BREEDING STRATEGIES
FOR SUSTAINABLE GENETIC IMPROVEMENT OF CAUCASIAN AND CARPATHIAN BROWN CATTLE BREEDS
## Contents

**Introduction** 1

**Breed characteristics** 2

**Description of Caucasian/Carpathian Brown population** 3
- Population key figures 3
- Phenotypical variation within the Pure Caucasian/Carpathian Brown Cattle population 3
- Genetic composition of Carpathian and Caucasian Brown Cattle 5

**Steps to develop a breeding strategy** 6
- Set up organizational structures 6
- Establish a herd book 7
- Develop breeding goals 7
- Establish an animal performance recording 7
- Develop a breeding programme 10
- Use artificial insemination 16
- Use genetic evaluation 17
- Develop a system to store genetic material 17
- Calculate the expected impact of the breeding strategy 17

**Workplan for the implementation of the breeding strategy** 18

**References** 19

**Appendices** 20
- Definition of terms related to breeding programmes 20
- Contributors to the elaboration of the breeding strategy (participants in the workshop in Kiev, 11-12 September 2019) 21
The aim of FAO project TCP/RER/3604 was to elaborate breeding goals and plans for breeding and breed development of Caucasian Brown Cattle in Armenia and Georgia and Carpathian Brown Cattle in Ukraine. As a first step, information was collected about the breeds themselves and the environments in which they are kept. Approximately 300 phenotypic pure cows and 20 pure bulls were selected in each country, and phenotypic information was recorded. The assessments were carried out under the guidance of Tamas Szobolevszki, with support from each country’s national consultants and service provider. Genetic material was collected, genotyped and used for a study on the genetic background of the breeds by the International Atomic Energy Agency (IAEA) in Vienna (FAO/IAEA, 2019).

At two workshops held with stakeholders involved in the breed development of Caucasian/Carpathian Brown Cattle, a concept of a breeding strategy was developed, taking circumstances for implementation into account.

The overall goal of the strategy is to conserve Carpathian Brown Cattle and Caucasian Brown Cattle breeds by making use of the potential for improving the breeds genetically. As the population of the pure Caucasian Brown Cattle in Armenia and Georgia is about 70 000 and 160 000 cows, respectively, this document has developed a breeding programme with the aim of increasing the genetic gain for Pure Caucasian Brown, according the breeding goal for the breed. For Carpathian Brown, whose population is estimated at fewer than 1 000, the aim is to develop an in situ conservation programme.

Detailed descriptions of the current circumstances of breeding are found in the reports of the three countries (Strategic Development Agency NGO (SDA), 2019; Georgian Veterinary Doctors United Association, 2019; M.V. Zubets Institute of Animal Breeding and Genetics, 2019). The paragraphs that follow give a summary.

**ARMENIA**
248 000 Caucasian Brown cows and between 70 000 and 75 000 Pure Caucasian Brown cows. About 30 percent of the total are PCBCs (Pure Caucasian/Carpathian Brown Cattle).

**Farm structure:**
- fewer than 5 cows: 160 240 farms
- 5 to 9 cows: 12 750 farms
- 10 to 19 cows: 3 233 farms
- 20 to 49 cows: 1 350 farms
- more than 50 cows: 427 farms

According to the Strategic Development Agency NGO (2019), the average milk yield does not exceed 2 000 kg; however, milk yields have been much higher in the past.

**GEORGIA**
659 175 Caucasian Brown Cows and approximately 160 000 Pure Caucasian Brown Cows.

**Farm structure:**
- 2 to 5 cows: most farmers
- 20 to 30 cattle: 15 percent to 20 percent of farms
- 200 to 300 cattle: 3 percent to 5 percent of farms

**UKRAINE**
400 to 500 Pure Carpathian Brown Cows from about 75 000 Carpathian Brown Cattle.

**Farm structure:**
- Most farms have fewer than five cows, with women primarily keeping the animals.
Breed characteristics

The breed characteristics described in the national reports are homogeneous coat colour type, light belt on the back, black muzzle, rings around the eyes, and dark colour of toes (hooves).

ARMENIA
Surveyed mature animals must show the following phenotypic traits to be considered a PCBC:
- Homogeneous coat colour type
- Light belt on the back
- Black muzzle
- Rings around the eyes
- Dark colour of toes (hooves)

GEORGIA
Surveyed mature animals must show the following phenotypic traits to be considered a PCBC:
- Main colour: dark brown
- Light belt on the back
- Dense body conformation
- Black muzzle
- Rings around the eyes
- Harmonious and dense udder conformation
- Dark feet, correct leg form
- Peak milk production: 15–20 kg/day

UKRAINE
Surveyed mature animals must show the following phenotypic traits to be considered a PCBC:
- Light belt on the back
- Black muzzle with white ring
- Black horn tips
- Ears with thick light hair
- Black hooves
- One-coloured coat
- Small, compact body
Description of Caucasian/Carpathian Brown population

Population key figures

Table 1 gives an overview of key figures provided by representatives of the project stakeholders along with information received from animal registration information. Other data are mainly estimates describing the current situation. The definition of the Caucasian/Carpathian Brown Cattle population is somewhat vague, as no respective information on pedigree information is available. The major part of the Caucasian/Carpathian Brown Cattle population is based on cross-breeding.

Information on artificial insemination was obtained through project surveys. As semen production is absent in Armenia and Georgia, the semen of local bulls is not used for artificial insemination. Semen from Brown Swiss and other breeds (see reports on surveys) is imported.

<table>
<thead>
<tr>
<th>Total population of Caucasian/Carpathian Brown Cattle</th>
<th>Armenia</th>
<th>Georgia</th>
<th>Ukraine</th>
</tr>
</thead>
<tbody>
<tr>
<td>248 000</td>
<td></td>
<td>659 175</td>
<td>75 000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Population of Pure Caucasian/Carpathian Brown Cattle (PCBC) phenotypically, according to phenotypic assessment (no genetic information available to date)</th>
<th>Armenia</th>
<th>Georgia</th>
<th>Ukraine</th>
</tr>
</thead>
<tbody>
<tr>
<td>70 000 –75 000 (approximately 30 percent)</td>
<td></td>
<td>160 000 (25 percent)</td>
<td></td>
</tr>
<tr>
<td>approximately 400-500 (or more – further investigation recommended)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Active population (herd book and artificial insemination)</th>
<th>Armenia</th>
<th>Georgia</th>
<th>Ukraine</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cows under artificial insemination (Caucasian Brown*/Carpathian Brown**)</th>
<th>Armenia</th>
<th>Georgia</th>
<th>Ukraine</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 000*</td>
<td></td>
<td>3 000 –4 000*</td>
<td></td>
</tr>
<tr>
<td>50**</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Key figures describing the current situation of Caucasian/Carpathian Brown population (as of August 2019)

Phenotypical variation within the Pure Caucasian/Carpathian Brown Cattle population

Within the project, 300 cows and 20 bulls from about 100 farms were selected from each of the three countries based on their phenotypic characteristics. Only cows and bulls that show the characteristic signs of PCBC were selected.
The results of the assessment are described in the country reports (Strategic Development Agency NGO (SDA), 2019; Georgian Veterinary Doctors United Association, 2019; M.V. Zubets Institute of Animal Breeding and Genetics, 2019). Farms with PCBC have been identified, and cows and bulls representing the best PCBC were selected for the survey.

