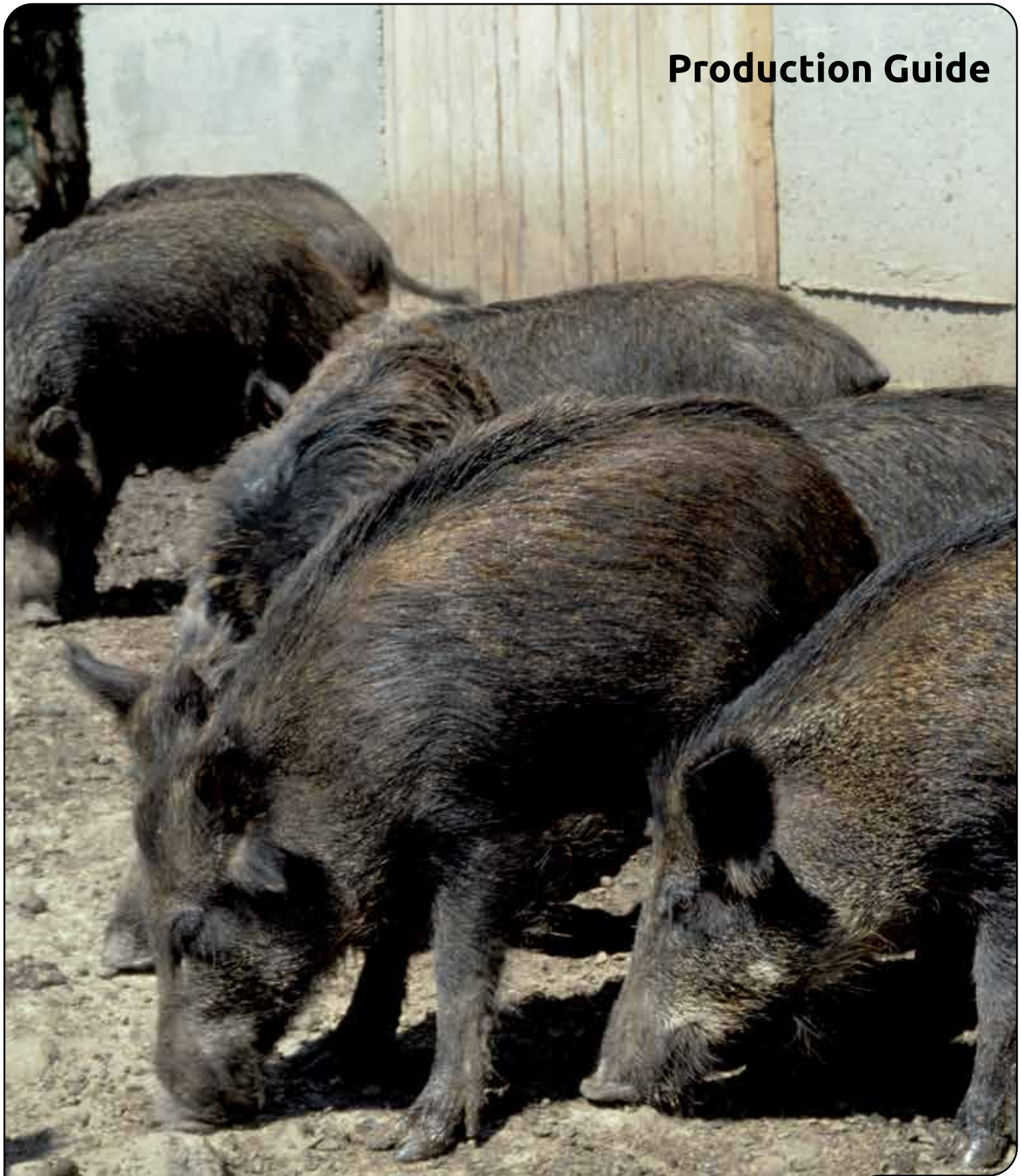
Production Guide



DOMESTIC GAME FARM ANIMALS

Wild Boar

CRAAQ

CULTIVER L'EXPERTISE
DIFFUSER LE SAVOIR

Notice

At the time of writing, the information contained in this collection of 10 factsheets was considered representative of knowledge about the wild boar farming and related subjects. The reader bears full responsibility for any consequences that may arise from using it. Since some of the information may have evolved significantly since these factsheets were written, the reader is invited to verify its accuracy before putting it into practice.

This project was partly funded by Agriculture and Agri-Food Canada, through the Canadian Agricultural Adaptation Program (CAAP). In Québec, the program component addressed to farm production is managed by the Conseil pour le développement de l'agriculture du Québec.

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PGGD0102-C02PDF
ISBN 978-2-7649-0407-7
Legal Deposit
Library and Archives Canada, 2013
Bibliothèque et Archives nationales du Québec, 2013

Production Guide

DOMESTIC GAME FARM ANIMALS

Introduction to Game Farming

CRAAQ

CULTIVER L'EXPERTISE
DIFFUSER LE SAVOIR

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Juan Pablo Soucy (red deer and wapiti)
© **Etienne Boucher**, MAPAQ (bison)
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INTRODUCTION

Large game animals have been raised in Quebec since the 1980s. By 2011 there were over 208 owners of large game animals in the province (Table 1), of whom 140 had more than 10 females.

Table 1. Number of big-game owners[1] by species

	Bison	Red deer	Wapiti[2]	Wild Boar
Number of owners	50	73	45	40

1. An owner is a person who has declared at least one female of a large game species, regardless of whether other species are also present. Source: *Fichier d'enregistrement des exploitations agricoles*, MAPAQ, 2011.
2. Outside of Québec, wapiti are usually called "elk".

As in other farm sectors, the start-up process for a bison, red deer, wapiti or wild boar farm should be systematic and well structured. At several points one can either carry on or decide to stop with no harm done. One can choose between purchasing a few animals for **hobby farming** or working to develop a **commercial operation**. Commercial undertakings in particular demand thorough preparation, including a business plan, technical and economic planning, learning about animal husbandry, nutrition, genetics and reproduction, and groundwork on marketing—especially since the bills will have to be paid from business earnings.

The main generators of income are:

- sale of venison products;
- agri-tourism (farm visits, etc.);
- sale of breeding stock;
- sale of velvet antlers (deer);
- hunting (game ranches).

NINE STEPS TO SETTING UP A GAME FARM

Step 1. Self-assessment: Do you have the skills to succeed as a producer in this industry?

Game farming doesn't just mean looking after a herd. There are many other skills to develop and hone – a game farmer wears many hats!

Producer[1]

Raising livestock requires solid production knowledge, a certain know-how, and a willingness to work whenever needed. Game farmers must understand their animals' behaviour, paying attention to their needs to get the best performance possible.

Entrepreneur

An entrepreneur is well organized and resourceful, has good planning skills and is able to react quickly to the unexpected. Every farm has ups and downs, and producers must be able to deal with them. Price drops, low production volumes, problems with disease… To succeed, preparation is essential, as is the ability to adapt to new challenges – and especially, never give up.

Manager

Keeping costs in check, regularly assessing productivity, culling unproductive animals… Good management skills are essential, for without them operations will be inefficient. Every activity (purchase of inputs, product sales, etc.) must be planned, and every decision will have a direct impact on the success of the business.

Businessperson

To satisfy the target clientele, producers need to be well organized, must know how to negotiate, be able to adapt, and ensure the best service they can. A farm's success is directly tied to its earnings. **Marketing must be a top priority whenever decisions are being made.**

1. Before plunging into intensive livestock production, it's best to gain experience by starting out with a small herd. This gives the producer a chance to test his or her interest, while developing a better grasp of the synergy between processes: production, slaughter, processing and distribution.

Step 2. Exchanges and networking with other industry stakeholders

It goes without saying that big game production today requires management skills in nutrition, genetics, reproduction and marketing. This diverse expertise, acquired over many years, is intrinsically linked to a producer's professional network. To start off on the right foot:

- visit existing farms, not only to see herds, but also to take note of different types of facilities. Chat with producers who are already in business, perhaps gleaning advice on purchasing animals, to avoid possible missteps;
- present the project to family and friends and to future potential meat buyers;
- meet with local butchers, grocers, restaurant owners and consumers to better understand their needs and the different markets for specialty game meat;
- meet with a business start-up advisor at the nearest *Centre local de développement* (CLD), plus an agronomist with a production-management background, to lay the groundwork for the future business;
- meet with the livestock advisor of the nearest MAPAQ (*ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec*) office to obtain information on financial assistance programs, among other things;
- find out about local veterinary services with experience in the species you want to raise.

Step 3. Be informed: Regulations, standards and obligations affecting livestock operations

There are certain legal and administrative regulations that every producer must know and respect, including the following.

Regulation respecting animals in captivity

This Regulation falls under the *Act respecting the conservation and development of wildlife*. Red deer, wapiti, bison and wild boar may be kept in captivity without a permit, under certain conditions. If however they are kept for hunting purposes, producers must apply to the MAPAQ for a game ranch permit. Conditions and obligations related to the permit are described in Division IX of the Regulation, which can be found at: http://www.canlii.org/en/qc/laws/regu/rrq-c-c-61.1-r-5/latest/rrq-c-c-61.1-r-5.html.

Sections 3 and 4 of the Regulation outline the general obligations of any person who keeps an animal in captivity (shelter, water, food) as well as those on humane slaughter. Sections 8 to 12 set out responsibilities related to pens and perimeter fencing, with the obligation to promptly notify a wildlife protection officer on discovering that an animal has escaped.

Regulation respecting the identification and traceability of certain animals (Animal Health Protection Act)

The permanent identification of cervids with a chip tag and bar code tag, with a few exceptions specified in the Regulation (http://www.canlii.org/en/qc/laws/regu/rrq-c-p-42-r-7/latest/rrq-c-p-42-r-7.html), is

mandatory in any herd with 6 or more cervids. Set up to enable swift action in the event of a food safety or animal health problem, the traceability system is managed, in Québec, by *Agri-Traçabilité Québec*. For more information, see: http://www.atq.qc.ca.

Agricultural Operations Regulation

Falling under the *Environment Quality* Act, the *Agricultural Operations Regulation* is aimed at protecting the environment, particularly water and soil, against pollution caused by certain agricultural activities. It sets out general obligations regarding livestock waste; describes design standards for raising and storage facilities; and lists situations in which an authorization certificate must be requested from, or project notice given to, the *ministère du Développement durable, de l'Environnement, de la Faune et des Parcs* (MDDEFP). To consult the Regulation, see http://www.canlii.org/en/qc/laws/regu/rrq-c-q-2-r-26/latest/rrq-c-q-2-r-26.html.

Would-be livestock producers must also submit a project notice to municipal authorities to obtain the necessary authorizations, notably in regard to distances from wells and neighbours.

Registration of agricultural operations with the MAPAQ

Qualifying as a producer with the MAPAQ has several advantages, including access to government support programs. To qualify, an operation must generate (or be expected to generate) farm revenues of at least $5,000. For more information (in French only), see http://www.mapaq.gouv.qc.ca/fr/Productions/enregistrement/Pages/enregistrement.aspx. The regulation requiring registration may be consulted at http://www.canlii.org/en/qc/laws/regu/rrq-c-m-14-r-1/latest/rrq-c-m-14-r-1.html. First-time applicants should contact their regional service centre (see http://www.mapaq.gouv.qc.ca/fr/Regions/Pages/Carte.aspx).

Standards and obligations regarding cutting, processing and sale of food products

In Québec, the slaughter, cutting, processing and sale of food products must be carried out in compliance with strict standards, and require permits. For more information (in French): www.mapaq.gouv.qc.ca/fr/md/Permis/Pages/Permis.aspx.

Step 4. Marketing: The number one priority

Before making a single purchase, nailing a single board or buying the first piece of equipment, it is imperative that you:

- determine the primary goal or outcome of the agribusiness (hobby farm, commercial production, off-farm sales), taking into account whether it will be a part-time or full-time undertaking;
- if the goal is off-farm sales, ensure there is a slaughterhouse, processing plant or butcher, either locally or in the region, as well as points of sale (grocers and restaurants);
- define the final product (carcass, cuts, processed products) and decide what operations if any will be performed on-site (cutting and/or processing);
- obtain information on the regulations governing slaughter, cutting, processing and sales (both on and off the farm).

> Without good market planning, earnings will be meagre or slow to develop.

Step 5. Development and creation of a business plan

A business plan is the paper version of all the dreaming, planning and decisions surrounding a particular project. The business plan outlines the business as the producer sees it, identifying its orientation, defining a start-up strategy, and setting goals. The business plan is a crucial requirement in any application for financial assistance.

It is recommended that the business plan be drawn up with the assistance of a private consultant, regional economic development agency or government bureau.

Step 6. Find the necessary capital

As part of the business plan, the producer will develop an investment calendar. Whether growth is projected over the short or long term, it can take a while for earnings to compensate expenses (stock purchases, maintenance), and the business may at first seem unprofitable. However, quickly making some initial sales can bring in much-needed income, despite the low production volumes at start-up, since production will grow as sales gradually increase.

Step 7. Implementation

- Build fences to make yards and pens, and construct a sorting centre with a squeeze and loading chute, so the animals can be handled safely.
- Purchase animals (this is one of the biggest expenses). Buying quality stock (in terms of both genetics and performance) will make every aspect of the operation easier.
- Set up purchase agreements with potential meat buyers (butchers, restaurants, etc.).

Step 8. Monitoring herd performance

- Maintain detailed stock records (age, weight curve from birth to slaughter, number of births, mating, etc.) to track both individual and herd performance. This information will help in selecting the best breeding stock.

