

Name of the program: BR10764965 «Development of technologies for keeping, feeding, rearing and reproduction in dairy cattle breeding based on the use of adapted resource-energy saving and digital technologies for various natural and climatic zones of Kazakhstan»

Relevance: At the moment, farmers in the Republic of Kazakhstan face two main problems that are closely related to each other, feeding and reproduction. Therefore, scientists set the task of transforming the dairy cattle industry, in which, with the introduction of new innovative methods and scientifically-based standards for the cultivation, maintenance, feeding, reproduction of animals using software, digital technologies, the above problems will be solved.

The main theoretical results will be obtained through the analysis of existing technologies. The program will be implemented through generally accepted and modern methods in animal science. In the field of development of prototypes of equipment and digital technologies, optimization methods and design theory will be used, as well as empirical methods, the methodological basis of which is a systematic approach, the theory of experiment planning and correlation analysis, computer modeling, signal theory and design of communication networks, as well as a full-scale experiment.

The results obtained within the framework of this program will allow solving urgent problems of socio-economic, innovative and scientific-technical development of the dairy cattle industry in various climatic zones of Kazakhstan, so the forecast assessment of economic and production indicators will make it possible to increase the productivity of dairy cows and increase the efficiency of feed conversion by 10-15%, reach the age of the first productive insemination of heifers in 15 months, increase the fertility of cows and heifers by 8-10%, reduce the cost of growing repair young, feed production based on adapted resource-energy saving and digital technologies by less than 12%.

Purpose: Development of technologies for the maintenance, feeding, cultivation and reproduction in dairy cattle breeding of adapted resource-energy saving, digital technologies for various natural and climatic zones of Kazakhstan.

Expected results:

At the end of the program:

Scientifically-based, organizational and technological standards for the maintenance, feeding and reproduction of dairy cows will be developed on the example of specific farms (at least 10) located in various regions of the republic, allowing to increase milk production.

Technological schemes for growing heifers will be developed for the purpose of early fruitful fertilization of young animals at 15 months of age.

A resource-saving technology for the production of highly digestible compound feeds of a new generation with programmable properties will be developed.

Methods will be developed to increase the conversion of nutrients and the productive effect of feed in dairy cattle breeding.

A prototype platform for stress-free control of the live weight of heifers will be developed.

At least 3 seminars on the dissemination of knowledge will be held.

The following will be obtained:

- 3 patents of the Republic of Kazakhstan and 3 patents of the Eurasian Patent Office on effective recipes of premixes;
- 1 patent of the Republic of Kazakhstan on resource-saving technologies for the production of highly digestible compound feeds.

Based on the results of scientific research, the following will be developed and published:

- methodological recommendation on resource-saving technologies for the production of highly digestible compound feeds of a new generation with programmable properties;
- methodological guidance on improving the conversion of nutrients and the productive effect of feed in dairy cattle breeding;
- a mobile application has been developed to compile feeding rations;
- at least 2 reports at international scientific conferences;
- at least 12 publications in foreign and domestic publications recommended by committee for control in the field of education and science;
- at least 4 articles in peer-reviewed foreign scientific publications with a non-zero impact factor and at least Q3;

According to the results of the research work, at least 5 master's graduation papers and at least 2 doctoral (PhD) papers will be prepared.

Achieved results for 2021. Algorithms of data collection on the technology of keeping, feeding, reproduction of dairy cows in 14 basic farms of Akmola, North Kazakhstan, Pavlodar, East Kazakhstan, West Kazakhstan, Almaty, Kostanay, Aktobe, Atyrau regions have been developed.

75 main production indicators have been developed to collect data on the content of dairy cows. The content of animals with loose and tethered keeping technology has been studied.

According to the parameters of feeding dairy cows, 32 main production indicators have been developed. When developing this standard, advanced technologies of the University of Pennsylvania were applied, with the advice of Alexander N. Hristov (PhD., P.A.S). Scientific research has been carried out to study the feed database of farms with the zootechnical analysis of feed used in farms.

33 main production indicators have been developed to collect data on the reproduction of dairy cows. Professor Troy Ott of the University of Pennsylvania took part in the development of this standard. The indicators of reproductive ability and the state of reproductive function of dairy cows were studied, the effectiveness of hormonal synchronization programs of the uterine livestock was determined, as a result of which the fertilization of cows averaged 80% at the first insemination, 56.6% at the 2nd insemination and 66.6% at the third insemination. To improve the fertility status, 100 boluses were installed in the basic farms to determine sexual hunting, with insemination of cows according to various schemes.