Tables 2, 3 and 4 show the existing phenotypic variation. It should be kept in mind that performance recording according to the International Committee for Animal Recording (ICAR) standards is missing. The information was provided by farmers and is not based on any analysis carried out during the project. Milk analyses based on individual animals is not available.

ARMENIA

According to the Armenian country report, Caucasian Brown cows weigh about 450 kg on average, while the Caucasian Brown in Armenia and Georgia are about 70 kg to 100 kg lighter. Table 2 shows the variation among the animals in Armenia, although the figures should be interpreted with caution, since body weight was calculated from girth circumference.

<table>
<thead>
<tr>
<th>Lactation days</th>
<th>Protein %</th>
<th>Fat %</th>
<th>Milk kg/day 1l*</th>
<th>Protein %</th>
<th>Fat %</th>
<th>Milk kg/day 1l**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>299.10</td>
<td>3.21</td>
<td>3.93</td>
<td>7.89</td>
<td>3.07</td>
<td>3.71</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>5.86</td>
<td>0.09</td>
<td>0.25</td>
<td>2.04</td>
<td>0.09</td>
<td>0.19</td>
</tr>
<tr>
<td>Maximum</td>
<td>365.00</td>
<td>3.80</td>
<td>5.50</td>
<td>19.00</td>
<td>3.70</td>
<td>5.00</td>
</tr>
<tr>
<td>Minimum</td>
<td>285.00</td>
<td>3.00</td>
<td>3.10</td>
<td>4.00</td>
<td>2.80</td>
<td>3.00</td>
</tr>
<tr>
<td>Mean</td>
<td>300.00</td>
<td>3.20</td>
<td>3.90</td>
<td>8.00</td>
<td>3.10</td>
<td>3.70</td>
</tr>
<tr>
<td>Quantil 90 %</td>
<td>290</td>
<td>3.1</td>
<td>3.8</td>
<td>6</td>
<td>3</td>
<td>3.5</td>
</tr>
<tr>
<td>Quantil 10 %</td>
<td>305</td>
<td>3.3</td>
<td>4.2</td>
<td>10</td>
<td>3.1</td>
<td>3.8</td>
</tr>
</tbody>
</table>

Source: Strategic Development Agency NGO (SDA), 2019. *1l=first lactation; **hl=highest lactation

GEORGIA

Based on breed standards from earlier studies, the live weight varies from 400 kg to 480 kg for cows and from 700 kg to 800 kg for bulls. The live weight based on measurement is currently about 380 kg of weight for cows.

According to Georgian Veterinary Doctors United Association (2019), “In Caucasian brown breed farms, individual recording of milking does not take place and there are no accurate data on the current state of milking productivity. The data of the expeditionary survey, which is obtained from the survey of farmers, are subjective.”

Table 3 gives an overview of the estimated performance of the PCBC population in Georgia.

<table>
<thead>
<tr>
<th>Lactation days</th>
<th>Protein %</th>
<th>Fat %</th>
<th>Milk kg/day 1l*</th>
<th>Protein %</th>
<th>Fat %</th>
<th>Milk kg/day 1l**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>276.82</td>
<td>8.64</td>
<td>2.79</td>
<td>3.53</td>
<td></td>
<td>15.82</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>35.23</td>
<td>5.00</td>
<td>20.00</td>
<td>25.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum</td>
<td>330.00</td>
<td>5.00</td>
<td>20.00</td>
<td>25.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>30.00</td>
<td>8.00</td>
<td>16.00</td>
<td>11.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>290.00</td>
<td>6.00</td>
<td>3.10</td>
<td>3.8</td>
<td>20.00</td>
<td></td>
</tr>
<tr>
<td>Quantil 90 %</td>
<td>218.50</td>
<td>13.00</td>
<td>7.00</td>
<td>16.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quantil 10 %</td>
<td>300.00</td>
<td>13.00</td>
<td>7.00</td>
<td>16.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Georgian Veterinary Doctors United Association, 2019. *1l=first lactation; **hl=highest lactation
If the performance in milk yield of Caucasian/Carpathian Brown is compared with other breeds, the body weight must be taken into consideration. According to Ledinek and Gruber (2015), a cow with an additional 100 kg of body weight must produce an additional 844 kg of energy-corrected-milk (ECM), due to the greater feed requirements, for maintenance to be equally efficient.

<table>
<thead>
<tr>
<th>Lactation days</th>
<th>Protein %</th>
<th>Fat %</th>
<th>Milk kg/day 1l*</th>
<th>Protein %</th>
<th>Fat %</th>
<th>Milk kg/day hl**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>3.65</td>
<td>10.06</td>
<td>3.72</td>
<td>13.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard deviation</td>
<td>0.18</td>
<td>1.95</td>
<td>0.10</td>
<td>2.94</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum</td>
<td>2.90</td>
<td>8.00</td>
<td>3.50</td>
<td>8.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>4.00</td>
<td>15.00</td>
<td>4.00</td>
<td>20.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>3.50</td>
<td>8.00</td>
<td>3.60</td>
<td>10.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quantil 90 %</td>
<td>3.80</td>
<td>12.00</td>
<td>3.82</td>
<td>18.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quantil 10 %</td>
<td>3.65</td>
<td>10.06</td>
<td>3.72</td>
<td>13.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: M.V. Zubets Institute of Animal Breeding and Genetics, 2019. *1l=first lactation; **hl=highest lactation

**TABLE 4 VARIATION AMONG CAUCASIAN BROWN CATTLE IN UKRAINE**

**GENETIC COMPOSITION OF CARPATHIAN AND CAUCASIAN BROWN CATTLE**

Within the project, molecular analyses have been conducted with the Affymetrix-Axiom platform (Axiom Bovine Genotyping v3 array) in 384-well format. The analyses were carried out by FAO/IAEA Joint Division. The results revealed a large effective population size, indicating that selection and artificial insemination are not really taking place. The large population size is also an indicator that there is potential for genetic improvement. The results show that the Caucasian Brown population from Armenia and Georgia can be assumed to be one breed but Carpathian Brown is different and justifies a separate approach.
Steps to develop a breeding strategy

To develop a sustainable and successful breeding strategy, the following steps should be followed. The activities described below play an integral and irreplaceable role in breed management. It is highly recommended that these steps be implement in the sequence in which they appear to ensure that the breeding strategy will cover all aspects of breed development.