Step 9. Specialization

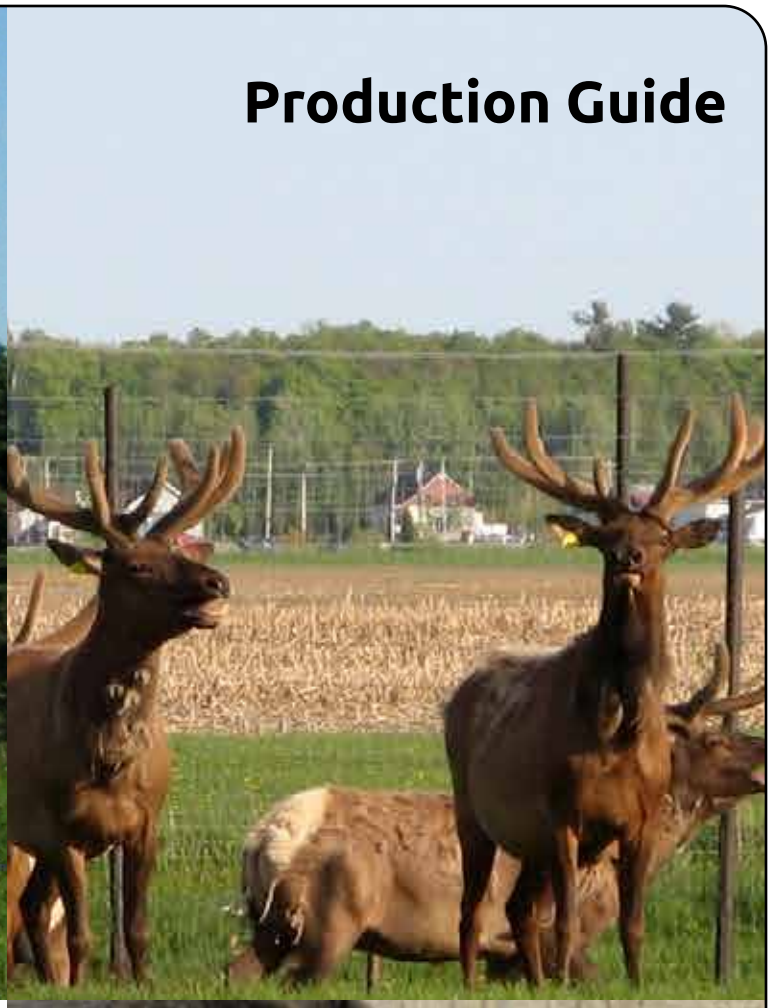
Strongly recommended:

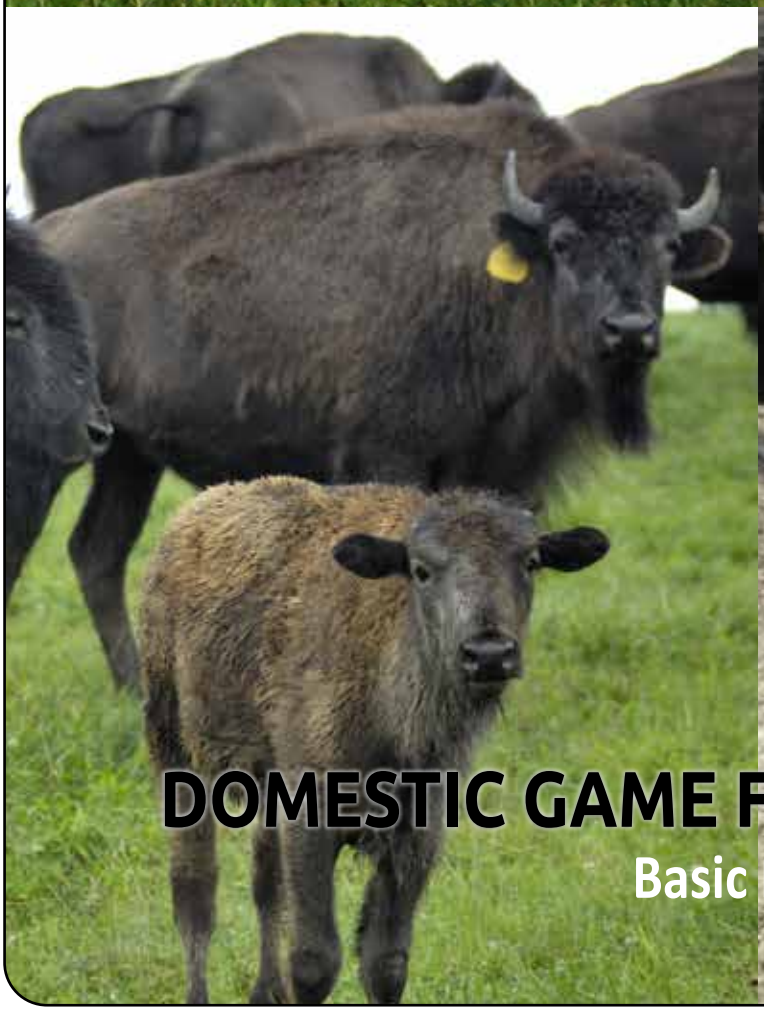
- for the first few years, take courses in production and animal husbandry, marketing, agri-tourism and so on, to expand your knowledge about aspects related to the objectives in your business plan;
- seek input from specialists in animal production, marketing and processing on any questions or challenges you encounter;
- continue learning and extending your knowledge as the business grows.

FOR MORE INFORMATION

Besides the websites mentioned above, here are some suggestions for where to obtain more information:

- the *Centre de référence en agriculture et agroalimentaire du Québec* (CRAAQ) distributes DVDs produced by the *Fédération des éleveurs de grands gibiers du Québec* on the breeding and handling of wild boar, bison, wapiti and red deer, as well as on marketing and cuts of meat. See: http://www.craaq.qc.ca/Publications-du-CRAAQ;
- the CRAAQ's "Références économiques" collection includes sample budgets for bison, red deer, wapiti and wild boar production. See: http://www.craaq.qc.ca/ReferencesEconomiques;
- other CRAAQ resources (financial assistance for young farmers, consulting services, resources for young farmers) can identify financial assistance programs, find advisors and provide certain other services. See: http://www.repertoiresducraaq.ca;
- regional agricultural training networks (*Collectifs régionaux en formation agricole*) are listed at http://www.formationagricole.com;
- the Ontario Ministry of Agriculture, Food and Rural Affairs provides good information about non-traditional livestock: http://www.omafra.gov.on.ca/english/livestock/index.html;
- the MAPAQ site offers a start-up kit for new producers on restaurant and retail sales (in French): http://www.mapaq.gouv.qc.ca/fr/restauration/nouveauxexploitants/pages/trousse.aspx





Production Guide

DOMESTIC GAME FARM ANIMALS

Basic Principles of Genetics

CRAAQ

CULTIVER L'EXPERTISE
DIFFUSER LE SAVOIR

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Photos (cover page)

Juan Pablo Soucy (red deer and wapiti)
© **Etienne Boucher**, MAPAQ (bison)
© **Michel Langlois**, MAPAQ (wild boar)

INTRODUCTION

Red deer, wapiti (elk), bison and wild boar farmers need to understand the basic principles of genetic selection, so they will be able to raise, breed and market animals with the right characteristics for particular markets (meat, hunting, velvet antler, etc.). Regardless of the type of livestock, every farmer will need, at one time or another, to purchase breeding stock, choose semen for artificial insemination (red deer, wapiti, bison), or select breeding stock from within their own herd.

Understanding and using the basic principles of genetics is part of the constant evolution and improvement of livestock (conformation, productivity, growth, etc.). Quality breeding stock and optimum production conditions are key to ensuring profitability.

GENETICS AND ENVIRONMENTAL FACTORS

An animal's performance (phenotype) is linked as much to its genetic makeup (genotype) as to its environment (Figure 1): the best breeding stock in the world would never reach its full potential in a subpar environment.

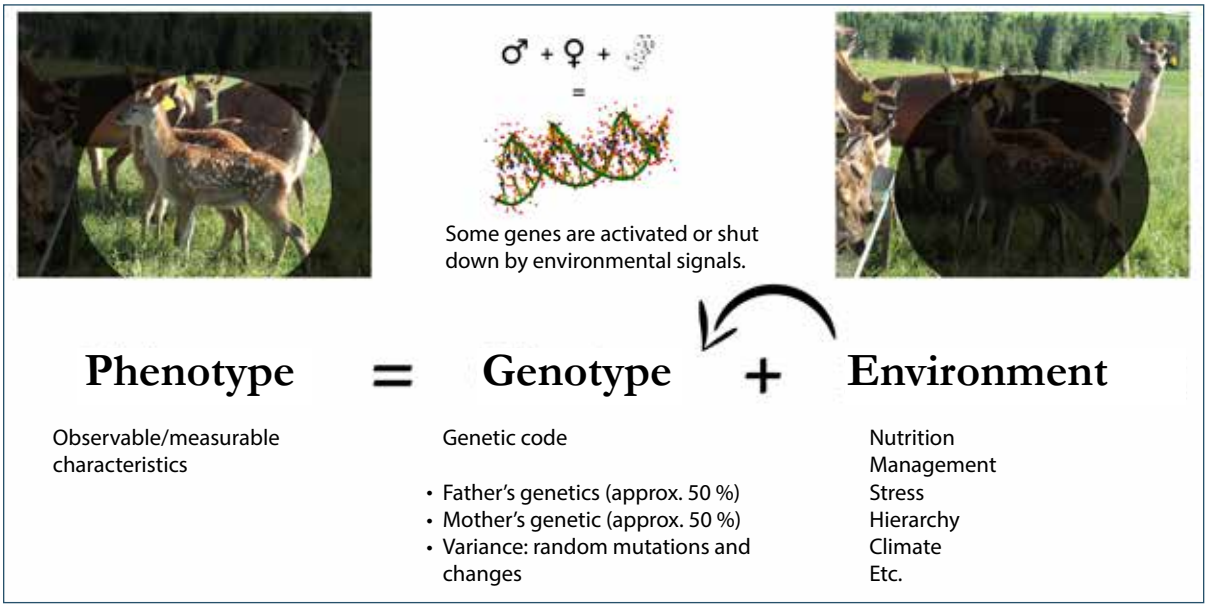


Figure 1. Factors affecting animal performance
Source: Juan Pablo Soucy

In animal production, the weakest link in the production chain determines performance. The classic illustration of this concept is a barrel in which each plank corresponds to some aspect of performance: inevitably, the shortest plank determines the maximum water level (Figure 2).

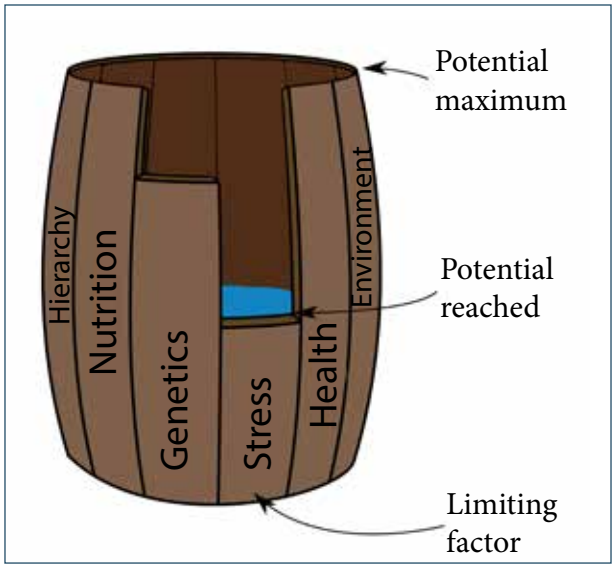


Figure 2. The weakest link in any production system limits potential animal performance
Source: Juan Pablo Soucy

DEFINITIONS

Genes and genetic makeup

A gene is a sequence in a unit of DNA that occupies a specific position on a chromosome and carries genetic information transferred from parents to offspring. With ~50% of its genes from its father, and ~50% from its mother, each individual carries a unique combination of genes (genetic makeup) that makes it different from other individuals.

Qualitative traits

Environmental conditions have little or no effect on qualitative traits, which are easily observable (e.g. eye colour, conformation, cervid antlers, hardiness, vigour, wild boars' flight instinct, etc.).

Producer organizations are working to develop conformation[1] tables for these alternative livestock, similar to those used for conventional livestock.

Quantitative traits

Quantitative traits are measurable characteristics that can be altered to a greater or lesser extent by environmental conditions (nutrition, housing, etc.). The genes involved in quantitative traits interact with environmental factors, and an animal's genetic potential may be undermined by inadequate production practices.

Most economically significant characteristics (growth rate, milk production, etc.) are quantitative traits.

1. For more information on red deer conformation see the following factsheet: *Evaluating Red Deer for Breeding*.

Heritability of qualitative traits

Heritability is a value between 0 and 100% (sometimes expressed as a decimal or fraction between 0 and 1) that indicates the importance of heredity in the expression of a particular characteristic and its transmission from parents to offspring. Environment is the other factor. Knowing the heritability of a trait facilitates the selection of breeding stock.

A desirable trait with high heritability will depend largely on heredity and should be included among selection criteria. The expression of a less heritable trait is influenced more by environmental factors than by heredity, but this does not preclude it from being a selection criterion; it simply means that genetic improvement for that trait will be slower.

Inbreeding

Inbreeding is a reproductive technique that consists of mating closely related individuals. Inbreeding was often used in the past to develop herds. It is no longer recommended because it increases the risk of accumulating unfavourable genes, reducing zootechnical performance, and creating hereditary anomalies.

If the same male is used over several years and bred with its own daughters, granddaughters, etc., inbreeding results, increasing the degree of consanguinity within the herd. Parentage should therefore be considered in planning reproductive groupings and purchasing breeding stock. Generally, the herd should be managed to ensure a maximum coefficient of consanguinity of no more than 6.26% to 10% (the equivalent of first cousins).