At the same time, work is underway to develop standards for the culling of breeding stock. Analysis of the reasons for the disposal of animals showed that the

main share falls on gynecological diseases, hoof diseases and other diseases, 19.2; 14.7%; 40.9% respectively.

Employees of the Kazakh Agrotechnical University are working on the development of a software application for compiling animal feeding diets. The functionality and technical implementation of the «Dairy Ration» program were studied: a web application and a mobile application. The solution is distinguished by the use of modern cloud and mobile technologies: it uses Google Firebase cloud services, authorization integrated with Google services. The solution allows you to calculate feeding rations taking into account 10 groups of indicators, with the ability to adjust the rigidity of restrictions, taking into account the price of feed components.

Optimal technological schemes for growing heifers in the dairy and post-dairy periods have been developed and determined. The schemes of growing young animals in different regions of the Republic of Kazakhstan have been selected. Balance experiments were carried out on calves. The developed schemes for raising calves during the dairy and post-dairy periods include the use of various periods of drinking colostrum, milk, WMS, as well as the use of pre-starters, starters and extruded feeds of the Kazakh Agrotechnical University in feeding.

Due to intensive feeding, the animals of the experimental groups distinguished themselves by a high degree of growth. The live weight of calves of the experimental groups on average exceeded the control by 11.56 kg, which is higher than the control indicator by 7.4% ($P < 0.05$). The growth and development of heifers of the experimental and control groups were studied using the assessment of the exterior by measurements and further calculation of body indices, with the aim of early fruitful fertilization of young animals. Morphological parameters of calves' blood were also studied.

A sketch sample of an automated system for stress-free weighing of repair heifers for directional cultivation has been developed. According to the preliminary results of experimental tests, an analysis of the components and details of the structure was carried out to make improvements to the drawings, which will facilitate assembly, installation and improve the practical properties of the structure.

According to the development of resource-saving technologies for the production of highly digestible compound feeds of a new generation with programmable properties, the selection of components was carried out, formulations were developed, platforms and raw materials were prepared for the development of technologies for the production of compound feeds for young animals. As a result of the research, an extrudate was obtained from a mixture of oats, barley and wheat. With short-term (3-5 s.) barothermal treatment at a temperature of 150-160 ° C and a pressure of up to 50 atm. the total number of microorganisms decreased to 29.0 CFU per plate, which is 15.5 times less than the initial level.

At the same time, patent studies have been conducted on effective recipes of premixes and feed additives for lactating cows. More than 120 patents of the Republic of Kazakhstan, countries of the near and far abroad have been analyzed

on the topic of research work and development over the past 20 years. Patent search reports have been prepared and submitted. The existing modern methods of increasing the conversion of nutrients and the productive effect of feed have been studied. Experimental animals were selected and groups were formed to conduct experiments. A scheme of scientific and economic experiments in all basic farms has been compiled. Several methods have been developed to increase the conversion of nutrients and the productive effect of feed. So, to increase the conversion of feed in animal feeding diets, a method was used - balancing protein nutrition with the addition of urea in cow diets, another method is this balancing of diets by nitrogen content, NDF and ADF in feed feeds. Constant monitoring of fatness and control of the rumen pH is the next way to increase the conversion of nutrients and the productive effect of feed.

In order to improve feed conversion and increase milk productivity, feed additives based on the use of yeast enriched with 1.5% potassium humate «Kazuglegumus» were used, the feed additive was given the author's name – «Konyr-su». Strong mineral additives based on natural zeolites were also used. Feeding animals concentrated feed in the form of compound feeds, balanced in nutrients and biologically active substances, allows 1.5-2 times to increase the productivity of animals and significantly (up to 30%) reduce feed consumption per unit of production. The results of the conducted scientific and economic experiments showed an increase in the conversion of nutrients, contributing to an increase in productivity by 15% and an improvement in the physiological condition of animals.

Achieved results for 2022. In accordance with the task, the formation of data on the technology of keeping cows according to production indicators in the basic farms of Akmola, North Kazakhstan, Pavlodar, West Kazakhstan, East Kazakhstan, Almaty, Kostanay, Aktobe regions was continued.