Set up organizational structures

A breeding strategy will only be successful if there is a breeding organization or association that assumes responsibility. It is important that the organization be equipped with the resources necessary to carry out its responsibilities and tasks. Interested farmers need to be organized through the exchange of knowledge, and stakeholders need to be involved in a breeding strategy. The structure of the breeding organization should be designed to be appropriate for each country, taking existing circumstances into account. The organization must assure that the various tasks can be fulfilled. The resources will need to be organized externally, especially at the outset. A strong breeding organization must have a strong link to official structures (e.g. government, extension, national breeding organizations).

A breeding organization should assume the following main responsibilities and tasks:

- Elaboration of breeding goals.
- Establishment of a herd book and breeding documents.
- Implementation of the breeding programme through the selection of bull dams, linear scoring of progenies, checking of pedigrees, selection of bulls, and storage of semen.
- Organization of marketing of cattle: A breeding organization needs income.
- Development of marketing concept: A breed needs to be promoted among the farmers and breeders so that they know the strengths of the PCBC and are proud and motivated to work with this breed. Marketing could also be broader, with the aim of increasing interest in the breed beyond farmers and breeders.

ECONOMIC ASPECTS OF A BREEDING ASSOCIATION

A strong breeding association is needed to assume responsibilities and tasks related to the breeding strategy. This requires financial resources for offices, staff and equipment. Financing could be obtained from membership fees, marketing activities and other services. To set up a breeding strategy for PCBC with a strong and responsible organization, subsidies from the country’s ministry of agriculture will be needed, at least at the beginning.

SYNERGIES AMONG COUNTRIES

To increase genetic gain and use synergies among the different countries and PCBC populations, it is important that cooperation among countries be promoted as much as possible. Possible avenues for cooperation include the following:

- One breeding goal: Based on the results from FAO/IAEA (2019), it is recommended that Caucasian Brown follow one breeding goal. A common breeding goal is a valuable precondition for future cooperation in genetic evaluation.
- Same traits and standards for performance recording: All of the countries should use the same traits and standards for performance recording. This is the basis for facilitating further cooperation, such as in genetic evaluation.
- Conformation recording: As mentioned in Section 4.4 on performance recording, conformation recording should follow the international standard for Brown Swiss Cattle. Cooperation among the three countries in this regard is highly recommended.
Cooperation regarding the database for performance recording: The infrastructure for performance recording is costly. Experiences from countries such as Germany and Austria show that cooperation among countries in the central storage of data and the development of tools for herd management and genetic evaluation can be significantly cost-saving.

One breeding programme for Armenia and Georgia: To increase the selection intensity in the breeding programme, cooperation between the Pure Caucasian Brown Cattle populations in Armenia and Georgia is important. The best bulls should be used in both countries.

Storage of genetic material: If investment in storage facilities for genetic material is needed, cooperation should be considered.

Genetic evaluation: As mentioned above, cooperation in genetic evaluation would be beneficial.

Establish a herd book

A herd book is a register of animals for a breed. Entries in a herd book typically include each animal, its identification number, date of birth, sex, name, the identification of its parents, and its owner. To be registered in a herd book, an animal must meet the criteria set out in the rules of the breed association that operates the herd book. These criteria typically include that the parents are registered in the same herd book and that the animal has the characteristics that define the breed. The recording of the pedigree also is important for genetic evaluation. Animals should have their own identification number, which needs to be in line with the National Animal Identification System.

The responsibility for the herd book is with the respective breeding association for PCBC.

Develop breeding goals

A breeding goal must meet the needs of breeders, and the responsible breeding organization must consider the breeders (female and male) while deciding on the goal.

The survey results provide information on the farmers’ opinion regarding the importance of different traits. Gender-disaggregated results on priorities expressed by farmers related to the weighting of trait complexes showed little variability (Bossányi, 2019). However, there are some differences.

For example, female farmers were less satisfied with the current performance of udder health and placed greater importance on improving udder health as a breeding goal.

Establish an animal performance recording

None of the beneficial countries have organized performance recording with central data storage for the Caucasian/Carpathian Brown Cattle. However, milk labs with the capability of analysing the milk content and somatic cell count of single animals is available in all three countries. The labs are appropriately equipped, but no routine standardization for milk content analysis is carried out. There is no routine sampling. Further, no logistics for performance recording are in place and the whole system needs to be set up.

The overall aim of recording the different performances of the animals is to use the information for the selection of superior animals and to assist in herd management. It is important that the traits are easy and cheap to record, that the information is uniformed, reliable and heritable, and that there is a desirable correlation to the target trait if an auxiliary trait is used. For each trait, the parameters to be recorded must be defined, as well as when, how often, from which animals, to what extent, and at which farms. For genetic evaluation, it is important that performances are also recorded from companion animals at the farm, and not only from a few selected animals per farm.

The different traits were derived by the representatives from the different countries at the workshop in Kiev. To keep costs low, recording should be done by ICAR method “B”, with the farmer assessing and documenting the information on the animals, accompanied by control visits by an employee of the recording organization. The priorities of the traits were derived based on the breeding goal, taking into account the ease of recording and the possibilities for implementation. Performance recording within the breeding strategy of Caucasian Brown Cattle in all three countries will include milk performance, fitness and beef traits.

The main priorities to consider during the recording of the different traits are as follows:

Priority 1: milk yield, fertility based on calving interval, culling information for longevity, and 200- and 365-day weights for heifers and bulls (measured indirectly by chest circumference).
Priority 2: milk content (lab), somatic cell count, and health information to be registered by farmers. The milk lab should have standardized equipment for the analyses needed.

**CONFORMATION RECORDING**

It is recommended that conformation be recorded by using a scheme harmonized and used by Brown Swiss breeding organizations worldwide.\(^1\) One reason is that cross-breeding of Caucasian Brown with Brown Swiss is part of a livestock improvement strategy in these countries, and linear traits should be comparable. Conformation recording is performed for registration in the herd book. Herd book cows are visited at the beginning of the lactation, and linear scoring is done by a certain number of progenies per bull. This information is used for genetic evaluation; based on this information, the best bulls are selected as proven bulls or progeny tested bulls. This information is also used to predict genomic breeding values of young animals (without progeny).