STEP-BY-STEP SELECTION PROCESS

The purpose of selecting breeding stock is to improve the herd by only mating animals that perform best in one or more ways. Selecting the best breeding stock ensures that their genes are transmitted and multiplied. The selection process must therefore start with clearly defining the type of animal desired to meet the target market, followed by considering which selection criteria can lead towards that animal.

The first step is to exclude animals that do not fit the desired profile, then to select for one or two criteria at a time until a satisfactory level is achieved.

Attempting to select for multiple traits at once will only slow the process of improvement. It is important to assess and account for the impact of selection on other aspects of production. For instance, selecting for higher weights at one year of age could also lead to higher birth weights, increased birthing difficulties, higher nutritional requirements, etc.

Bison

Only healthy, vigorous, productive animals with good conformation and a good temperament should be selected for breeding stock. Currently, most producers keep the majority of their females if they are good breeders. The selection of breeding bulls is more important, hinging on one or two characteristics with high heritability (carcass, growth, weight, reproductive efficiency) (Table 1). A producer who is raising bison for meat will want to develop animals with the highest feed efficiency possible. Breeding-stock operations will want to develop fertile animals that calve easily and produce offspring with good growth and conformation.

Table 1. Comparative heritability estimates for various characteristics in beef cattle[1]

Characteristics	Heritability (%)	Characteristics	Heritability (%)
Adapted from Alberta Agriculture, 1988; Hamilton and Wilton, 1987		*Adapted from Utrera and Van Vleck, 2004; Cammack and coll., 2009*	
Reproduction		Carcass mass	35 – 42%
Age at puberty (females)	20 – 40%	Area of rib-eye muscle	28 – 36%
Scrotal circumference	20 – 50%	Carcass yield	37 – 41%
Milk production	25%	Calving date	10 – 49%
Weight performance			
Birth weight	25 – 40%		
Weaning weight	25 – 30%		
Weight at 1 year	50 – 60%		
Weight at maturity	50 – 80%		
Growth			
Daily gain: birth to weaning	25 – 30%		
Daily gain: post-weaning to market weight	45 – 50%		
Carcass characteristics			
Carcass classification	35 – 45%		
Backfat thickness	25 – 40%		
Area of rib-eye muscle	25 – 40%		

1. Because bison are of the same family as cattle, similar characteristics may be assumed between the two species.

Wapiti and red deer

Females that have had repeated problems with calving in previous seasons, and males with lower reproductive performance (number of offspring, distribution of births) should not be selected as breeding stock. Breeding bulls can be selected to meet the target market (breeding stock, velvet, venison) based on weight and velvet yield (Table 2). Cows can be selected based on the birth weight of their offspring, tendency to conceive in the early autumn, temperament, growth curve, etc.

Table 2. Comparative heritability estimates for various characteristics in red deer and wapiti

Red deer and wapiti		Red deer	
Characteristics	Heritability (%)	Characteristics	Heritability (%)
Adapted from Jordan and coll., 1994; Friedel, 1994		*Adapted from McManus and Hamilton, 1991; van den Berg and Garrick, 1997; Kruuk and coll., 2002; Delgadillo Calvillo and coll., 2008; Quinn-Walsh and coll., 2010; Ramírez Valverde and coll., 2011*	
Weaning weight	25%	Velvet antler mass	26 – 36%
Weight: 1 year	35 – 40%	Body mass at maturity	54 – 62%
Weight: 3 years	40%	Body mass at birth	15 – 27%
Milk production	20 – 30%	Body mass at weaning	14 – 21%
Type	35 – 40%	Body mass at 1 year	16 – 34%
Fat accumulation	35%	Gain post-weaning	10 – 14%
Antler weight	20 – 25%		
Velvet antler growth	35%		
Behaviour	20 – 30%		

Wild boar

Male breeding stock should be selected for good conformation and solid legs. The parents' behaviour and social hierarchy are also important selection criteria.

For the hunting market (game ranches), hardy individuals with good flight instincts should be selected. Producers raising their own stock will probably have to compromise between sow selection and hunting stock. As for meat producers, they require prolific sows with good mothering abilities, high rates of offspring survival, good growth rates, good carcass yield, good muscling, etc. Sows must have enough nipples to feed 6 to 8 piglets. If data are available, producers should use male and female breeding stock from uniform litters, which will help guarantee a good lineage.

Table 3 outlines the heritability of major characteristics in domestic hogs.

Table 3. Heritability estimates of major characteristics in swine[1]

Characteristics	Heritability (%)
Reproduction	
Age at first estrus	30%
Number of nipples	30%
Gestation period	40%
Growth	
Average daily growth	30%
Appetite	35%
Leg quality	35%
Carcass	
Carcass yield	35%
Backfat thickness	45%
Area of rib-eye muscle	45%
Percentage muscle	50%
Carcass length	60%

1. Because hogs are of the same family (*Suidae*) and close cousins of wild boar, similar characteristics may be assumed between the two species.

Adapted from CPAQ, 1995

SPEED OF GENETIC IMPROVEMENTS

The speed at which selection advances genetic improvement (and thus, herd performance) depends on four main factors:

- selection differential: the difference (with regard to one or more traits) between the parents selected to produce the next generation and the average for that species. The greater this difference, the stronger the effects of selection will be;
- heritability: the more a given trait is heritable, the more precisely breeding stock can be selected for it;
- selection intensity: the degree of superiority of animals selected for breeding, compared to the average;
- generation interval: the average age of parents at the birth of their first offspring. The shorter this interval, the more swiftly genetic improvement can progress.

Example

A wapiti producer sets a selection differential of 3.2 kg for velvet antler production by 2 year bulls. By mating bulls that will be 3 years old at their offspring's birth with cows that will then be 7 years old, the producer can expect the calves to produce 0.22 kg/year more velvet than the previous generation, based on the following calculation:

$$\text{Genetic progress} = \frac{0.35 \text{ (heritability)} \times 3.2 \text{ kg}}{5 \text{ yrs (average age of parents)}} = 0.22 \text{ kg/yr}$$

ARTIFICIAL INSEMINATION

In red deer, wapiti, bison and wild boar, artificial insemination is primarily used for genetic improvement:

- to tap into the genetic makeup of semen from high-quality male breeding stock without having to invest in the purchase of elite animals;
- to improve herd quality faster than with natural mating;
- to allow the extensive use of male breeding stock with desirable genetic characteristics, by:
  - fertilizing a greater number of females;
  - using the same semen over a long period through freezing;
- to mitigate the risks of diseases transmitted through natural mating.

Despite these advantages, artificial insemination can be challenging, and is not for everyone. For most producers, natural mating with the best male breeding stock in the herd will be a better option.

Artificial insemination is more commonly used for red deer than for wapiti or bison. Some producers use artificial insemination for several years to improve herd genetics, then go back to natural mating with the resulting stock. Even if artificial insemination is used, the use of a back-up male is recommended in the cycle following insemination[2].

The success rate of artificial insemination varies depending on several factors. Artificial insemination requires considerable handling of the animals, including the administration of hormones to stimulate and synchronize estrus and ovulation, and the insemination process itself. These procedures require good anatomical and physiological knowledge, and must be performed with precision. Many producers start by using the services of an experienced professional (e.g. a veterinarian), but eventually learn the technique themselves. Note that it is essential to have the proper equipment (a squeeze) for immobilizing the females during handling.

2. For more information (particularly on insemination), see the following factsheets: *Reproductive Management of Red Deer* and *Reproductive Management of Wapiti*.

Production objectives should first be identified (herd improvement, velvet production, trophy animals, etc.) in order to select the most appropriate semen to achieve those objectives. Basic selection criteria should be applied in choosing females for artificial insemination: quality animals, previous births, calm and accustomed to handling, good body condition, etc.

CROSS BREEDING

Cross breeding refers to reproduction between unrelated strains of the same species (such as red deer and wapiti) to rapidly improve specific characteristics. Cross breeding is common in New Zealand, where red deer cows are bred (either naturally or artificially) with elk: the hybrid calf (which is then called "wapiti" in that country) is bigger than red deer calves, and the hybrid animals have better growth rates. Depending on its origin, a herd of deer may include both purebred and hybrid animals. For the purebred red deer industry, such hybridization is problematic, since crosses between hybrids or with purebred animals result in the herd having persistent hybrid genes, and thus to the gradual erosion of genetic purity.

Blood tests to identify variants of hemoglobin, a blood protein, can be used to verify the status of herd members or animals being considered for purchase. Such tests exploit the fact that the hemoglobin of a purebred is different from that of a hybrid. There is also a registration system for producers of purebred red deer.

Bison

Bison/cattle crosses are possible, but not recommended. The two types of meat are distinct in terms of taste, composition (protein) and cost. Bison meat has advantages that would be undermined by interbreeding.

Cross breeding between plains bison and wood bison does seem beneficial, and producers have noted that the hybrid offspring have higher, wider and deeper haunches, and higher carcass weights, attractive features for meat producers. The animals do not appear to have greater bone mass, but do seem to have smaller heads. However, such hybrid bison cannot be registered, exported, or entered in competitions.

BIBLIOGRAPHY

Alberta Agriculture and Rural Development. 1988; rev. 1995. *Beef Herd Management* Reference Binder and Study Guide. Sect. 201, 202, 203 and 210.

Cammack, K.M., M.G. Thomas and R.M. Enns. 2009. *Review: Reproductive Traits and Their Heritabilities in Beef Cattle*. The Professional Animal Scientist 25(5): 517-528.

CPAQ. 1997. *Le cerf rouge-Guide d'élevage*. Conseil des productions animales du Québec. 131 pp.

CPAQ. 1997. *Le bison-Guide d'élevage*. Conseil des productions animales du Québec. 129 pp.

CPAQ. 1995. *Guide porc-Section Génétique*. Conseil des productions animales du Québec.

CRAAQ. 2006. *L'élevage du wapiti*. Centre de référence en agriculture et agroalimentaire du Québec. 88 pp.

CRAAQ. 2003. *Le sanglier-Guide d'élevage*. Centre de référence en agriculture et agroalimentaire du Québec. 113 pp.

Delgadillo Calvillo, A.C., R. López Ordaz, H.H. Montaldo, J.M. Berruecos Villalobos, A.A. Luna and C.G. Vásquez Peláez. 2008. *Componentes de varianza genéticos, directos y maternos para características de crecimiento en ciervo rojo (Cervus elaphus scoticus)*. Vet. Méx. 39(3): 237-245.

Friedel, B. 1994. *Selecting elk for velvet growth, body size or reproduction*. Canadian Elk and Deer Farmer, Summer: 34-35.

Hamilton, T. and J.W. Wilton. 1987. *Crossbreeding Systems for Commercial Beef Production*. Ontario Ministry of Agriculture and Food. Agdex 420/36. 4 pp.

Jordan, R.M., C. Anfang, C. Sheaffer and C. Wolf. 1994. *A Deer Production Primer*. University of Minnesota. 69 pp.

Kruuk, E.B, J. Slate, J.M. Pemberton, S. Brotherstone, F. Guinness and T. Clutton-Brock. 2002. *Antler size in red deer: Heritability and selection but no evolution*. Evolution 56(8): 1683-1695.

McManus, C.M. and W.J. Hamilton. 1991. *Estimation of genetic and phenotypic parameters for growth and reproductive traits for red deer on an upland farm*. Animal Production 53(2): 227-235.

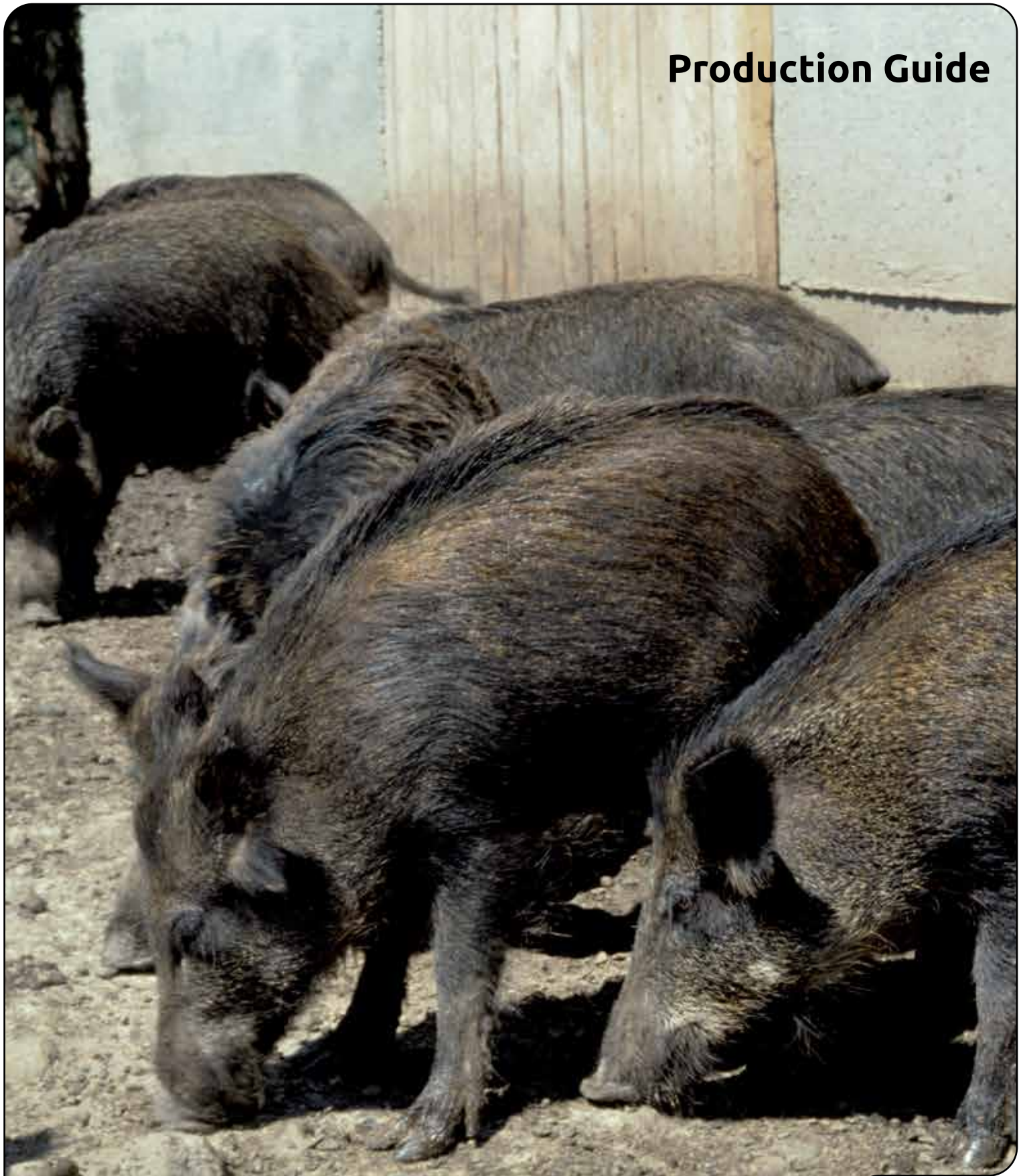
Quinn-Walsh, E.C., D.L. Johnson, J. Chardon and R.J. Spelman. 2010. *Deer Improvement's breeding programme for venison production in red deer (Cervus elaphus)*. Proceedings of the New Zealand Society of Animal Production 70: 278-282.