Seminars were held to familiarize with the recommendations for assessing the quality of well-being (Welfare Quality ®) of a dairy herd on an industrialized cattle farm according to the Protocol for Assessing the Welfare of Cattle of the Welfare Quality ® project within the framework of the 6th Framework Study of the European Commission, contract No. FOOD-CT-2004–506508 (<http://www.welfarequalitynetwork.net/en-us/reports/assessment-protocols>).

The official permission was obtained of the project coordinator Mrs. Anne de Lorme (Anke.delorm@wur.nl) for the use of the protocol in conducting research.

To assess the quality of well-being, field studies were organized at dairy farms in different regions of Kazakhstan when cows were indoors. Measurements of the well-being of cows were carried out according to 33 parameters, 12 criteria and 4 principles. Descriptive statistical data on indicators of welfare principles, as well as indicators of well-being criteria were collected on basic farms. On average, farms scored from 29.5 to 38.8 points on all the principles of well-being, with the exception of "Good Housing", for which they scored an average of 55.7 points, with slight differences between farms. The score for the state of the body was determined using the Body Condition mobile application, which evaluates the state

of fatness of cows on a 5-point scale. According to our estimates, the average fatness score of cows was at the level of 3.17 ± 0.074 points.

According to the tasks set, work continued on the development of feeding standards for dairy cows in basic farms in various natural and climatic zones of Kazakhstan. The NRC standards developed by scientists of the National Academy of Sciences of the USA were adopted as the basis for the development of feeding standards for dairy cows. In 2022, a license agreement was signed between S. Seifullin KazATU and the National Academy of Sciences of the USA for the use of NRC standards in the territory of the Republic of Kazakhstan. To analyze the effectiveness of the use of NRC standards within the framework of this Program, under the leadership of the leading scientist of the University of Pennsylvania, Doctor of Sciences Alexander Hristov, an analysis of feeding and its impact on the productivity, reproductive and other parameters of dairy cows in basic farms in various climatic zones of Kazakhstan was carried out. Analysis of the content of the main nutrients in the diets of dairy cows in terms of 1 kilogram of dry matter showed that the content of dry matter varied in the diet of lactating cows ranging from 15.99 kg in low-yielding cows to 24.46 kg in high-yielding and new-bodied cows. The most clear and very important method for feeding dairy cows is the Van Soest method for determining carbohydrates, which allows you to determine the content of structural and non-structural carbohydrates, namely neutral detergent fiber (NDF). The content of NDF in the dry matter of the diet is accepted according to the norms of the NRC minimum – 28%, maximum – 40%, and in the dry matter of the main feed minimum – 22%, maximum – 32%. At the same time, milk productivity and milk composition of cows of Holstein, black-and-white, Simmental breeds of dairy and combined directions of productivity were determined in the basic farms. Control milking was carried out and milk samples were taken for analysis from each cow. So, on the basis of laboratory studies, the indicators of the amount of fat – 3.53%, protein – 3.16%, lactose 4.6%, urea – 28.8 mg/% were determined in the farm. Somatic cells – 190 thousand / cm³, Milk yield averaged 23.7 liters per head.

According to the task, the developed, on-screen form allowed for the registration of feeds in offline mode. A form of registration of feeding rations for various groups of animals (dry, milking, young, repair) has also been developed, taking into account various parameters: age, live weight, pregnancy days, fatness, milking days, lactation number, age of the 1st calving, interbody interval, breed, live weight, calf weight at birth, dairy productivity, etc. To assess the diet, indicators are used according to the methods of Nutrient Requirements of Dairy Cattle, according to such indicators as: milk productivity, energy yield (NEI Allowed milk), protein yield (MP Allowed milk), the total energy balance (NEI Balance), the number of days to set the condition, the balance of digestible protein (RDP Balance), the total energy of the diet (Diet NEI), the proportion of crude protein (Diet CP), dry matter (DMI). In order to centrally save data, the possibility of restoring them when replacing a mobile device, models, web services for synchronization and web interfaces for displaying and editing information in the "Herd Management" section have been developed. The module "Feeding rations

(preparation of rations)" of the mobile application "Farmer's Tablet" has also been developed.