The following actions should be taken to establish a well-performing conformation recording system:

- **Set up electronic data storage (database or simpler system).** It is important to ensure that there are data security and data safety systems in place. The system should be adaptable, allowing for the future extension of the system to ensure sustainability.

- **Provide feedback to farmers.** In order to create a sustainable participation in performance recording, farmers must benefit from the results by adequate getting feedback and support, which can be used in to increase production.

---

\(^1\) For more information, see [http://www.braunviehaustria.at/home/ausgabe-news/article/lineare-nachzuchtbeschreibung-braunvieh.html](http://www.braunviehaustria.at/home/ausgabe-news/article/lineare-nachzuchtbeschreibung-braunvieh.html)

---

**TABLE 5**

PROPOSAL FOR RECORDING OF TRAITS FOR CAUCASIAN BROWN CATTLE (PRIORITIES ELABORATED AT THE WORKSHOP)

<table>
<thead>
<tr>
<th>Traits</th>
<th>Who records?</th>
<th>How</th>
<th>How often? When?</th>
<th>Herd test</th>
<th>Infrastructure needed</th>
<th>Priority (1: high; 5: low)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual control milking (milk kg)</td>
<td>Farmer</td>
<td>With measures</td>
<td>Every month during the lactation period</td>
<td>All</td>
<td>Technical equipment</td>
<td>1</td>
<td>Method B, according to ICAR – install control system</td>
</tr>
<tr>
<td>Content of milk</td>
<td>Farmer</td>
<td>Sampling</td>
<td>Every month during the lactation period</td>
<td>All</td>
<td>Technical equipment</td>
<td>1</td>
<td>Standardization of equipment in lab</td>
</tr>
<tr>
<td>Reproduction</td>
<td>Farmer, artificial insemination technician</td>
<td>With recording</td>
<td>If needed</td>
<td>All</td>
<td>None</td>
<td>2</td>
<td>To record: Calving data, insemination data (also for natural service), time to dry off</td>
</tr>
<tr>
<td>Meat production</td>
<td>Farmer</td>
<td>Measurement and visual</td>
<td>If needed</td>
<td>All</td>
<td>None</td>
<td>2</td>
<td>Birth weight Weight at 200 days, weight at 365 days</td>
</tr>
<tr>
<td>Udder health</td>
<td>Vet, milker</td>
<td>Manual and visual</td>
<td>Permanent</td>
<td>All</td>
<td>None</td>
<td>1</td>
<td>Mastitis (yes/no) Somatic cell count lab</td>
</tr>
<tr>
<td>Other morphology and functional tests</td>
<td>Farmer</td>
<td>Manual and visual</td>
<td>Every two or three months during the lactation period</td>
<td>All</td>
<td>None</td>
<td>1</td>
<td>International Brown Swiss standard advisable (comparability also for crossbreeds)</td>
</tr>
<tr>
<td>Feet and legs</td>
<td>Vet, hoof trimmer</td>
<td>Manual and visual</td>
<td>If needed</td>
<td>All</td>
<td>None</td>
<td>1</td>
<td>ICAR codes</td>
</tr>
</tbody>
</table>
Use information technologies, if possible.
For example, mobile applications could be used to allow farmers to document information and to provide management support. For those not able to use mobile recording, a paper based solution could be provided for taking notes and to make sure that data are recorded by external personnel into the central database.

Check for existing technologies in the country or abroad. It would be an advantage if existing systems could be used, as feedback would be available more quickly.

ORGANIZATIONAL ASPECTS
It must be decided whether performance recording should be under the responsibility of the breeding association, another organization or the ministry. Systems should be comparable so that they can form the basis for extended cooperation, such as within genetic evaluation.

Developing a performance recording system under the responsibility of the breeding association is an easier task, as the number of covered animals is smaller, thereby reducing the need for significant investment. If the performance recording is controlled by the government, a larger database and performance recording system are needed; however, they are immediately linked to the national animal identification and traceability system. It should be kept in mind that that in the future a state-controlled performance recording system will most likely be developed.

TRAITS TO RECORD
The following traits should be recorded:

- **Unique animal identification number.**
- **Milk yield (milk kg):** As income is based in the first instance on milk yield, improving the milk yield is of the highest importance. Therefore,recording reliable information on the milk yield of individual animals is urgently needed. Performance recording needs to be established according to international standards from ICAR (method B).
- **Milk content parameters:** Milk content (fat, protein) and milk quality parameters are, like somatic cell count, valuable in the long term for a system with a high standard for milk quality. To perform tests on individual animals, a functioning lab with standardized equipment and the logistics to transport the milk samples to the lab are required.
- **Weight of females and males at 200 days and 365 days:** To assess the daily weight gain, the weights of females and males should be assessed at 200 days and 365 days by the farmer and recorded.
- **Calving data for reproduction:** The breed is known for its good reproductive performance, and this strength should be maintained. Therefore, it is important to collect data on reproductive performance, to include such traits in genetic evaluation. Reproductive performance is a complex trait, with many traits describing it (e.g. ability to conceive, reproductive disorders). For advanced trait definitions, data on insemination or reproductive disorders are needed. In countries with limited data availability, it is recommended that the calving dates be recorded and that the time between calving be used as a trait to include in selection decisions.
- **Culling reasons:** Culling reasons are helpful as predictors for longevity (Heise et al., 2018). They can be easily obtained by asking the farmer why the cows were culled. Codes for culling reasons need to be defined according to international practices. If calving data and culling reasons are obtained, longevity can be predicted. The longevity of Caucasian and Carpathian Brown Cattle is very high, and this strength should be preserved.
- **Health data, especially mastitis and claw health:** Farmers need to be motivated to document health
events according a standardized list of health codes.\(^2\) Events should be documented by farmers along with the animal ID, event date and event code. The data should be registered in a central database by the performance recording organization.

**DEVELOPMENT OF THE SYSTEM**

The development of the performance recording system should consider the following:

- **Stepwise development:** Given the logistics involved, the performance recording system should be developed within one farm and then extended to two or three more herds for testing. The test should include training for, and feedback from, the people involved.

- **Central database with feedback to farmers:** A central factor for success is a central database with provision of feedback to farms, such as herd management reports.

- **Standardization and training for recording:** To ensure high-quality data, standardized recording schemes and regular training are important.