Ramírez Valverde, R., A. Sánchez Cervantes, J.G. García Muñiz, R. Núñez Domínguez and V. Lemus-Ramírez. 2011. *Efectos ambientales y parámetros genéticos de variables de crecimiento para un rebaño de ciervo rojo (Cervus elaphus) en cautiverio*. Rev. Mex. Cienc. Pecu. 2(3): 319-330.

Utrera, A.R. and L.D. Van Vleck. 2004. *Heritability estimates for carcass traits of cattle: A review*. Genetics and Molecular Research 3(3): 380-394.

Van den Berg, G.H.J. and D.J. Garrick. 1997. *Inheritance of adult velvet antler weights and live weights in farmed red deer*. Livestock Production Science 49(3): 287-295.

Production Guide



DOMESTIC GAME FARM ANIMALS

Reproductive Management of Wild Boar

CRAAQ
CULTIVER L'EXPERTISE
DIFFUSER LE SAVOIR

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INTRODUCTION

The wild boar of western continental Europe (*Sus scrofa scrofa*) has 36 chromosomes, while the domestic pig (*Sus scrofa domesticus*) has 38. Their hybrids may have 37, 36 or 38. The presence of porcine genes in wild boar makes marketing more complex, and is prejudicial to production. With its low and heavy profile, coloration ranging from pale to dark, abundant hair and elongated groin, the wild boar's anatomy is fairly different from most of its cousins (pig, peccary and warthog).

Regardless of the purpose of production (meat sales or hunting), wild boar are generally raised extensively in pastures and bushes. One technique is to keep selected breeding stock in pens and separate them into herds of at least 20 females (sows) and 2 males (sires) that can be controlled and handled efficiently. To increase the chances of success, the wild boar farmer must be mindful of the species' habits and reproductive cycle. Reproductive success depends on various parameters, including climate, feeding and a peaceful habitat or breeding site.

As in most wild mammals at our latitudes, wild boar reproduction is seasonal, being conditioned and influenced by environmental factors:

- natural physical factors: photoperiod and temperature;
- chemical and nutritional factors: pheromones, group effect, sharing of space, all of which influence social relationships among individuals.

A wild boar farmer cannot do much about environmental factors, except to modify photoperiod slightly through changes in lighting in indoor areas. This can help to increase fertility and thus the number of farrowings per year.

PHYSIOLOGY AND BEHAVIOUR

Males

On average, male wild boars reach sexual maturity (puberty) at 10 to 12 months, while complete body development will not be reached until 5 years. To improve development and optimal reproductive performance, even though a sire can mate at 8 months it should not be used for reproduction before 2 years of age. From the onset of puberty, exocrine activity in the testicles is constant. However, there is seasonal variation consisting of significantly lower testicular weight and testosterone levels in the summer months, a period of sexual inactivity. The gap between young male and young female weights becomes increasingly pronounced after age 2, when sexual dimorphism begins.

Depending on a breeding male's age and nutrition, its live weight can reach 250 kg.

Females

In Quebec, wild boar sows reach sexual maturity at 10 to 12 months, but to avoid compromising their growth and future productiveness they should not be mated until they weigh 90 kg. Physiologically, a sow

can give birth at 15 months, but generally on the farm a sow will have its first litter at 20 months, when it is better developed, farrows more live piglets and is a better nursing mother.

The estrus cycle lasts 21 days, with ovarian function halting in early June (summer solstice). The inactive sexual period lasts at least until September and can extend into November, since stops and starts in sexual activity are closely linked to nutritional and photoperiod factors (see the section on seasonal anestrus below). In each estrus cycle, for the best conception rates, the sow should only be exposed to the males for 2-3 days of the receptivity period.

A sow's live weight varies from 90 to 150 kg, with full body development being reached by 3 years of age.

Mating

Generally speaking, in Québec a wild boar sow will come into heat from September to mid-November, and as long as she is not pregnant the 21-day estrus cycle will repeat regularly until the end of June. The breeding season can vary depending on the abundance of food and the sow's body condition.

In the wild as in captivity, it is generally the lead sow (the first to come into heat) that triggers heat in the other females in the herd. A little before that, she starts leaving saliva and lachrymal gland secretions on trees and other objects, to alert and arouse the males. In full heat, the lead sow secretes a great deal of estrogen and other pheromones in her urine and saliva. Stimulated by the various secretions and odours, the other sows in the herd will also go into heat. In the production conditions common in Quebec, where farrowing occurs in a maternity barn, not all the females are necessarily in heat at the same time. Estrus can also be triggered by weaning and will start about 7 days after the piglets are separated from their mothers.

According to Meynhardt (1991), wild boar use 10 basic sounds for all their communication needs; some are particular to the individual, while others, such as warnings, are common to all wild boar. One such sound is particular to the breeding season and mating when the male communicates at length with the female, pursues and mounts her, caresses her, butts her in the flanks with his groin and repeats this ritual until the sow is ready and consents to mating. Sometimes the sows are capricious; they enjoy being courted and don't submit easily to the male. Breeding lasts only a few minutes, and often an experienced and physically fit adult male will cover the sow a second time, after a 20 to 30 minute rest. The male ejaculates 250 to 400 ml (9 to 14 oz.) of semen at each mating. Semen quality and volume vary with the time of year (Kozdowski and Dubiel, 2004).

Sires eat less when the sows are in heat, and can even lose weight during the breeding season.

Gestation

Gestation lasts an average of 115 days (3 months, 3 weeks and 3 days), but can range from 110 to 120 days. In the wild, a sow usually has just one litter per year, or occasionally two. In production conditions in Quebec, with adequate management and good nutrition, two litters per year are possible for sows 3 years and older (Figure 1). In a well-designed nursery, all sows can average three gestations every 2 years (Figure 2). In this case there is a spike in litters farrowed in February and March, with piglets weaned by late April to early May, and with the sows rebred in May and early June (before anestrus, the drop of summer sexual activity) for another farrowing peak in August and September.

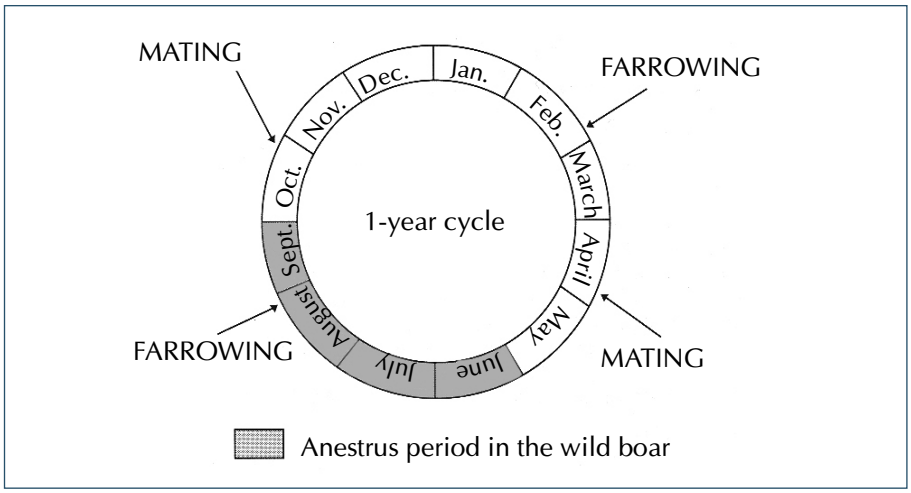


Figure 1. Managing breeding to obtain two deliveries per year in sows of 3 years and up

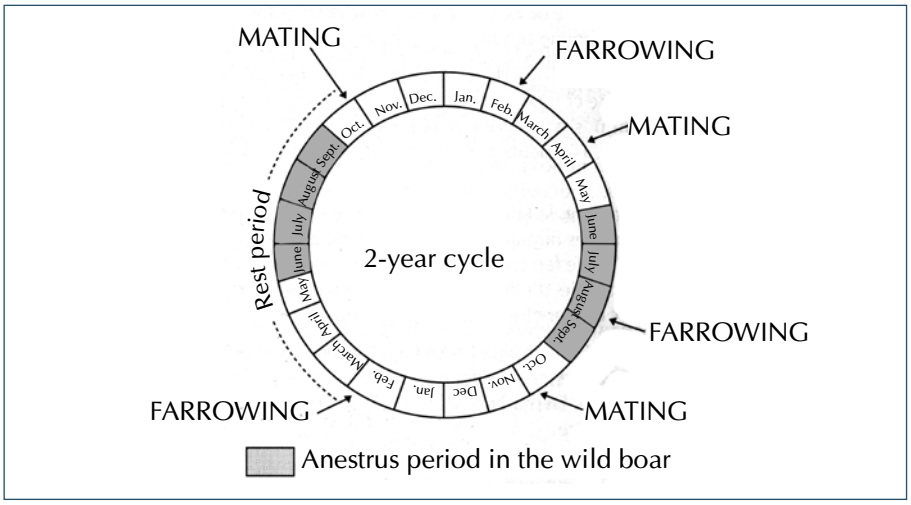


Figure 2. Managing breeding to obtain an average of three farrowings every 2 years for all sows

Farrowing

Farrowing usually takes place from January to September, with spikes in February and March, then in August and September. Depending on when first mating occurs, first farrowings usually come at the beginning of February, or occasionally as early as December. Each sow needs to be alone in her own nest prior to farrowing, and generally will not leave the nest except to eat during the first week after farrowing. The nest is built by the sow. The nest retains the mother's body heat, due to the nest's cauldron shape and good insulation properties, and stays at a temperature of 32 to 33 °C (90 to 92 °F). Farrowing usually lasts 3 to 4 hours.

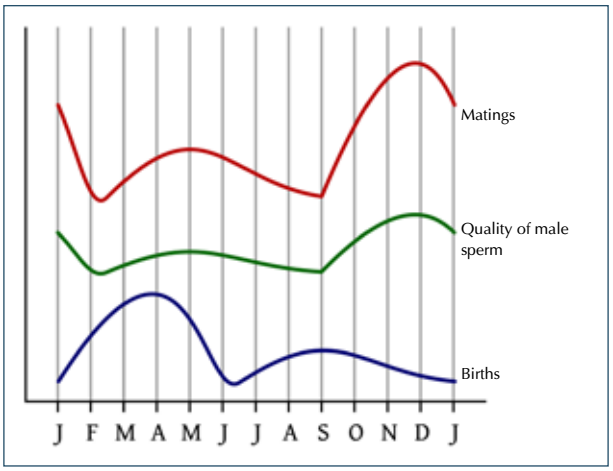


Figure 3. Seasonality of wild boar reproductive activity

A litter can range from 2 to 12 piglets (5 on average), which are born with their eyes open. A sow farrowing for the first time usually has no more than 2 to 4 piglets. The litter size will correlate to the sow's age, weight and body condition at the time of mating. A 5 or 6 year old adult sow with optimal body condition will deliver 7 or 8 vigorous, healthy piglets that benefit from better lactation and will therefore grow faster.

Piglets are born weighing about 750 g (1.7 lb.) on average, but ranging from 600 g to 1100 g (1.3 to 2.4 lb.), and measuring about 25 cm (10") in length. At birth, the sow imprints the piglets with her scent, a process lasting about 2 hours. The sow and piglets recognize each other by scent and sound, rarely by sight, which is weak in wild boars (Meynhardt, 1991).

The primary cause of mortality among piglets born outdoors is cold and humidity. To maintain body temperature the piglet needs to burn calories, but it has no fat reserves to provide the necessary energy.

From birth to 3 or 4 months, the piglet sports 11 parallel stripes, dark brown to black on a light grey background, running from head to tail. This feature gradually disappears, the hair turning from beige to reddish brown by 12 months. From uniform red at 12 to 15 months, it gradually becomes dark grey by around 20 to 24 months.

