserve of a hamster is 20 kg. In the examined area the plantations of corn include 70 ha and yield ca 2000 q of corn, out of which as much as 180 q or 9% can be accumulated by hamsters in underground burrows. Hence during the whole year these rodents cause considerable losses in the total production of plantations, especially in respect of grain.

An additional effect of hamsters on the environment depends on the

fact that their excrements remain in the ecosystem and are utilized for the new primary production. One hamster excretes daily ca 1.2 g of dry weight of faeces, or 438 g per year. This is a higher value than the body weight of a single hamster (362 g). However, most of the faeces are deposited in special burrows at the depth of 1—1.5 m (Karaseva & Shilayeva, 1965) and hence their decomposition is slow and return to the ecosystem delayed.

REFERENCES

1. Davis D. E. & Golley F. D., 1963: Principles in mammalogy. Reinhold Publ. Corp.: 1—335, New York.
2. Drożdż A., 1966: Food habits and food supply of rodents in the beech forest. *Acta theriol.*, 11, 15: 363—384.
3. Drożdż A., 1968: Digestibility and assimilation of natural foods in small rodents. *Acta theriol.*, 13, 21: 367—389.
4. Drożdż A., Górecki A., Grodziński & Pelikan J., 1971: Bioenergetics of water voles (*Arvicola terrestris* L.) from southern Moravia. *Ann. Zool. Fennici* 8: 97—103.
5. Erdakov L. N., 1972: Potrieblenie energii i koeficient utylizacji u obyknoviennoho homjaka i vodjanoj krysy. *Ekologija*, 1: 66—69.
6. Feriancova-Masarova E. & Hanák V., 1965: Cicavce. *Wyd. Slov. Akad. Vied*: 1—332, Bratislava.
7. Górecki A., 1965: Kalorymetr w badaniach ekologicznych. *Ekol. pol.*, B, 11: 14b—158.
8. Holišova V., 1959: Potrava hraboše polniho. [In: »Hraboš polni — *Microtus arvalis*« ed. J. Kratochvil]. *Ceskoslov. Akad. Ved*: 100—120, Praha.
9. Holišova V., 1965: The food of *Pitymys subterraneus* and *P. taticus* (*Rodentia, Microtidae*) in the mountain zone of the *Sorbeto-Piceetum*. *Folia zool.*, 14, 1: 15—28, Brno.
10. Karaseva E. B. & Shilayeva L. M., 1965: Stroenie nor obyknovenogo homjaka v zavisimosti ot ego vozrasta i sezona goda. *Bjul. mosk. Obšč. Isp. Prir., Biol.*, 70, 6: 30—39.
11. Kayser Ch., 1971: La depense d'energie des hibernants au cours du cycle circoannien. *Comptes rendus, Biol.*, 165, 5: 1145—1147.
12. Kleiber M., 1961: The fire of life — an introduction to animal energetics. *J. Wiley*: 1—454, New York.
13. Mohr U., Schuller M., Reznik C., Aithoff J. & Page H., 1973: Breeding of European hamsters. *Lab. Animal Sci.*, 23, 6: 799—802.
14. Nehring K., 1959: Ogólne żywienie zwierząt. *Państw. Wyd. Roln. i Leśne*: 1—574, Warszawa.
15. Nehring K., Schiemann R., Hoffmann L., Klippel W. & Jentsch W., 1965: Utilization of the energy concentrates in relation to their nutrient composition. [In: »Energy metabolism«, Ed. K. L. Blaxter]. *Academic Press*: 243—268, London — New York.
16. Nijkamp H. J., 1965: Some remarks about determination of the heat of combustion and the carbon content of urine. [In: »Energy metabolism«, Ed. K. L. Blaxter]. *Academic Press*, 147—158, London — New York.
17. Surdacki S., 1964: Über die Nahrung des Hamsters, *Cricetus cricetus* Linnaeus, 1758. *Acta theriol.*, 9, 20: 384—386.

18. Walker E. P., 1964: Mammals of the world. Hopkins Press: 647—1500, Baltimore.
19. Williams O., 1955: The food of mice and shrews in a Colorado montane forest. Univ. Colorado Stud., Biol., 3: 109—114.
20. Williams O., 1962: A technique for studying microtine food habits. J. Mammal., 43: 365—368.

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KONSUMPCJA I WYKORZYSTANIE NATURALNYCH POKARMÓW PRZEZ CHOMIKI

Streszczenie

Zbadano stosunki pokarmowe chomików *Cricetus cricetus* (Linnaeus, 1758) metodą analizy żołądków. Na podstawie morfologii epiderm oznaczono zielone części 11 gatunków roślin, a na podstawie ziaren skrobi oznaczono nasiona 6 roślin uprawnych. Do badań nad składem pokarmowym użyto 100 żołądków, z których 75 zawierało pokarm z lata, a pozostałe 25 zawierało pokarm z jesieni. Zaobserwowano ścisły związek zawartości żołądków z porą roku. Analiza makroskopowa wykazała występowanie w żołądkach chomików zwierząt bezkręgowych i kręgowych. Latem w pokarmie chomików dominują zielone części pszenicy i rzepaku, ziarna maku i koniczyna. W mniejszej ilości występują zwierzęta bezkręgowce, burak pastewny i lucerna (Tabele 1, 2). Jesienią chomiki żywią się głównie koniczyną, bulwami ziemniaka, bezkręgowcami, nasionami pszenicy, a także w mniejszej ilości nasionami owsa, fasoli, bobiku i zwierzętami kręgowymi. Analiza pokarmowa wykazała polifagiczność chomików, które mogą się żywić zarówno pokarmowymi objętościowymi jak i treściowymi (Tabela 3).

Przeprowadzając doświadczenia żywieniowe zbadano konsumpcję strawność i asymilację 7 naturalnych pasz u 35 chomików. Kaloryczność pasz treściwych użytych w doświadczeniach wynosiła średnio 3,863 kcal/g, a objętościowych 4,306 kcal/g. Zwierzęta pobierały dziennie od 0,04 do 0,28 kcal/g, średnio 0,12 kcal/g, tj. około 52 kcal/zwierzę (Tabela 4). Energia strawna pasz objętościowych (pszenica zielona, burak pastewny, lucerna) wahała się od 56 do 85%, a dla pasz treściwych (owies, pszenica, bobik, kukurydza) przyjmowała wartość od 80 do 91% (Tabela 5). Zwierzęta karmione paszami objętościowymi traciły z kałem i moczem 34,5% pobranej energii. W przypadku pasz treściwych energetyczne straty z kałem i moczem dochodziły do 13%. Energia przemienna wyrażona w procentach wahała się od 50,5 do 79,5% dla pasz objętościowych (lucerna i buraka pastewnego), a dla pasz treściwych (owes i pszenicy) wynosiła około 87% (Tabela 6).

Na podstawie uzyskanych danych o wybiórczości, konsumpcji i zapotrzebowaniu energetycznym chomików podjęto próby oszacowania strat czynionych przez te gryzonie na polach uprawnych. Przy średnim zagęszczeniu 10 chomików na ha mogą one zużyć aż do 9% ogólnej produkcji pól, z czego znaczna większość strat spowodowanych jest magazynowaniem przez chomiki zapasów pokarmowych, głównie w postaci ziarn zbóż.