- **Monitoring of implementation:** A general monitoring of the implementation that includes checks of data quality is important. Care also should be taken that the progeny of the best bulls and best females (including relatives) are included in the performance recording. Linking the breeding programme with the artificial insemination system is essential.

**BREEDING SCHEME**

Given the local conditions, the open nucleus breeding programme is recommended, as it can be implemented with the most success.

In situations where the existing infrastructure is limited (e.g. lacking animal identification and performance recording), nucleus breeding programmes are recommended (Kariuki et al., 2014). According to Oldenbroek and van der Waaij (2015), nucleus programmes are characterized by a limited number of female animals with genetic superiority. These are the dams to breed sires. They are owned by a breeding organization or a limited number of breeders and called a nucleus. They deliver the next generation of sires to mate with dams. They are recorded for a large number of traits. The breeding organization makes decisions regarding selection and mating in the nucleus and contract herds; as a consequence, breeding goals are used steadily, the recording of traits and pedigree is complete, and selection and mating in the nucleus are under full control. Over generations, this results in a high rate of genetic improvement.

The size of the nucleus is important for achieving genetic gain. A size of 5 percent to 10 percent of the cows of the population is recommended by Phillips (2001). In the case of a Pure Carpathian Brown Cattle population with 500 cows, this would mean a nucleus size of 50 cows. Kariuki et al. (2014) analysed the impact of size of the nucleus depending on varying population sizes, from 500 to 5 000 cows, and with different breeding programmes (e.g. phenotypic performance, progeny testing, genomic selection without
participants preferred a dispersed nucleus, where the best cows are still with the different farms. The advantage of the dispersed nucleus is that the breeding strategy can be more easily expanded to the other herds. The disadvantage is the challenge of setting up the infrastructure necessary to implement the breeding strategy.

**PLAN FOR THE IMPLEMENTATION OF A BREEDING PROGRAMME IN ARMENIA**

Out of 70,000 PCBC, the best 5,000 cows will be selected as herd book cows and will be under performance recording. Thirty percent of these cows will be under artificial insemination, for which the best young bulls selected from the 1,500 bull dams will be used. About 570 natural service bulls will be used for the population of 70,000 PCBC, which are distributed across 900 villages. The best 60 calves will be selected as artificial insemination candidates. They should be raised together, as they could then be compared with respect to their daily gains and conformation. This can be done at a contract farm or a central station. From the 570 natural service bulls and the artificial insemination candidates, which are part of the natural service bulls, the 10 best bulls will be selected for artificial insemination. The aim is for each young bull to have 30 progeny from the herd book cows. Therefore, about 300 doses of semen are needed. Each year, the best bull dams will be selected and mated to bull sires and the best artificial insemination young bulls.

The semen of the improved PCB bulls can also be used in the whole Caucasian Brown Cattle population.

progeny testing, genomic selection with progeny testing). They showed that for all scenarios, the genetic response could be improved greatly by increasing the size of the nucleus from 100 to 200 bull dams. If the nucleus is too small, hardly any selection is possible. Additionally, inbreeding must be considered. Therefore, for the Caucasian and Carpathian Brown Cattle, a nucleus size of 200 cows is recommended. An open nucleus, with the continuous replacement of low-performing cows with young cows from outside herds, can increase the genetic gain of the nucleus. Sourcing the cows from a wider gene pool is also very valuable for managing the rate of inbreeding and genetic diversity.

A nucleus can be formed by cows that are kept on farms or nucleus animals on station. With the lack of an infrastructure for animal identification and animal performance recording, keeping a nucleus on station has an advantage. Since targeted mating and selection of the best bulls are essential, it is important that high-quality phenotyping is possible. One precondition for a central nucleus is that farmers must sell or give their best animals to the central station.

A dispersed nucleus scheme, where the purebred breeding animals are kept on different farms by smallholders, has a higher probability of implementation. Additionally, a dispersed nucleus has an advantage in that the dissemination of genetic gain to commercial herds would be easier to implement.

Within the context of the stakeholder workshop in Kiev (and the aim to develop the livestock sector nationally),
TABLE 6
OVERVIEW OF THE STEPS OF IMPLEMENTATION CONCERNING PERFORMANCE RECORDING, HERD BOOK AND NUMBER OF SELECTED ANIMALS FOR THE BREEDING PROGRAMME IN ARMENIA

<table>
<thead>
<tr>
<th></th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 5</th>
<th>Year 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farms</td>
<td>400</td>
<td>500</td>
<td>600</td>
<td>800</td>
</tr>
<tr>
<td>Number and percentage of PBCB cows within herd book</td>
<td>2 500</td>
<td>3 750</td>
<td>5 000</td>
<td>10 000</td>
</tr>
<tr>
<td></td>
<td>1%</td>
<td>15%</td>
<td>2%</td>
<td>4%</td>
</tr>
<tr>
<td>Number and percentage under performance recording</td>
<td>2 500</td>
<td>28 000</td>
<td>37 500</td>
<td>20 000</td>
</tr>
<tr>
<td></td>
<td>10%</td>
<td>12%</td>
<td>15%</td>
<td>20%</td>
</tr>
<tr>
<td>Percentage of artificial insemination of herd book cows</td>
<td>10% (2 500)</td>
<td>12% (28 000)</td>
<td>15% (37 500)</td>
<td>20% (20 000)</td>
</tr>
<tr>
<td>Percentage of artificial insemination of bull dams</td>
<td>50%</td>
<td>75%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Number bull dams</td>
<td>1 000</td>
<td>1 200</td>
<td>1 500</td>
<td>3 000</td>
</tr>
<tr>
<td>Artificial insemination bull candidates</td>
<td>50</td>
<td>60</td>
<td>60</td>
<td>80</td>
</tr>
<tr>
<td>Artificial insemination bulls (Young bulls (YB))</td>
<td></td>
<td></td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Natural Service bulls</td>
<td>350</td>
<td>460</td>
<td>570</td>
<td>1 140</td>
</tr>
<tr>
<td>Proven bulls: selected from own programme/from other population/total</td>
<td></td>
<td></td>
<td>5/5/10 (2 years of use)</td>
<td></td>
</tr>
<tr>
<td>Bull sires: young bulls/progeny tested/total</td>
<td></td>
<td></td>
<td>2/3/5 (1 year of use)</td>
<td></td>
</tr>
</tbody>
</table>

FIGURE 1
BREEDING PROGRAMME IN ARMENIA (SCENARIO AFTER FIVE YEARS OF IMPLEMENTATION)