Nursing and care of piglets

The piglet's first weeks after birth are crucial since the piglets are completely dependent on the mother's milk. Nursing continues for 42 to 50 days. At first the piglets go from one teat to the next, but by the second or third day each piglet chooses a particular teat that it will suckle until weaned. The milk production from a given teat will therefore determine the piglet's growth. From birth to weaning, a piglet may gain from 4 to 6 kg (9 to 13 lb.), and will weigh 6 to 7 kg (13 to 15 lb.) when weaned.

The iron content of sow's milk is poor. To prevent anaemia, it is recommended that piglets be given iron injections starting three days after birth. Males destined for meat production must be castrated as soon as possible, and before 15 days.

For the first 5 or 6 days, the piglets live exclusively in the nest; later they start to move around, progressively discovering their environment under the sow's surveillance. As little as a week after birth the piglets tend to follow their mother. For the first few days the sow feels very vulnerable and can be highly aggressive if her tranquility is disturbed. Consequently, since there is a risk of her destroying or injuring her young if she feels insecure, it is important that she be disturbed as little as possible. Any sow that has eaten her young must be culled, since the behaviour will repeat at the next farrowing.

To complement the mother's milk, after 15 days the piglets will eat solid food given to the sow. In outdoor production systems it is important to set aside a creep feed area accessible only to the piglets so they can feed adequately.

Weaning

After weaning, piglets are separated from their mothers at around 42 to 50 days and receive a balanced ration of feed to promote healthy growth.

Seasonal anestrus

In optimal feeding conditions, there is always a summer anestrus period (a rest period due to the absence of reproductive heat) generally lasting from mid-June to mid-September (Mauget, 1980).

Photoperiod, i.e. the cycle of daylight, has a significant influence on the sow's estrus cycle. The latter is triggered when the days shorten, while higher summer temperatures and longer days have the opposite effect of provoking anestrus. Lower temperatures and shorter days influence the timing of the resumption of estrus cycles, delaying or hastening it depending on conditions. Peak breeding season often occurs during the winter solstice in mid-December.

HUSBANDRY AND PRODUCTIVITY

Gestating sows need rest, peace and quiet, so visits by strangers should be restricted. The fright provoked by unexpected/unfamiliar sounds or unusual actions can cause traumatic abortions, particularly at the approach of farrowing.

Farrowing in a maternity barn

When a maternity barn is used the producer should gradually increase each sow's meal ration every day, starting 8 to 10 days before farrowing to meet the sow's nutritional needs. This reduces competition for food and ensures that each sow receives her daily ration. For the sow's comfort, and for nest-building, a good quantity of straw should be available. Straw also has a calming effect that helps the sow get used to her new environment.

Farrowing in individual pens

Another practice is to set up individual outdoor pens consisting of a small enclosed area or shelter where only the piglets can go. This enables the producer to provide the piglets with all the necessary feed, care and treatments, and to gradually prepare them for weaning.

Production in outdoor group enclosures

Some wild boar producers use large paddocks, with treed sections to protect the animals from inclement weather and to provide shade. Such paddocks generally include a few shelters in which 15 to 20 wild boar can take cover. This production method is satisfactory for animals that are growing and of uniform weight and the same sex, to avoid undesired pregnancies (unless the males are castrated). Since large paddocks tend to give disappointing results where farrowing is concerned, they are not recommended.

Reproductive capacity

Compared to other ungulates of the same size (red deer, fallow deer, sheep, etc.), the wild boar has the greatest reproductive capacity. Its great adaptability has no doubt contributed to its domestication, as it does to its productivity. The average litter size of 5 piglets per sow depends heavily on the sow's age and body condition at breeding. Adult sows of 6 to 8 years old that are in good body condition generally have larger litters (7 to 8 piglets) and successfully wean a higher percentage of the piglets.

Surviving weaning

In the wild, piglet mortality is 30 to 50% in the first week of life. In farmed production systems, the mortality rate of piglets should not exceed 10 to 15% from birth to weaning. The main cause of pre-weaning mortality is the sows crushing or killing the piglets. To maximize profitability, wild boar producers should aim to farrow and wean as many piglets as possible, and to market as many wild boars as possible per sow.

BIBLIOGRAPHY

CPAQ. 1997. *Le Sanglier - Guide d'élevage*. Collection Grands Gibiers domestiques, Conseil des productions animales du Québec. 123 pp.

Hector, D. and J. Hector 1973. *Le sanglier et son élevage*. La Maison Rustique, Paris. 108 pp.

Kozdowski, R. and A. Dubiel. 2004, T*he effect of season on the properties of wild boar (Sus scrofa L.) semen*. Animal Reproduction Science, 80: 281–289

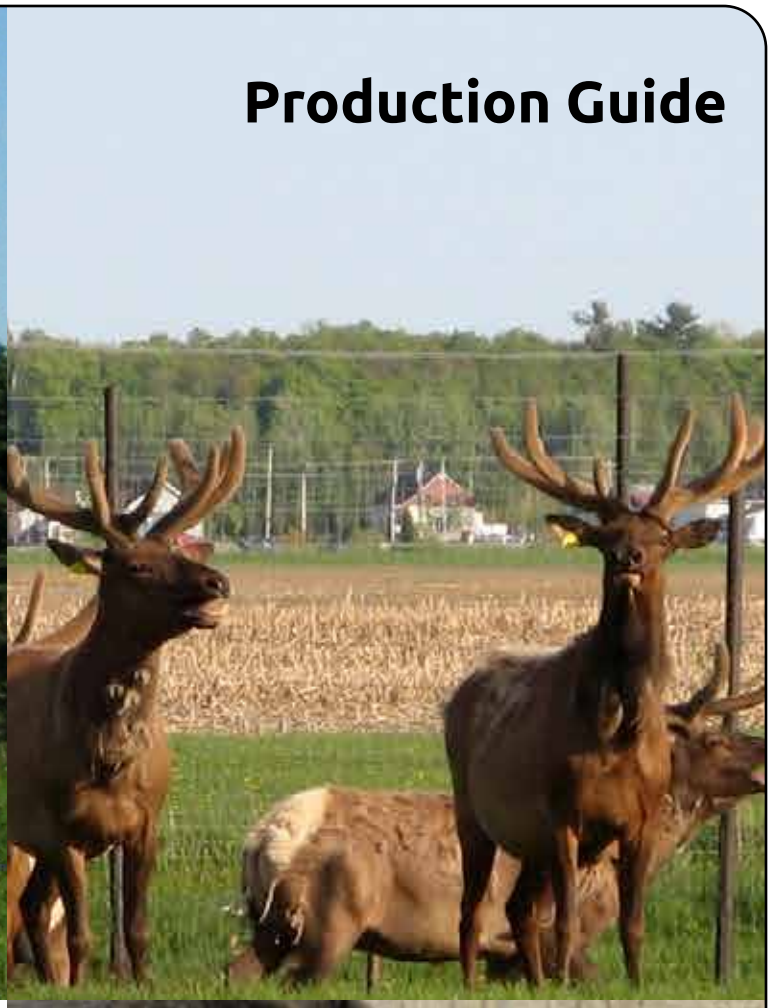
Marion, F. 1982. *Le sanglier.* Collection "Grand gibier", Gerfaut Club-Princesse, Paris. 177 pp.

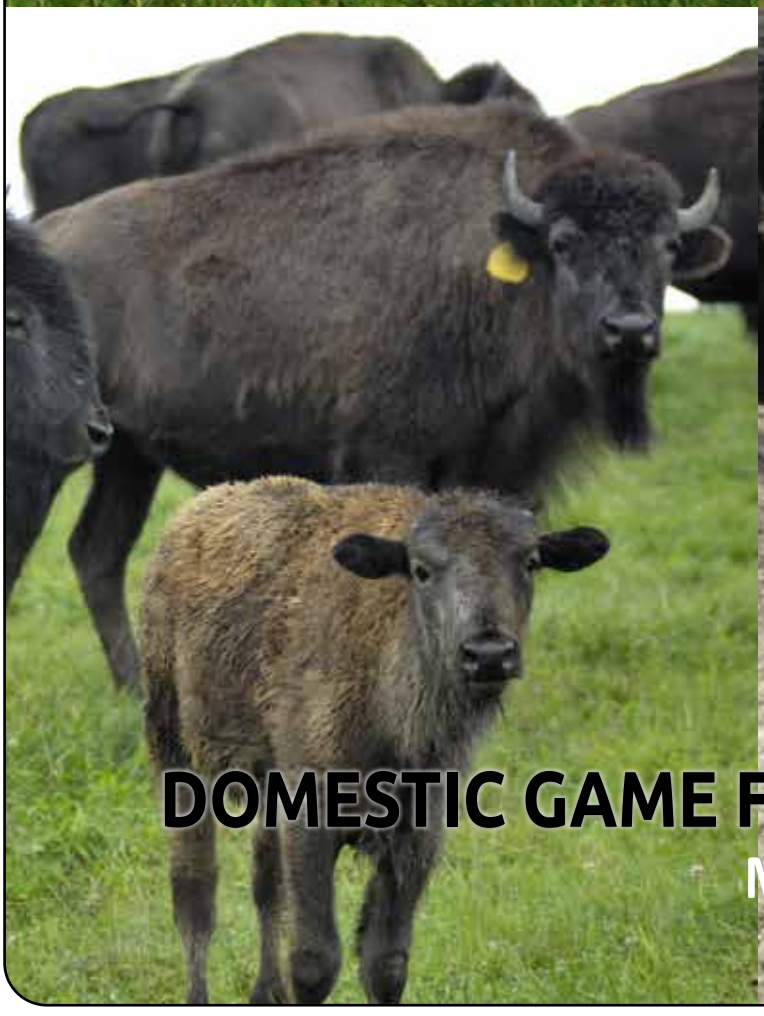
Meynhardt, H. 1991. *Ma vie chez les sangliers*. Hatier, Les Éditions du chasseur français, Paris, (translated from the German by André Dick). 165 pp.

Pinet, J.-M. 2005. *L'élevage du sanglier de race pure.* Éditions de l'ADEPRINA, Paris. 171 pp.

Sonnier, T. 1988-1989. *Le Sanglier: un élevage peu connu mais un revenu d'appoint intéressant*. Mémoire de fin d'études. BTS Productions animales. 79 pp.

Spitz, D. and D. Pepin (eds). 1984. *Symposium international sur le sanglier*. Les colloques de l'INRA, nº 22, INRA, Paris. 226 pp.





Production Guide

DOMESTIC GAME FARM ANIMALS

Marketing – Overview

CRAAQ
CULTIVER L'EXPERTISE
DIFFUSER LE SAVOIR

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Juan Pablo Soucy (red deer and wapiti)
© **Etienne Boucher**, MAPAQ (bison)
© **Michel Langlois**, MAPAQ (wild boar)

INTRODUCTION

On a number of points, marketing meat from farmed large game, with related activities like agritourism and hunting, is different from marketing conventional livestock (beef, pork, poultry, etc.). Farmed game meat is a high-end, niche product with a special flavour and a strong identification with small, local producers. For some people the animals themselves are more appealing, in part because they are associated with free-range farming in a natural environment. These differences present some advantages, counterbalancing the challenge of constant competition with other types of meat.

The four main types of farmed game meat in Québec are red deer, wapiti (generally referred to as "elk" outside of Québec), bison and wild boar. Not all are at the same level where marketing is concerned, but the gaps are narrowing. Some of the marketing groups formed by red deer farmers have been operating for over 10 years, while there are groups of wapiti farmers whose marketing is handled by processor/distributors. For bison and wild boar producers however, no such groups have been formed so far.

Whichever animal they raise, Québec's large game farmers must stay on their toes, paying careful attention not only to the market but to social and economic factors. Above all, they should keep in mind that diversification (of products, services and marketing) can be the key to profitability.

FARMED GAME MEATS

Game meat can be sold either wholesale (as carcasses) or retail (as cuts and processed products). In either case, for the producer to be certain of being able to sell his production, sales agreements should be in place before animals are purchased and shipped to the farm. As well, early consideration must be given to how animals will be shipped to the abattoir, and to the proximity and type of slaughter services available.

Wholesale

The wholesale market involves producers selling whole carcasses to a processor/distributor, either directly or in a group with other producers. The group approach is popular with red deer farmers, and becoming more so with wapiti producers, while bison and wild boar producers are at the discussion stage. It is an approach that resembles how animals are marketed in more traditional livestock industries. It lets producers concentrate on their herds, focusing their efforts on optimizing performance and genetics. The potential drawbacks include production limits (depending on the group) and lower profitability. When processing, distribution and/or marketing are not handled by the producer, the farmer loses the opportunity to profit from the value added by these steps.

For a new producer, the group approach can be particularly attractive inasmuch as it provides some assurance of sales. However, the producer must be able to meet the standards of the group (or its distributor) in terms of quality and volume. Not all such groups have a large enough market to be able to take on a new producer.

The wholesale market is generally preferred by producers in remote locations, those who farm intensively to generate economies of scale, and those who focus on breeding stock or high-quality stags, bulls or male wild boars for hunting (as opposed to the sale of meat).

The main processor/distributors in the wholesale market are *Les Viandes de la Petite-Nation*, *Gibiers Canabec* and *La Maison du Gibier*. Over the years their marketing and promotional activities have made consumers more aware of venison products.

Retail

Farmers who process, distribute and market their own products can achieve greater levels of profitability, since there are fewer middlemen between them and the consumer. This is primarily how wild boar meat is marketed.

Retail sales include the sale of carcasses to individuals for méchouis, farm gate sales of cuts and/or processed products, and sales in farmer's markets, through websites, to retailers and local restaurants, and for country dining (see the section Agritourism). Retail sales require the most work and the highest initial investment. Since the best days for retail sales are when consumers are off work, this approach requires a producer who can work on weekends and holidays, and who enjoys interacting with the public. The added layer of regulations and obligations regarding processing and sales can be daunting for smaller processors.