The work of collecting data on the reproduction of a herd of dairy cows continues with the involvement of a foreign consultant, Professor Troy Ott of Pennsylvania State University, USA, who in turn developed forms for collecting information for further analysis and adjustment of actions to improve the fertility status of the herd of basic farms. The level of reproduction in developed countries will be determined by indicators that are calculated differently than in our country. Open Days are the days between calving and fruitful conception in this farm for 295 days. The conception rate (all services) is calculated by dividing the number of pregnant heads by the number of inseminated in each month and is a coefficient of 3.17. The conception rate to first service is calculated by dividing the number of pregnant heads by the number of inseminated for the first time – 1.27. If for us the service period is the period from calving to the first mating, then for foreign farmers the number of days between inseminations (for example, between the 1st insemination and the 2nd), etc. During the research in the base farm, 50 heads were selected for artificial insemination, of which 25 cows and 25 heifers using the same-sex seed of the Holstein black-and-white breed, the name of the producer bull AltaRECOIL 011HO11736. A comprehensive diagnostic study on pregnancy and diseases of reproductive function in animals was investigated using an Alfa Vision scanner.

For the purpose of early fruitful fertilization of young calves, the dynamics of live weight of calves was studied by monthly individual weighing, according to the results of which the absolute and average daily, relative gains of live weight were calculated. At the same time, the developed schemes for raising calves in the dairy and post-dairy periods include the use of various periods of drinking colostrum, milk, WMS, as well as the use of pre-starters, starters, and extruded feeds of the Kazakh Agrotechnical University in feeding. The feeding schemes also provide for a reduction in the drinking period, which leads to a reduction in the cost of milk, WMS. Live weight monitoring showed that the live weight of heifers at the age of three months was higher than calves in the control group by 7.8 kg or 8.3%, and already at the age of six months by 34 kg or 23%. According to the results of the dynamics of absolute, average daily, relative increments, it can be seen that the live weight of calves at birth averaged 25-27 kg, at the same time, at 3 months of age, calves of the second experimental group showed better indicators in comparison with calves of the first experimental and control groups, so the absolute increase was at the level of 22.6 kg, which is 8% is correspondingly higher. At 6 months of age, this indicator was at the level of 23.4 kg or 5% and 26.9% higher than in heifers of the two groups, respectively. During the research period, measurements were also taken and the indices of the physique of heifers were calculated. The analysis of the physique indices showed that the calves of the 1st and 2nd experimental groups had better development in comparison with the calves of the control group, so according to the index of legginess, pectoral, massiveness, the calves of the second experimental group at the age of six months exceeded their peers by 7% and 5%, respectively. Analysis of hematological

parameters showed that calves of all three groups had blood values within the normal range, however, in calves of the 2 experimental group, the number of erythrocytes and hemoglobin was slightly higher and amounted to $6.75 \times 10^{12}/L$, 90.70 ± 7.63 g/L, respectively.

When solving the problem of creating a prototype of automatic equipment for stress-free determination of the live weight of heifers identified by RFID, computer-aided design classes were used: MCAD and CAE (when designing the design of weighing platforms), ECAD (when developing electronic devices). According to the developed draft drawings of a prototype weighing platform, the assembly of test equipment for weighing young animals while drinking at a drinking trough on a dairy farm was carried out. The basic design of the weighing platform resembles a "telephone booth" with two side walls and a back wall with a hole for the animal's head. The assembled weighing unit was installed in the cowshed at the drinkers on the experimental farm.