Caucasian Brown Breeding Programme
Armenia, 5 years scenario

Note: AI - artificial insemination, BS - bull sire, HB - herd book, NS - natural service, PT - progeny tested bull.
PLAN FOR THE IMPLEMENTATION OF A BREEDING PROGRAMME FOR PCBC IN GEORGIA

Out of 160 000 PCBC, the best 1 000 cows (which are from approximately 200 farms in seven regions) will be selected as herd book cows and will be under performance recording. Fifty percent of these cows will be under artificial insemination in five years. The best young bulls selected from the 200 bull dams (and progeny tested bulls, as soon as they are available) will be used. Approximately 45 natural service bulls will be used for the population of 160 000 PCBC, which are distributed across the villages in the seven regions. From the 45 natural service bulls, the best six bulls will be selected for artificial insemination. Fifty percent of the 1 000 herd book cows should be inseminated with the six young artificial insemination bulls. The aim is for each artificial insemination young bull to reach at least 15 female progeny that are within the herd book and that have information on performance. Out of the six artificial insemination bulls, the best three will be selected each year as progeny tested bulls. In five years, 8 000 of the 160 000 PCBC should be inseminated artificially. Due to bad semen quality and lack of expertise in artificial insemination, four doses of semen are required for each born calf. Each year, the best bull dams will be selected and mated to bull sires and the best artificial insemination young bulls. All bull dams should be inseminated with bull sires. Bull sires will be the best of

| TABLE 7 | OVERVIEW OF THE STEPS OF IMPLEMENTATION CONCERNING PERFORMANCE RECORDING, HERD BOOK AND NUMBER OF SELECTED ANIMALS FOR THE BREEDING PROGRAMME IN GEORGIA |
|-----------------|-----------------|-----------------|-----------------|-----------------|
|                 | Year 1 | Year 2 | Year 5 | Year 10 |
| Farms in seven regions | 50     | 100   | 200   | 300–400  |
| Number and percentage of PCBC cows within herd book | 200 | 0.03% | 400 | 0.06% | 1 000 | 0.15% | 2 500 | 0.38% |
| Number and percentage under performance recording | 200 | 0.03% | 400 | 0.06% | 1 000 | 0.15% | 2 500 | 3.8% |
| Percentage of artificial insemination of herd book cows | 50% | 50% | 50% | 75% |
| Percentage of artificial insemination of bull dams | 50% | 75% | 100% | 100% |
| Percentage of artificial insemination of PCBC cows | 1% | 2.5% | 5% (8 000 out of 160 000) | 20% |
| Number bull dams | 50 | 100 | 200 | 400–500 |
| Artificial insemination bull candidates | 20 | 45 | 90 | 150–200 |
| Artificial insemination young bulls | 3 | 3 | 6 | 6 |
| Natural service bulls | 10 | 20 | 45 | 80 |
| Proven bulls: Selected from own programme/from other population/total | 3/3/6 |
| Bull sires: young bulls/progeny tested/total | 3 | 3 | 3/3/6 | 6 |
the artificial insemination young bulls and the best of the progeny tested bulls. Progeny tested bulls also can be used from Armenia for artificial insemination in Caucasian Brown in Georgia.

Based on the assumptions of this five-year scenario, 2 000 doses of semen are needed for the herd book cows, including the bull dams, and 32 000 doses are needed for the 8 000 PCBC cows, if four doses are needed per calf. If the best three bulls are selected as progeny tested bulls out of the six artificial insemination young bulls (after about four years, when the progeny information is available) and used for the insemination of the PCBC population, approximately 11 000 doses per progeny tested bull would be needed for the Caucasian Brown Cattle population. To have these doses of semen available, two possibilities exist.

In a waiting bull system, the young bulls have to be kept for about four years until the results from the progeny are available. Then, semen will be produced only from the best bulls. The profitability of this system depends on the various costs (e.g. semen production per dose, keeping the bull) and the amount of semen needed. In the case of a waiting bull system, there is the advantage that a substantial portion of the semen from very good bulls can be sold. The semen can be produced on demand. This is potentially lucrative provided there is a respective market. This will depend on the development of artificial insemination service in the country and on the image of the breed. The use of semen from the best PCBC bulls from Armenia could be considered.

**PLAN FOR THE IMPLEMENTATION OF A BREEDING PROGRAMME IN UKRAINE**

Carpathian Brown Cattle is considered an extinct breed in Ukraine. According to inquiry, about 500 PCBC are available. No consistent figures are available about the size of the total population of Carpathian Brown, but the estimation is approximately 75 000 Carpathian Brown cows.

Carpathian Brown Cattle are genetically different from Caucasian Brown Cattle in Armenia and Georgia. It seems...
that there are some ancestors from the same exotic breeds in the pedigree, but the offspring and main composition are different, and the Carpathian Brown can therefore be considered a separate breed (FAO/IAEA, 2019). More information on the background can be found in the reports of the various studies [survey, genomic study, breeding strategy] conducted within this project.

Currently there is neither a conservation nor a breeding programme for PCBC. Animals are registered, but performance recording is not currently in place for this breed. Artificial insemination is only partly used. If artificial insemination is used, it is done primarily with imported semen from breeds like Holstein, Brown Swiss and others. Bulls are kept at village level for natural service. The owner keeps the bull and earns money for mating cows. There is no selection, and there is no artificial insemination station with the production of semen from Carpathian Brown bulls. Semen from five- to seven-year-old Carpathian Brown bulls is available at the research station. Cross-breeding is common, mainly with beef bulls and

**TABLE 8**

<table>
<thead>
<tr>
<th>Year</th>
<th>Farms/cows within herd book</th>
<th>Number and percentage under performance recording</th>
<th>Number and percentage under artificial insemination</th>
<th>Number bull dams</th>
<th>Number of bull sires</th>
<th>Artificial insemination bulls</th>
<th>Natural Service bulls</th>
<th>Proven bulls: selected from own programme/from other population/total</th>
<th>Bull sires: young bulls/progeny tested/total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 1</td>
<td>1 farm and 200 cows in herd book</td>
<td>200 100%</td>
<td>200 100%</td>
<td>100</td>
<td>12</td>
<td>5 (old bulls)</td>
<td>7</td>
<td>2/2/4</td>
<td>3</td>
</tr>
<tr>
<td>Year 2</td>
<td>1 farm and 300 cows in herd book</td>
<td>300 100%</td>
<td>300 100%</td>
<td>150</td>
<td>4</td>
<td>5</td>
<td>60</td>
<td>2/2/4</td>
<td>3</td>
</tr>
<tr>
<td>Year 5</td>
<td>2 farms (1 highland and 1 lowland) and 400 cows in herd book</td>
<td>400 100%</td>
<td>400 100%</td>
<td>200</td>
<td>10</td>
<td>5</td>
<td>60</td>
<td>2/2/4</td>
<td>2/2/4</td>
</tr>
<tr>
<td>Year 10</td>
<td>3 farms (2 highland and 1 lowland) and 500 cows in herd book</td>
<td>500 100%</td>
<td>500 100%</td>
<td>250</td>
<td>10</td>
<td>10</td>
<td>60</td>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>

There can be more cattle involved in performance recording – not only PCBC – to compare, select, improve quality, etc.
Simmental cattle. Young bulls are slaughtered and would presently not be available for selection.