In the retail market it takes quality products, attractive presentation, and sales personnel who are good at dealing with the public, to maintain repeat sales.

Méchouis

Perhaps in part thanks to the *Asterix* movies, wild boar has become popular for méchouis in Québec. Deer, wapiti and bison producers would do well to explore the potential of this market. Sale for a méchoui turns an entire carcass to profit, with added value since the producer provides the service. Providing a méchoui requires time, equipment and a permit. Considerable travel may be necessary, usually on weekends. Good presentation, attention to detail and cleanliness are essential for a successful méchoui business

On-farm sales

There are several types of on-farm sales. Whether through a sales counter, farm dining, agritourism visits or photo safaris, this type of marketing enables some producers to make a good profit. They take courses about the different cuts of meat, processing methods and sales techniques, and hygiene and food safety (this is mandatory), then set themselves up with the facilities needed and the required permits. By also offering processed products (terrines, sausages, meat sauce etc.) they can extract full value from each carcass.

Some of these businesses are so successful, they also provide an outlet for other producers or distributors.

Farmer's markets and internet sales

Where customer traffic to the farm would be insufficient, producers who are good at dealing with the public can sell directly at farmer's markets, eliminating the need for marketing infrastructure on the farm. There are however costs associated with selling at farmer's markets, including sales permits and fees charged by market administrators. Another option is to set up a website and sell over the internet. This can complement other kinds of marketing while offering consumers the ultimate in convenience.

Supplying local retailers and restaurants

A number of grocery and restaurant chains have "buy local" policies that give local producers a place on store shelves and a presence on menus. Since producers deal with them directly, they can obtain better prices than when middlemen are involved. Good cooperation is essential to ensure a regular supply and consistent quality despite the seasonality of farm production. This can mean selling fresh products during the period when animals are slaughtered, while using frozen products during periods when the animals are being finished.

Special initiatives

It is worth mentioning a few initiatives currently available for developing new markets for game meat from certified farms. These include the *Cerf de Boileau* in the Outaouais, *Sélection Nordique* deer produced by 15 red deer farmers, *Cerf des Appalaches*, and the registered certification program *Grands gibiers du Québec certifiés™* (http://www.grandsgibiers.com/certification.php).

BREEDING STOCK

Producing quality breeding stock requires a solid understanding of genetics for informed choices to be made when selecting breeders. The animals are expected to be of superior quality, so prices are higher. Often, the seller will provide advice and follow-up if requested.

Thanks to the long experience of producers in this area, the genetic quality of Quebec's breeding stock has improved considerably in the last 30 years. Buying animals is a major investment, especially for a new producer who is building a herd. It is important to purchase quality stock[1] that will help the business achieve its production and economic goals. At the same time, the price paid for the herd must be affordable, in terms of the potential profit earned by the purchaser from the sale of meat and other products.

Demand for breeding stock is closely linked to the development potential of commercial operations, and thus to demand for meat. Prices for breeding stock are therefore higher when there is stronger demand for meat, but lower when the market is slow. In recent years, difficulties in developing new markets for farmed game meat have led to lower prices for breeding stock.

1. Two other factsheets in this series discuss the principal criteria to consider when purchasing red deer or bison: *Evaluating Red Deer for Breeding* and *Reproductive Management of Bison*.

AGRITOURISM

Agritourism is defined as a tourism activity associated with agriculture that takes place on a farm and brings producers and tourists together. Examples of agritourism include farm stays and educational activities, accommodation, food services, promotional activities and the sale of farm produce and regional agrifood products.

Depending on a region's agritourism potential, farm stays, on-farm sales and country meals can help make an operation profitable. Customers may be willing to pay a little more for a visit combined with a flavourful farm-cooked meal.

What is the average age and income of the surrounding population? How much do people know about large game animals and how they are raised? Successful agritourism means satisfying the interests, needs and expectations of the pool of prospective customers. Besides having the necessary permits, the premises must be clean and be equipped with adequate toilet facilities.

One does not become an "agritourism farmer" overnight. Being available, sociable, hospitable and open to others, and having pride in your business, animals and products, are just some of the qualities needed to succeed. *Le Pense-bête de l'agrotourisme* provided at http://www.mapaq.gouv.qc.ca/fr/Productions/agritourism/Pages/pense_bete.aspx (in French only) is a great source of information for producers who are interested in developing an agritourism project. Presented as a series of topical factsheets, this checklist is a practical guide to the procedures and stages involved, from the business plan to visitor reception to customer service, along with site preparation and regulations.

On the other hand, if the farm is distant from any city, major road or tourist attraction, the producer must go to his or her customers, since they will not come out to the farm. Distance to the abattoir is another factor: the business plan must include a realistic estimate of shipping costs and potential losses during shipping. Refrigeration equipment could be needed, adding to costs, while frequent deliveries of small quantities would cut into profits significantly.

VELVET ANTLER AND HARD ANTLER

Velvet antler (antler covered with velvet, early in the growth period) can be harvested and sold to be dried, ground and packaged in capsules. Velvet antler is highly prized in Asia for its therapeutic properties. In Canada, velvet antler capsules may be available in pharmacies or directly from the farmer.

Velvet antler prices have varied enormously. In the late 1990s producers could get over $100 for a pound of frozen velvet antler, leading to high prices for breeding stock. The market dropped significantly in the early 2000s when bovine spongiform encephalopathy (BSE) was detected in a small number of cattle, while chronic wasting disease (CWD) was found in cervids in Western Canada. Countries that had been the main buyers of Canadian velvet antler closed their borders, causing velvet antler prices to plummet to less than $20 a pound in 2010. This devastating price drop forced wapiti and red deer farmers to focus on

developing the market for game meat. The ups and downs of world markets and the presence of CWD in Canada are still affecting velvet antler sales. However, prices are slowly recovering, thanks to marketing efforts to recapture overseas customers that emphasize producers' efforts to eliminate CWD.

Hard antlers, i.e. antlers that are beyond the velvet stage, are in demand for crafts and the domestic pet food market, where a few companies process and market them as dog chews. The hard antler market is a temporary alternative to velvet antler, and prices reached record highs in 2011 and 2012.

HUNTING ACTIVITIES

Some operators have developed networks of contacts who provide them with a clientele of hunting enthusiasts eager for a trophy at any price.

Game ranches buy trophy animals from a small number of large game producers with extensive experience in advanced genetics. There seems to be a steady demand, since year after year, just before hunting season, trophy animals are sold by game farms to the game ranches. The producer should insist on being paid before the animals are shipped.

Producers interested in adding a hunting component to their business should review the applicable regulations, in particular the *Regulation respecting animals in captivity*, under the *Act respecting the conservation and development of wildlife*. They must also obtain a permit from the ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec.

Hunting activities practised in Québec primarily involve cervids. Bison and wild boar are also exploited for hunting, but to a lesser extent.

MARKETING STRATEGY

A good marketing strategy takes into account the producer's geographical location, the socio-economic environment, the markets, possible types of marketing, the producer's skills, labour needs and availability, existing or needed facilities, and the possible subcontracting of one or more parts of the marketing process. When the target clientele and product offering have been determined, a marketing plan can be developed to guide the producer's overall strategy. The marketing plan proposes activities to reach the target clientele, develop sales and position the producer in the market. A budget should be drawn up, covering not only the preparation of the marketing plan but the practical steps of implementing the strategy. Too often, producers forget to budget for promotional, distribution and marketing elements. Publicity can take different forms depending on financial means: posters, media, website, etc.

There are resources available to help the producer develop a marketing plan and strategy, including:

- the nearest local development centre (see http://www.acldq.qc.ca);
- companies specializing in communication and graphics;
- marketing students in universities and colleges.

SURVEY OF LEGISLATION APPLICABLE TO MARKETING

While there is no legislation specific to farmed large game animals, there are laws and regulations applying to various sectors that could affect large game producers.

Quebec legislation governs economic activities within the borders of the province. Thus, intraprovincial trade in game meat is subject to Québec legislation, while interprovincial and international trade are governed by federal legislation.

The laws and regulations of Québec are most easily consulted through the website of the Canadian Legal Information Institute (http://www.canlii.org/en/qc/laws/index.html). Those of greatest relevance include the:

- *Act respecting the conservation and development of wildlife* (*Regulation respecting animals in captivity*). The operation of a game ranch requires a licence;
- *Animal Health Protection Act*. Sets out sanitation standards for places where animals are raised and sold;
- *Food Products Act*;
- *Act respecting tourist accommodation establishments*;
- *Act respecting reserved designations and added-value claims*.

Canada's laws and regulations are most easily consulted through the same site as above (http://www.canlii.org/en/ca/laws/index.html). Those of greatest relevance include the:

- *Meat Inspection Act*;
- *Canada Agricultural Products Act*;
- *Health of Animals Act* (particularly with regard to importing and exporting livestock);
- *Agricultural Products Marketing Act*;
- *Consumer Packaging and Labelling Act*.

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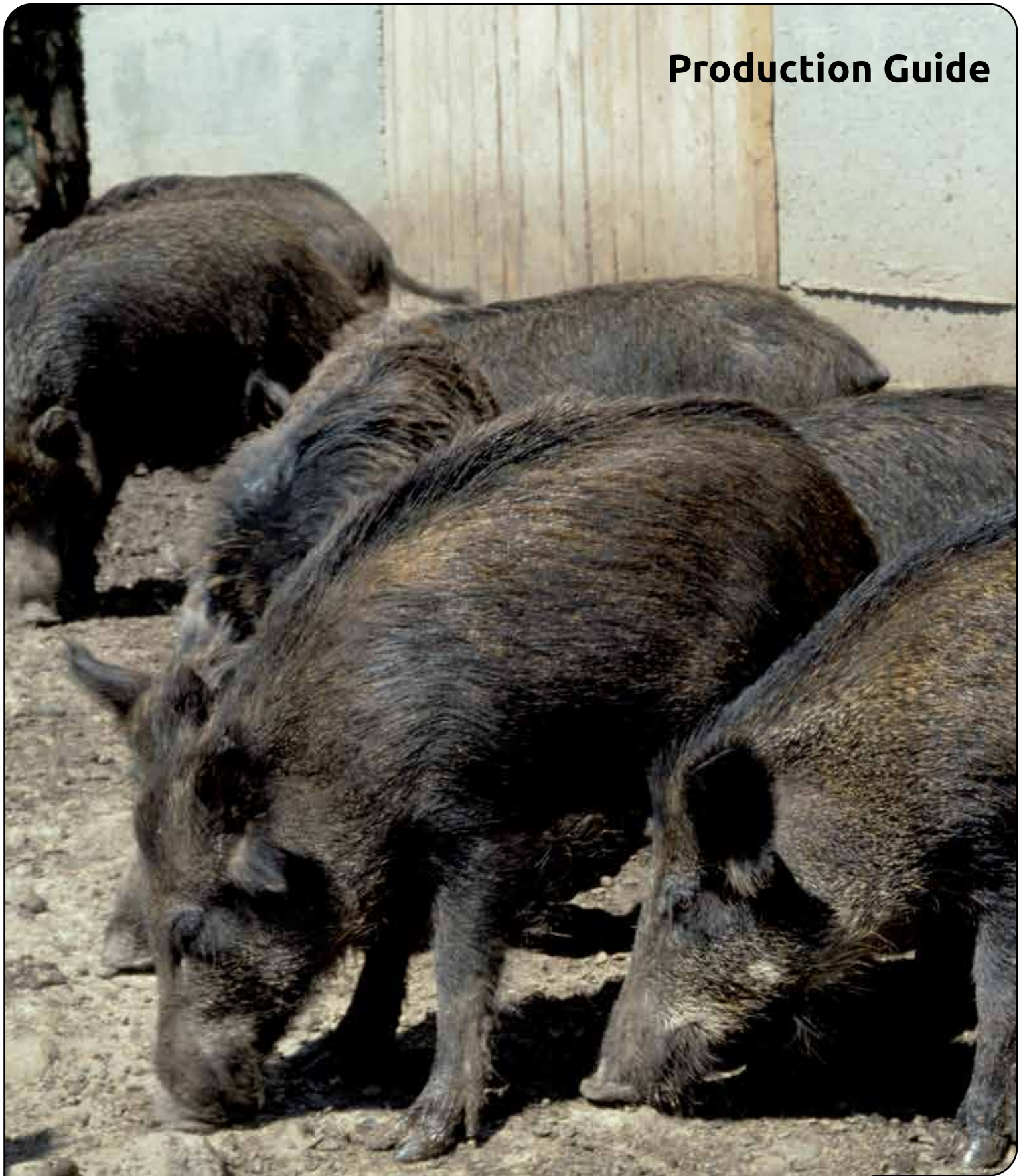

DOMESTIC GAME FARM ANIMALS

Wild Boar Meat – Overview

CRAAQ
CULTIVER L'EXPERTISE
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INTRODUCTION

Québec consumers are increasingly eager for new foods and flavours, a context that suggests interesting opportunities for products like wild boar. Recognized as a high-end product, wild boar meat was initially limited to top restaurants, country dining and méchouis. Today, with the steady growth of farm sales, the ever more frequent presence of wild boar and other game meats in food markets, and the popularity of processed products like wild boar sausages, we are clearly in the midst of a revolution in Quebecer's eating habits. This makes it all the more important to offer consumers a top quality product that consistently makes for delicious eating.

GENERAL INFORMATION

In Québec, wild boar herds generally consist of purebreds, with some herds having a certain proportion of hybrids with a greater or lesser share of porcine (domestic pig) genetics. Hybrids (between wild boar and domestic pigs) are usually the result of less rigorous quality control in breeding and reproduction programs. The animal's genotype has an impact on its muscle tissue characteristics, the process by which muscle is transformed into meat, and the quality of the meat. Genetic variation therefore creates a situation where carcasses and meat are variable and hard to typify. To avoid this, breeding stock must be systematically screened for genetic purity.