According to the development of resource-saving technologies for the production of highly digestible compound feeds of a new generation with programmable properties, an analysis of the feed base was carried out, which is the main action in the preparation of animal diets. Feed analysis was carried out by means of a FOSS analyzer. In this regard, we determined the chemical composition of feed used for repair calves during the entire period of the experiment. The extruded feed produced on the KATU platform consisted of 80% barley and 20% oats. In the NFT feed, the raw fat content was $3.2 \pm 0.31\%$, the crude fiber index was $4.1 \pm 0.86\%$, the amount of starch was $51.4 \pm 1.1\%$. The feed produced in KATU consists of fully extruded OE grain in it at 12.9 MJ. The animals were divided into two groups of 10 heads each, according to the method of pairs of analogues: the control group (CG) and the experimental group (EG). The drinking patterns of the WMS (0-2.5 months) and the maintenance of the repair young were the same throughout the entire time of the experiment. With age, in the experimental groups, according to their live weight, the daily dacha also grew, coarse feed at the age of 0-2 months was 1 kg, and concentrated 0.3, at the age of 3-4 months – 2 kg and 0.5 kg, and at the age of 5-6 months – 3 kg and 0.8 kg. The dynamics of the live weight of calves has shown that already from the 3rd month of life, when the animals completely switch to vegetable feed, the age difference becomes increasingly. So, for the 3rd month of the calves' life, the live weight of the exhaust gas was 89.1 ± 3.11 kg, the KG was lower by 7.2 kg. By the 6th month, the difference between the groups was 23.6 kg, in OG 146.4 ± 5.72 kg, and in KG 122.8 ± 2.69 kg. According to the above, the resource-saving technology of production of highly digestible compound feed KATU for the repair of young animals gave a positive result.

Schemes of scientific and economic experiments on the conversion of nutrients and productive action in dairy cattle breeding are being worked out in all basic farms of Akmola, North Kazakhstan, Pavlodar, East Kazakhstan, Kostanay, Aktobe regions. The developed formulation of Zeolite-chlorella premix (ZCP) for lactating cows consists of 28-29% zeolite, 1.5-2% dry chlorella powder and 75-76% sunflower cake as a filler. - Zeolite top dressing was introduced into the diet

of the experimental group instead of the nutritionally equivalent number of concentrates in the recommended dose for dairy cows. During the experimental period, the cows of the 2nd experimental group receiving zeolite top dressing had average daily milk yields higher than the average daily milk yields of cows of the 1st control group by 1.08 ± 0.04 kg in the first month of top dressing and by 1.4 ± 0.08 kg in the second month of top dressing. At the same time, in the second month of feeding, the qualitative indicators of milk from cows of the experimental group improved, which reflected an increase in the average fat content from 3.99% to 4.03% and a decrease in the number of somatic cells from 366 to 313 thousand / ml.

At the same time, work has been conducted to improve the formulation of the "Konyr-su" feed additive to increase its effectiveness. Experimental studies were carried out on the effect of the feed additive "Konyr-su" on the body of calves in the post-dairy period, during which constant monitoring of the physiological state of animals, feed consumption, motor activity, determination of live weight was carried out. The dynamics of the live weight of calves before the test was on average 87.0 kg in the control and 90.2 kg in the experimental. The live weight of calves of the experimental group increased by 6 kg from the first month of use, by the end of the experiment the difference was 13.1 kg or 7.9%. Experiments were also conducted to determine the effectiveness of the biological product in the production experience on the livestock of a milking herd in the amount of one hundred heads. Analysis of the effect of the feed additive on the dairy productivity of cows showed that a month after receiving the feed additive, there was an increase in one-time milk yield by 0.5 liters and amounted to 6.65 ± 1.34 liters in July, 7.12 ± 1.17 liters in August.

Several premix formulations were worked out, of which the most optimal from an economic point of view was chosen. The developed premix recipe contains 4 fat-soluble vitamins and 7 water-soluble vitamins, while the number of fat-soluble vitamins presented in the premix covers 10% of the daily needs of dairy cows in these vitamins. In addition, the premix contains 4 macronutrients and 7 trace elements that provide 5% of the cows' needs for these elements. Rapeseed cake with a crude protein content of 16.8% was used as a filler for the premix, the biological usefulness of the premix was ensured by the inclusion of minerals, vitamins, humic and fulvic acids, as well as 1% *Bacillus subtilis* spores in its composition. Milk yield at the beginning of the experiment in the experimental groups averaged 8.9 kg, which is 2.69 kg or 30.3% more than in the control group. According to the content of somatic cells, it can be noted that all groups had indicators within the normal range.