There is a law on animal breeding, with several regulations on animal identification, performance recording, and other factors. A programme for the conservation of breeds was elaborated but is not yet in place (Reznikova, personal communication, 2019).

Programmes with subsidies per cow have been available in the country. No specific obligations concerning maintaining the breed have been required. However, this system of subsidies was stopped recently (Reznikova, personal communication, 2019).

The recommended conservation method would be to buy the best PCB cows and keep the nucleus centrally at a station. This would have the advantage that performance can be monitored and recorded with much better precision and quality. Targeted mating could be possible even if artificial insemination is not working properly. This would require that the best bulls be kept at the station as well.

To ensure that the best animals are within the nucleus, the best PCBC from the various farms need to be selected additionally and bought at an early stage. To ensure that bulls with high genetic potential from external herds are available, a programme to motivate farmers to mate the best cows with PCB bulls is needed. Additionally, the best bulls must be made available for the breeding programme. To ensure the possibility of selecting the best animals from external herds, there is a need for a performance recording system. Kariuki et al. (2014) showed the benefit of a larger nucleus. A substantial increase in genetic gain was realized when the size of the nucleus was increased from 100 to 200 bull dams. It is important that genetic gain is disseminated to the whole Carpathian Brown Cattle population.

Use artificial insemination

The value of superior individual animals is limited if they do not efficiently contribute to the improvement of the gene pool of the whole target population. The wide impact of genetic improvement depends on the dissemination of genetic gain to the different farms and animals.

Reproductive technologies, especially artificial insemination, are very important in this respect.

It is also important that performance recording be done for female progeny of artificial insemination bulls. This way, reliable data about their performance will be available for comparison with the rest of the population.
Use genetic evaluation

If animal identification is in place, and simple and reliable performance data are available from a minimum of 1000 animals, the first steps towards the elaboration of a genetic evaluation can be undertaken. Start with simple calculation of "breeding value" (correction of herd effect) based on a pilot study, and use this information for selection. As a second step, genetic parameters should be estimated and a simple genetic evaluation developed. The overall aim has to be continuous routine genetic evaluation, with published breeding values for males and females to be used for the selection of bull dams and bulls for the breeding programme and also to be available for farmers in the selection of replacements in the herds.

Genotyping of animals offers new possibilities for breeding programmes, since genetic gain can be increased significantly by using this technology (Schaeffer, 2006; VanRaden, 2019). In general, genomic evaluation favours large populations, as the achievable reliability of the breeding value depends very much on the number of genotypes. If genomic evaluation is implemented, it must be a system in which nearly all PCBC cows under performance recording will need to be genotyped, along with selected bulls.

It is challenging to implement a genomic evaluation and selection, as a whole system of logistics is needed. This includes the collection of samples, correct identification, storage and processing of data, checks of pedigrees and hereditary disorders, and the prediction of genomic breeding values.

It only makes sense at a later stage, when the base of a breeding strategy (breeding organization, performance recording) is working routinely.

The storage of DNA or genotypes of animals with high genetic potential should be considered from the outset.

Develop a system to store genetic material

Storage of genetic material from animals with high genetic potentials should be considered in all three countries, right from the beginning. It is important to keep the following factors in mind:

- A unique animal identification system is a precondition.
- If semen is available, store 20 doses of semen from each bull with high genetic potential from the breeding programme.
- Even if there is no possibility to store and process single nucleotide polymorphism (SNP) data (data from genomic testing), take an ear tag or hair sample and send it out for DNA extraction.
- It is important to use a high-quality system of DNA storage. The quality of the DNA must be assured for a long time, and the DNA from individual animals must be identified easily. Austria and Germany, for example, store the DNA for Fleckvieh/Brown Swiss at the Austrian Institute of Technology in Tulln, Austria.

Calculate the expected impact of the breeding strategy

After several years of implementation of the breeding strategy, it is recommended that a research study be conducted, together with a university, on the optimization of breeding plans. The research should focus on assessing the genetic progress and increased profit achieved through breeding the Caucasian and Carpathian Brown Cattle breed. Alternative scenarios can then be evaluated. Besides direct evaluation criteria for a breeding programme, Lamuno et al. (2018) describe other aspects for evaluation of a breeding strategy, such as socio-economic aspects.
# Workplan for the implementation of the breeding strategy

<table>
<thead>
<tr>
<th>Steps to Develop a Breeding Strategy</th>
<th>Years</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plan for implementation and commitment of the appropriate ministry to support and guide.</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Develop projects and financing possibilities for specific measures (e.g. performance recording, semen production).</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Set up the breeding association.</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Approve the breeding goal.</td>
<td>x</td>
<td>1-2</td>
</tr>
<tr>
<td>Performance recording – logistic</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Performance recording – milk lab</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Performance recording – herd management reports for farmers</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Identify potential farms and animals for participation in the breeding programme.</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Set up the herd book.</td>
<td>x</td>
<td>1</td>
</tr>
<tr>
<td>Set up the artificial insemination infrastructure, including semen production.</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Set up the storage of genetic material.</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Select the best bulls and females for the breeding programme.</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Set up genetic evaluation.</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Set up genomic evaluation.</td>
<td>x</td>
<td>5</td>
</tr>
</tbody>
</table>

*Priorities are ranked from 1 to 5, with 1 being the highest priority.*
References


Appendix I

Definition of terms related to breeding programmes

Several synonyms are often used for animal groups and selection measures. For the sake of better understanding, uniform terms are used in this report. These are to be understood as follows:

- **Bull dam**: Cow or heifer selected by the breeding association on the basis of defined criteria for targeted mating, to produce the next generation of bulls. Synonyms: potential mother of young bull, bull mother, or cow for planned mating.

- **Young bull**: Bull which (ideally born from a planned mating), after selection by a breeding association or insemination station, is paired to a part of the cow population, using only a limited number of sperm portions. Synonym: test animal.