How much exercise the wild boar gets, and the nature of its feed in terms of energy and protein content, have an enormous influence on the growth rate, fat stores and muscle tissue characteristics, and in turn influence carcass quality and the eating quality of the meat. As a result, meat from farm-raised wild boar is very different from that of feral wild boar. The latter generally finds food of poorer quality, highly variable and less abundant, and the animal has to be constantly on the move to find what it needs to survive.

For these reasons, what little information is available on the subject of wild boar meat should be put in context when describing and characterizing the wild boar meat produced in Québec.

YIELD

Compared to pigs and even hybrid crosses, wild boar growth is relatively slow (Alberta Agricultural Food and Rural Development, 1997; Rehfeldt and coll., 2008; Skewes and coll., 2008; Oshima and coll., 2009). A farm-raised wild boar is slaughtered when it weighs about 90 kg, at 13 to 18 months of age, whereas a domestic hog, with an average daily weight gain (ADG) of a kilogram per day, is slaughtered at 125 kg before it reaches 5 months. The slaughter age for wild boar is variable because of more diverse farming practices and less homogeneous species genetics.

On average, the dressing percentage output per skinned carcass is 58% of the live weight, or 78% with hide (unpublished data collected in Québec). The skin therefore accounts for a large percentage of the carcass, i.e. nearly 20%. Figure 1 presents the weights of the different parts of the carcass of a wild boar raised in Québec, with and without trimmings.

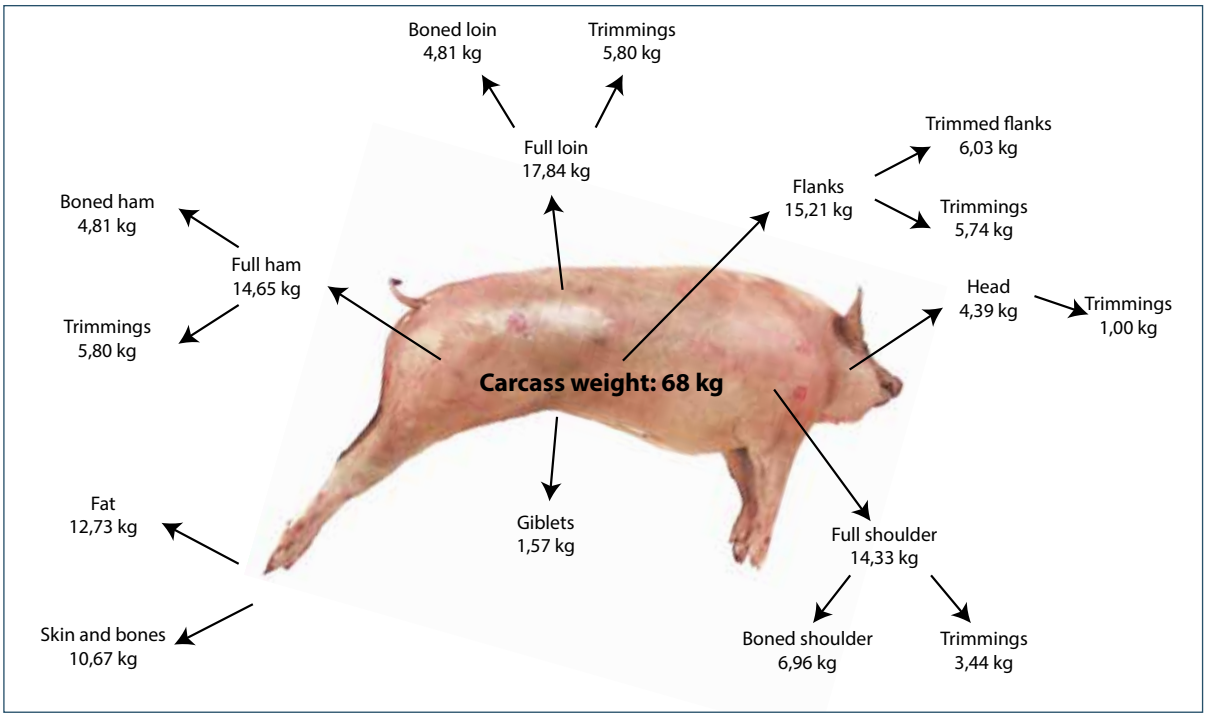


Figure 1. Yield from a typical 87 kg butchered wild boar (live weight)

PROPERTIES

Like most red meats, wild boar meat is a good source of protein. The available data indicates that it is a relatively lean meat (Zomborszky and coll., 1996; Alberta Agricultural Food and Rural Development, 1997; Oshima and coll., 2009), since there is little fat in the muscle. In most species, adipose tissue first develops under the skin (subcutaneous fat) and subsequently, throughout growth, between the muscles (intramuscular fat). Toward the end of growth, given the right genetic and nutritional conditions, fatty tissue develops inside the muscles. Known as marbling, this intramuscular fat contributes significantly to the eating quality of the meat.

Though farm-raised wild boar are fatter than feral wild boar, their growth rate, genetics and feed result in the fat being deposited under the skin instead of in the muscles. Overfeeding should be avoided, since excessive fat deposits require additional effort by the butcher to prepare a visually pleasing product (Figure 2).

Figure 2. Influence of body condition on subcutaneous fat deposits (these two slices of loin are from wild boars of comparable weight, but with different body conditions)
Photo: Juan Pablo Soucy

Though the nutritional composition of meat varies by cut, Table 1 presents the carcass average. As with most red meats, wild boar meat is a good source of iron and vitamin B complex (USDA Agricultural Research Service, 2011).

Table 1. Average nutritional composition of raw wild boar meat (100 g)

	Water (g)	Lipids (g)	Cholesterol (mg)	Protein (g)	Energy (kJ)
Wild boar	72,5	2,85	77	21,5	510

Source: Health Canada, 2010

PRODUCT QUALITY

Meat quality can be defined in different ways depending on your approach and what characteristics are desired. Organoleptic (sensory) characteristics have to do with the pleasure of consuming the product. They include four perceptible parameters of one or more senses: colour, juiciness, flavour and tenderness. These parameters are especially important because they influence consumer eating habits. It is from that perspective, eating pleasure, that the following paragraphs explain the quality of wild boar meat.

The first thing to understand is that meat quality is influenced by changes that occur in muscle after the animal dies. The organoleptic or sensory quality of a cut of meat depends on the character of the raw material (muscle), its transformation into meat, and finally the preparation and conservation of the cut in question. For optimal quality, it is important that all three stages be properly controlled.

Raw material

Muscles are composed of three types of tissue that have a decisive impact on the organoleptic quality of the meat: connective tissue, adipose tissue (fat) and muscle tissue.

Connective tissue, consisting mainly of collagen, affects the tenderness of the meat. Forming a sheath around the bundles of muscle fibres, connective tissue is responsible for transmitting the contractile force of muscle to the skeleton during movement. Thus, skeletal muscle (e.g. shoulder or calf muscle) contains more connective tissue than supporting muscle (e.g. loin or filet mignon). This is why skeletal muscle should be cooked slowly in the oven or slow-cooker, while loin or filet mignon, containing less connective tissue, can be quickly grilled. Also, since connective tissue ages with the animal, meat from older animals takes longer to break down during cooking.

From the available data it appears that connective tissue is more developed in wild boar (especially when raised in their natural environment), and in game animals in general, than in domestic pigs (Oshima and coll., 2009). To minimize the connective tissue's influence on meat tenderness, a faster growth rate is preferable so the animals can be slaughtered while relatively young. Cooking methods must also be adapted to the cut for its full gastronomic potential to be expressed.

Today's health-conscious consumers want to reduce their consumption of fat. Less subcutaneous fat and fat around muscle (partly removed during butchering) is therefore desirable. However, fat should not be completely eliminated, since it contributes to flavour, juiciness and tenderness. Marbling, the presence of veins of fat in meat, is desirable from the point of view of sensory quality.

A wild boar in its wild state is relatively lean, but farm-raised wild boar are very different. While farmed wild boar will generally have a significant amount of subcutaneous fat, genetic selection and good husbandry practices can minimize excessive subcutaneous fat. As well, this fat is easily trimmed by the butcher or the consumer.

Lastly, muscle tissue is composed of red and white muscle fibres whose respective characteristics affect all the quality parameters. The most obvious illustration is the difference between chicken breast meat (white fibres) and a chicken drumstick (red fibres).

Wild boar meat has a higher proportion of red fibres than pork (Essen-Gustavsson and Lindholm, 1984; Rehfeldt and coll., 2008; Oshima and coll., 2009; Żochowska-Kujawska and coll., 2009), which gives it a dark red colour. The wild boars' genetics are largely responsible for this trait. Over thousands of years, exercise has always been an integral part of the life of wild boar, strongly determining the characteristics of its muscle fibres. Exercise promotes the development of red fibres, which are more aerobic and resistant to fatigue. In the case of domestic pigs, selection for faster growth and muscle bulk favoured the development of white fibres. In short, domestication (less exercise, abundant food and selection for muscle bulk and faster growth) favours white fibre development and increased fibre size. In contrast, the muscle fibres of wild boar are generally smaller than those of pigs (Müller and coll., 2002; Rehfeldt and coll., 2008).

All of these muscle characteristics (connective tissue, fat, fibre size and type) combine to make wild boar meat different from other meats in terms of colour, juiciness, flavour and tenderness.

Colour

The high proportion of red muscle fibre gives wild boar meat its dark red, almost burgundy colour. An abundance of myoglobin (a pigment that stores oxygen in the muscles) is what gives red muscle fibre its colour (Livingston and Brown, 1981). Beyond genetic factors, exercise can increase the high concentration of myoglobin in wild boar, a concentration that increases with age. This is why meat from culled wild boar is darker than that of feeder wild boar, which in turn is darker than that of piglets. Some producers obtain darker meat by keeping their wild boar beyond their target market weight, but careful management is required to avoid higher production costs or reduced tenderness. Proper aging and careful control of input costs are essential.

Meat colour is also strongly influenced by pH. While no pH problems have been reported in farm-raised wild boar in Québec, it is important to keep stress to a minimum before slaughter, both for the animals' well-being and to allow a normal lowering of pH. Inadequate lowering of pH results in overly dark meat. Stress before slaughter can cause the animal to deplete its energy reserves, and if these reserves are too low, the acidity of the meat cannot develop normally and pH remains high. With a darker, sticky quality, the resulting meat is unattractive and has a shorter shelf life. On the other hand, if pH declines too quickly or too far, the meat will be paler. This phenomenon has been extensively studied in pigs, where the genetic factors responsible have been identified. The large proportion of red fibres in wild boar meat makes it much less susceptible to turning pale.

Transformation of muscle into meat

After the animal's death, muscle loses its energy reserves. A natural acidity develops, observed as a drop in pH. With the depletion of energy reserves, the muscle passes from a quivering[1] state to a firm state called rigor mortis. When this occurs, various enzymes are released that tenderize the meat and work throughout the aging process. The transformation of muscle into meat thus occurs in three stages: drop in pH, onset of rigor mortis and aging due to enzymes. Together they influence meat colour, flavour and tenderness.

Figure 3. Quality of wild boar meat in terms of colour (left to right: optimal colour, too dark, too light)

Photo: Juan Pablo Soucy

1. A soft muscle that still shows signs of palpitations.

Flavour

Flavour is a combination of sensations perceived by both the taste buds and olfactory receptors (smell). The taste buds enable us to distinguish sweet, salty, bitter and sour, while smell enables us to perceive an array of compounds that are liberated during chewing. The different aromas of meat develop in cooking, through various reactions among the molecules in the meat. The fat and protein content of the meat therefore has an important impact, with the characteristic flavour of a particular type of meat being largely related to its fat content and the molecules therein, while the muscle (proteins) is responsible for the general meat taste.

Feeding practices affect the taste of meat by influencing its composition (tissues and molecules). Wild boar meat has a "gamey" flavour that is stronger than in most other meats, intensifying as the animal ages. Quite distinct from pork, this characteristic flavour is caused by different levels of the compounds present in all meat (Lammers and coll. 2009). That is, in both pork and wild boar meat the same compounds develop during cooking, but in different proportions. The differences are due to genetics and nutrition.

Tenderness

The tenderness of meat depends essentially on three factors: the basic toughness of collagen, the state of contraction during rigor mortis and the tenderizing of the meat by aging (Koohmaraie and Geesink, 2006).

More developed in the wild boar than in pigs, connective tissue is responsible for the meat's "basic toughness", i.e. a toughness present at the moment of slaughter that is moderated by aging (Bailey, 1972). Generally speaking, as an animal ages its connective tissue becomes harder to dissolve during cooking, making it less tender.

The more a muscle contracts during rigor mortis, the less tender it will be. Normally this contraction is quite limited. However, cooling the carcass too quickly can cause a contraction phenomenon called "cold shortening" (Honkel, 2004). Generally, to avoid this problem the temperature of the carcass should not reach 10 °C until the energy reserves are sufficiently spent (pH 6.0).

In the days following slaughter, enzymes go to work that tenderize the meat. This is why meat is left to age in a cooler or refrigerator, either as a complete carcass or butchered and packaged, before being consumed. The important thing is to let the meat age long enough, which varies from species to species. In pork for example, meat can be 80% tenderized in 4 days, while for lamb or beef it takes 8 to 10 days (Dransfield and coll., 1981), and often beef is aged for 14 to 21 days. It generally takes longer to tenderize muscle composed of red fibres. In wild boar meat, the composition of the muscle fibres suggests that aging time should be somewhere between that for pork and beef. One study reports a 25% increase in tenderness after 12 days, with 17% in the first 6 days (Żmijewski and Korzeniowski, 2001). A week of aging (or 4 to 14 days) should therefore be enough to obtain adequate tenderness.