At the same time, a premix has been developed to enrich the feeding diet with vitamin and mineral substances, which will function as an activator of enzymes and structural elements in all metabolic processes that are involved in the metabolism of proteins, carbohydrates, fats, water regime and hormonal functioning of the body. The chemical composition of the premix includes components in the following ratio: phosphorus (P) – 1.75%, calcium (Ca) – 1.75%, vitamin A -16,000,000 I.U./kg, vitamin D3 – 3,200,000 I.U. / kg, vitamin E -

60,000 I.U./kg, manganese (Mn) -80,500 mg/kg, copper (Cu) – 40,000 mg/kg, zinc (Zn) – 160,500 mg/kg, iodine (I) – 2170 mg/kg, selenium (Se) – 800 mg/kg and cobalt (Co) - 800 mg/kg, and chalk fodder and chickpea flour are used as fillers, as a source of calcium. The productive indicators of the Holstein black-and-white breed in the basic farms showed that the average daily milk yield increased by 1.4 kg or 1.6%.

Insufficient NDF content in the diet of cows affects the health of its rumen, leads to acidosis. And if this shortage is of a long-term nature, then this leads to problems with the hooves and even the displacement of the abomasum. For the experiment, 3 heads of Holstein cows of 3 lactation were selected for each group. Cows of the 1st control group received the diet adopted on the farm. Cows of the experimental group II and experimental group III received rations with NDF levels of 34 and 44%, respectively. The specified NDF level is achieved by manipulating the amount of coarse feed being set wheat hay and barley straw. The ratio of the amount of feed consumed to the unit of output received is the conversion. The smaller the conversion, the less feed needs to be spent on the production of livestock products. It is precisely such combinations of NDF (28-34%) in the diet that can provide the necessary level of productivity in farm conditions.

The northern vitamin-mineral premix (Svim) is being evaluated to increase milk productivity, stimulate reproductive function, and preserve newborn young cattle. In the proposed premix, conventionally called PSViM-1 (northern vitamin and trace element premix), wheat bran is the filler. The premix is applied at the rate of 1 kg per 99 kg of feed, for this the estimated amount of premix is mixed with filler (grain, bran, compound feed). Analyzing the effect of the fed premix, we can say that the milk productivity of the first heifers of the experimental groups increased by 9-10.3% compared to the control.

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The list of publications and patents published within the framework of this program:

1. «The influence of the technology of feeding repair heifers of black-and-white breed on their growth in the conditions of farms of the Kostanay region». Materials of the IV International Scientific and practical conference «Modern problems of animal science», dedicated to the memory of Doctor of Agricultural Sciences, Professor B.M. Muslimov.

https://ksu.edu.kz/images/page/ksu/nauka-i-innovacii/sbornik_nauchnyh_trudov_materialy_iv_mezhd_n-praktich_konferencii_kru_im_a_bajtursynova_25_11_2021.pdf

2 Recommendations on standards for culling cows and heifers of dairy productivity in the Republic of Kazakhstan. Publishing house of «Kazyna Uyasy» LLP, 2022. The recommendations were reviewed and approved for publication by

S. Seifullin STC KATU, Protocol No. 2 of February 07, 2022.

3 Influence of the age of cows on indicators of reproductivity and milk productivity. “3i: intellect, idea, innovation - intellect, idea, innovation”: Multidisciplinary scientific journal of Kostanay Regional University named after A. Baitursynov, No. 3 September 2022.

4 Influence of zeolite compound on metabolism and feed conversion of dairy cows. “3i: intellect, idea, innovation - intellect, idea, innovation”: Multidisciplinary scientific journal of Kostanay Regional University named after A. Baitursynov, No. 3 September 2022.

5 Chemical composition of cow's' milk as an indicator of feeding value. “3i: intellect, idea, innovation - intelligence, idea, innovation”: Multidisciplinary scientific journal of Kostanay Regional University named after A. Baitursynov, No. 2 June 2022.

6 The effect of live weight of cows on their milk productivity. Scientific and practical journal of the West Kazakhstan Agrarian and Technical University named after Zhangir Khan. Science and Education, No.3-2 (68) 2022.

7 Efficiency of methods of cleaning and disinfection of the dispensary for calves. Bulletin of science of the Kazakh Agrotechnical University named after S. Seifullin (interdisciplinary), 1 part. №3 (114).

8 Lengthening of the service period in Holstein cows: norm or pathology. Materials of the international scientific and practical conference "Effective methods of managing the selection and breeding process in herd horse breeding". - Pavlodar: Toraigyrov University, 2022. - 240 p.

9 Use of extruded compound feed in calf breeding. Materials of the international scientific and practical conference «Seifullins readings - 18(2): «Science of the xxi century - the era of transformation». Astana, 2022. – 336 p.