- **Artificial insemination bull candidates**: Male calves from the bull dam, selected and monitored during raising. It is recommended that the best of them be selected and raised centrally at a farm/enterprise, and that the best of that group be selected as artificial insemination young bulls.

- **Artificial insemination young bull**: Out of the young bulls raised from the male bull calves (progeny from planned mating with bull dams), the best bulls to be selected for artificial insemination.

- **Natural service bull**: Out of the young bulls raised from the male offspring of the bull dams, the second-choice bulls to be selected for natural service and distributed to villages, where care is taken that the females are mated with these natural service bulls.

- **Proven bull/progeny tested bull**: The young bulls selected within the breeding programme based on progeny records. It is recommended that proven/progeny tested bulls of PCBC from other populations be used – for example, bulls from Armenia in Georgia.

- **Bull sire**: The best young bulls (artificial insemination and natural service) and proven bulls within the breeding programme to be selected for planned mating with bull dams, in order to create the next generation of bulls. The very best proven/progeny tested PCBC bulls from other populations can be used for planned/targeted mating. Synonyms: bull father, planned mating bulls.
Appendix II

Contributors to the elaboration of the breeding strategy (participants in the workshop in Kiev, 11-12 September 2019)

Olen Alshanova  National coordinator of the project (Deputy Head of Agrarian Policy and Agriculture Department of Ministry of Agrarian Policy of Ukraine), Ukraine
Ostap Zhukorskiy  Secretary of Zootecnichian Department of National Academy of Agrarian Sciences, National Coordinator of Animal Genetic Resources of Ukraine, Ukraine

Roswitha Baumung  Animal Production Officer
Zsófia Bossányi  International consultant on gender and social protection
Christa Egger-Danner  International consultant on breed development
Eran Raizman  Senior Animal Production and Health Officer
Tibor Szücs  Livestock production consultant
Meruzhan Zadayan  FAO-national consultant, Armenia
Ashot Hovhannisyan  FAO national consultant, Armenia
Levon Ter-Isahakyan  Head of the livestock department at Ministry of Agriculture, Armenia
Tigran Chitchyan  Head Animal Husbandry Department at Armenian National Agrarian University, Armenia
Armen Avetisyan  President of the Pedigree Animal Breeders Association, Armenia
Armen Jaghinyan  Senior private veterinarian, Armenia
Miqael Haykuni  Veterinary specialist with the Strategic Development Agency, Armenia
Davit Navasardyan  Animal breeding specialist at the CARD AgroService CJSC, Armenia
Giorgi Chagelishvili  FAO-national consultant, Georgia
Zura Kulijanashvili  Georgian Business Development Center, Georgia
Giorgi Khatashvili  Caucasus Genetics, Georgia
Zviad Asanishvili  Head of the Animal Registration and Identification Division of the Veterinary Department, Georgia
Rusudan Barkalaia  Head of the Department of Livestock Breeding and Forage Production, Georgia
Natalia Reznikova  FAO-national consultant, Ukraine

Olena Alshanova  National coordinator of the project (Deputy Head of Agrarian Policy and Agriculture Department of Ministry of Agrarian Policy of Ukraine), Ukraine
Ostap Zhukorskiy  Secretary of Zootecnichian Department of National Academy of Agrarian Sciences, National Coordinator of Animal Genetic Resources of Ukraine, Ukraine

Armen Avetisyan  President of the Pedigree Animal Breeders Association, Armenia
Armen Jaghinyan  Senior private veterinarian, Armenia
Miqael Haykuni  Veterinary specialist with the Strategic Development Agency, Armenia
Davit Navasardyan  Animal breeding specialist at the CARD AgroService CJSC, Armenia
Giorgi Chagelishvili  FAO-national consultant, Georgia
Zura Kulijanashvili  Georgian Business Development Center, Georgia
Giorgi Khatashvili  Caucasus Genetics, Georgia
Zviad Asanishvili  Head of the Animal Registration and Identification Division of the Veterinary Department, Georgia
Rusudan Barkalaia  Head of the Department of Livestock Breeding and Forage Production, Georgia
Natalia Reznikova  FAO-national consultant, Ukraine

Olena Alshanova  National coordinator of the project (Deputy Head of Agrarian Policy and Agriculture Department of Ministry of Agrarian Policy of Ukraine), Ukraine
Ostap Zhukorskiy  Secretary of Zootecnichian Department of National Academy of Agrarian Sciences, National Coordinator of Animal Genetic Resources of Ukraine, Ukraine

Armen Avetisyan  President of the Pedigree Animal Breeders Association, Armenia
Armen Jaghinyan  Senior private veterinarian, Armenia
Miqael Haykuni  Veterinary specialist with the Strategic Development Agency, Armenia
Davit Navasardyan  Animal breeding specialist at the CARD AgroService CJSC, Armenia
Giorgi Chagelishvili  FAO-national consultant, Georgia
Zura Kulijanashvili  Georgian Business Development Center, Georgia
Giorgi Khatashvili  Caucasus Genetics, Georgia
Zviad Asanishvili  Head of the Animal Registration and Identification Division of the Veterinary Department, Georgia
Rusudan Barkalaia  Head of the Department of Livestock Breeding and Forage Production, Georgia
Natalia Reznikova  FAO-national consultant, Ukraine
The aim of FAO project TCP/RER/3604 was to elaborate breeding goals and plans for breeding and breed development of Caucasian Brown Cattle in Armenia and Georgia and Carpathian Brown Cattle in Ukraine. As a first step, information was collected about the breeds themselves and the environments in which they are kept. Approximately 300 phenotypic pure cows and 20 pure bulls were selected in each country, and phenotypic information was recorded. The assessments were carried out under the guidance of Tamas Szobolevszki, with support from each country’s national consultants and service provider. Genetic material was collected, genotyped and used for a study on the genetic background of the breeds by the International Atomic Energy Agency (IAEA) in Vienna (FAO/IAEA, 2019).

At two workshops held with stakeholders involved in the breed development of Caucasian/Carpathian Brown Cattle, a concept of a breeding strategy was developed, taking circumstances for implementation into account.

The overall goal of the strategy is to conserve Carpathian Brown Cattle and Caucasian Brown Cattle breeds by making use of the potential for improving the breeds genetically. As the population of the pure Caucasian Brown Cattle in Armenia and Georgia is about 70 000 and 160 000 cows, respectively, this document has developed a breeding programme with the aim of increasing the genetic gain for Pure Caucasian Brown, according the breeding goal for the breed. For Carpathian Brown, whose population is estimated at fewer than 1 000, the aim is to develop an in situ conservation programme.