MARKETING

Every aspect of selling the product, including determining the target clientele, is vital to the producer's economic survival.

Wild Boar Meat – Overview

The principal markets available for wild boar meat are restaurants and retail sales. Most restaurants prefer to buy only the cuts they need. Restaurants are an attractive market for producers who can ensure a regular supply, consistent quality and a uniform product. As for retail, the solutions possible (by order of increasing convenience for the consumer) include on-farm sales (cuts or carcasses for méchoui barbecues), country dining, a stall at a farmer's market, and selling through a website.

On-farm sales are handled by the producer-processor-distributor, i.e. a producer performing all three operations. Distribution is what takes the most time and the greatest initial investment. For a business short on manpower, on-farm sales come with significant time constraints. Since the best times for selling are when people are off work, opting for this type of marketing requires a producer who can work on weekends and holidays and who enjoys interacting with the public. The producer must also comply with regulations that can be complex and costly for small producers (obtaining the right permits, health and safety training, etc.).

In Québec, most of the laws and regulations around food preparation and distribution are administered by the ministère de l'Agriculture, des Pêcheries et de l'Alimentation (MAPAQ) under the *Food Products Act*. A producer who wishes to export must consult the Canadian Food Inspection Agency, which administers additional legislation to that end.

Sales of whole carcasses to individuals account for a much smaller portion of the market, often consisting of direct sales of live animals by the producer to the consumer.

Though not yet common in Québec, marketing through a distributor lets the producer focus on the herd, devoting all his or her efforts to optimizing performance and genetics. This can be attractive for a new operation, since sales are relatively assured. However, the distributor must have access to a large enough market to be able to take on a new producer. In turn, the producer must ensure that the quality and volumes produced consistently meet expectations.

Though still marginal, mixed marketing strategies are emerging in which certain stages of production or sales are done on a contract basis. They let the producer focus on the tasks in which he or she excels, delegating the rest to others. For example, a breeder can contract out some of the finishing, while a producer who only raises a few sows but has a farm outlet can sell wild boar meat supplied by other producers.

Lastly, with the appropriate permit from MAPAQ a producer can diversify the business by adding a hunting option. The crucial regulations are set out in the *Regulation respecting animals in captivity*. Some game farms are themselves in the market for wild boar of 40 to 50 kg or more, provided they were raised in conditions that promote wild behaviour. This can be a good market for new producers.

Keep in mind that the more middlemen there are between producer and consumer, the less income the producer will receive per kilogram sold. Nonetheless, the price differential is indicative of the many steps and considerable effort involved between an animal at the farm gate and quality meat on the consumer's plate.

CONCLUSION

Wild boar meat is a high-end product that consumers seek out for a culinary experience. In that context, it is imperative that practices be put in place to ensure the supply of a quality product that will consistently satisfy consumer expectations. There are many challenges to be met (in genetics, farm management, marketing, etc.), but with such a new product the opportunities are considerable.

BIBLIOGRAPHY

Alberta Agricultural Food and Rural Development. 1997. *Agricultural Business Profiles: Commercial Wild Boar Industry*. Agdex 498/830-1. pp. 1-13.

Bailey, A.J. 1972. *The basis of meat texture*. J. Sci. Food Agric. 23: 995-1007.

Dransfield, E., R.C.D. Jones and H.J.H. MacFie. 1981. *Tenderising in M. longissimus dorsi of beef, veal, rabbit, lamb and pork*. Meat Sci. 5: 139-147.

Essen-Gustavsson, B. and A. Lindholm. 1984. *Fiber types and metabolic characteristics in muscles of wild boars, normal and halothane sensitive Swedish landrace pigs*. Comp. Biochem. Physiol. A Comp. Physiol. 78: 67-71.

Health Canada. 2010. *The Canadian Nutrient File* [online]. http://hc-sc.gc.ca/fn-an/nutrition/fiche-nutri-data/cnf_aboutus-aproposdenous_fcen-eng.php

Honikel, K.O. 2004. *Conversion of muscle to meat: Cold and heat shortening*. In: W. Jensen, C. Devine, M. Dikeman, eds. Encyclopedia of meat sciences, pp. 318-323, Elsevier Academic Press, Oxford, UK.

Koohmaraie, M. and G.H. Geesink. 2006. *Contribution of postmortem muscle biochemistry to the delivery of consistent meat quality with particular focus on the calpain system*. Meat Sci. 74: 34-43.

Lammers, M., K. Dietze and W. Ternes. 2009. *A comparison of the volatile profiles of frying European and Australian wild boar meat with industrial genotype pork by dynamic headspace-GC/MS analysis*. J. Muscle Foods 20: 255-274.

Livingston, D.J. and W.D. Brown. 1981. *The chemistry of myoglobin and its reaction*. Food Technol. 35: 244-252.

Müller, E., M. Rutten, G. Moser, G. Reiner, H. Bartenschlager and H. Geldermann. 2002. *Fibre structure and metabolites in M. longissimus dorsi of Wild Boar, Pietrain and Meishan pigs as well as their crossbred generations*. J. Anim. Breed. Genet. 119: 125-137.

Oshima, I., H. Iwamoto, Y.-N. Nakamura, K. Takayama, Y. Ono, T. Murakami, N. Shiba, S. Tabata and S. Nishimura. 2009. *Comparative study of the histochemical properties, collagen content and architecture of the skeletal muscles of wild boar crossbred pigs and commercial hybrid pigs*. Meat Sci. 81: 382-390.

Rehfeldt, C., M. Henning and I. Fiedler. 2008. *Consequences of pig domestication for skeletal muscle growth and cellularity*. Livest. Sci. 116: 30-41.

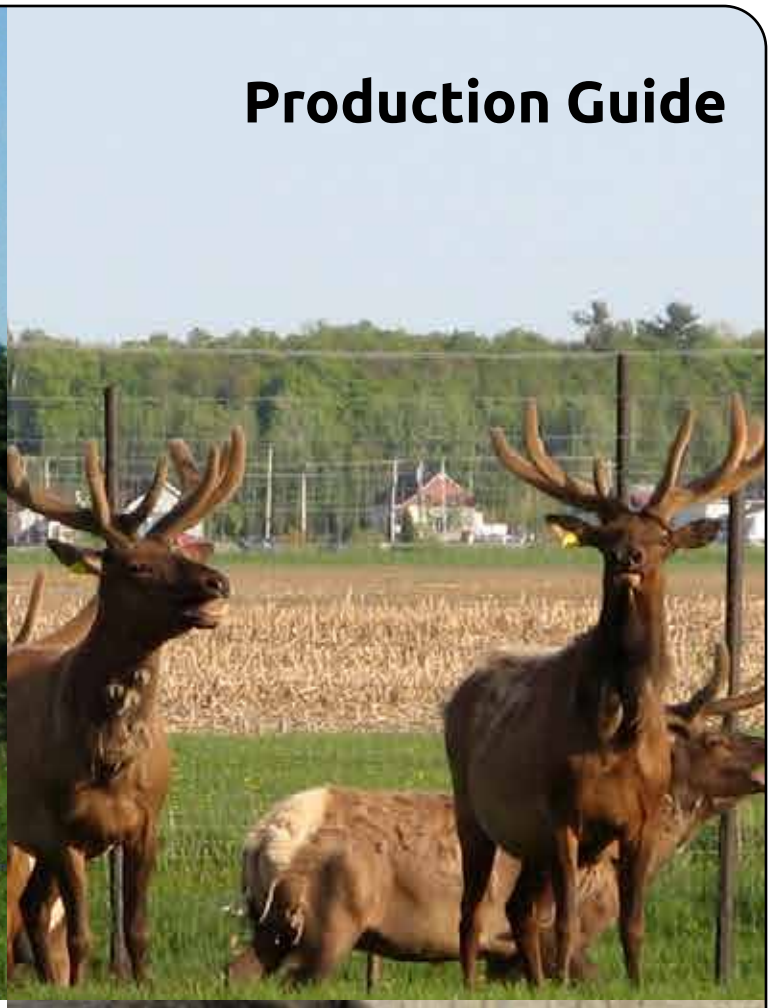
Skewes, O., R. Morales, F. González, P. Hofbauer and P. Paulsen. 2008. *Carcass and meat quality traits of wild boar (Sus scrofa s. L.) with 2n = 36 karyotype compared to those of phenotypically similar cross-breeds (2n = 37 and 2n = 38) raised under same farming conditions. 1. Carcass quantity and meat dressing*. Meat Sci. 80: 1200-1204.

USDA Agricultural Research Service. 2011. *USDA National Nutrient Database for Standard Reference, Release 24* [online]. http://www.ars.usda.gov/ba/bhnrc/ndl.

Żmijewski, T. and T. Korzeniowski. 2001. *Technological properties of wild boars meat*. EJPAU. 4.

Żochowska-Kujawska, J., M. Sobczak and K. Lachowicz. 2009. *Comparison of the texture, rheological properties and myofibre characteristics of SM (Semimembranous) muscle of selected species of game animals*. Pol. J. Food Nutr. Sci. 59: 243-246.

Zomborszky, Z., G. Szentmihalyi, I. Sarudi, P. Horn and C.S. Szabo. 1996. *Nutrient composition of muscles in deer and boar*. J. Food Sci. 61: 625-627.



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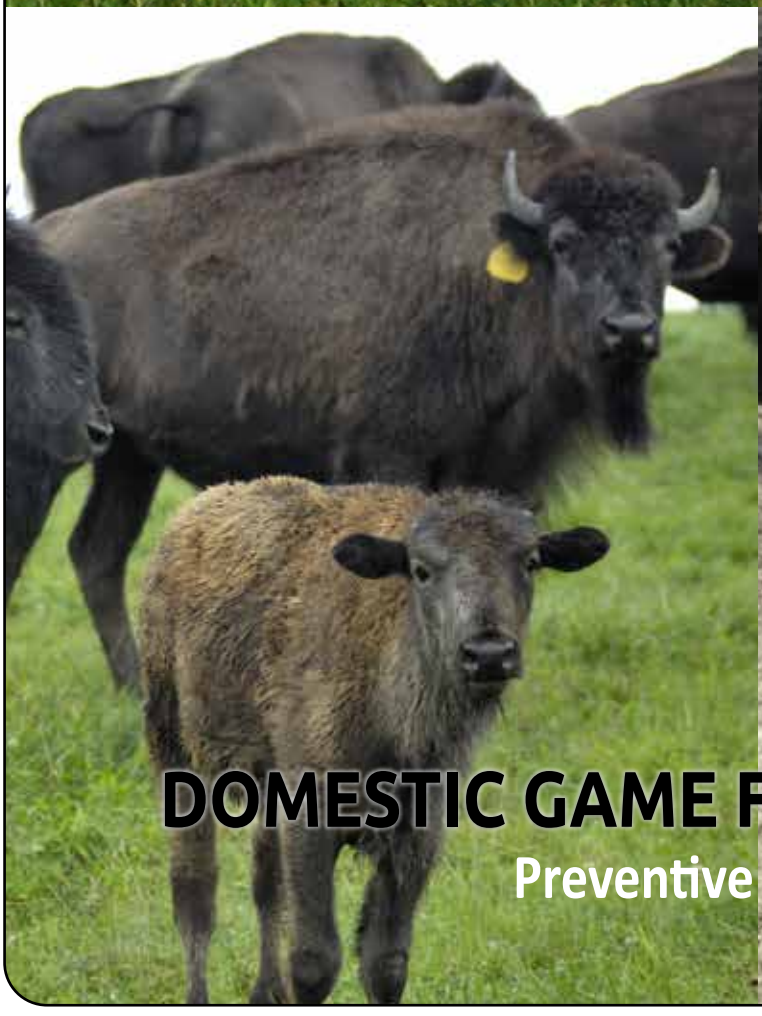

DOMESTIC GAME FARM ANIMALS

Preventive Medicine – Overview

CRAAQ

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INTRODUCTION

For anyone farming game animals like wild boar, bison, deer and wapiti (known as elk outside of Québec), disease prevention should be a priority. Healthy conditions and proper feeding will go a long way toward ensuring the health of a herd. Remember that when animals live in poor conditions they are stressed and weakened, which predisposes them to disease.

Also, since many problems are multi-factoral, the effectiveness of preventive and curative treatments can be significantly influenced by the conditions in which animals are raised.

This leaflet presents the various preventive health measures that can be used by game farmers with animals like wild boar, bison, deer and wapiti.

GENERAL RULES

Here are the fundamental rules of disease prevention in game farming:

1. For wild boar farming, keep a distance of at least 5 km from the nearest pig farm. To reduce the risk of disease transmission, keep well away from fields where pig manure is spread;
2. To reduce stress on the animals, keep a good distance from busy roads;
3. Ensure that pens and pastures are well drained, since mud and stagnant water are breeding grounds for parasites;
4. Feeders and feeding areas should be kept clean to reduce disease transmission;
5. Restrict visitor access;
6. Quarantine newly purchased animals;
7. Divide the animals into age groups;
8. Practise pasture rotation and alternative tillage to reduce the parasite load in pens and pastures;
9. Keep good records of all curative and preventive treatments performed;
10. Promptly dispose of carcasses of dead animals.

WILD BOAR

Since the wild boar is very similar to the domestic pig, it is susceptible to many of the same diseases. Unfortunately there is no documentation specific to wild boar describing their diseases and the effectiveness of vaccines and other livestock medicines.

The preventive treatments listed in Tables 1 and 2 are administered to domestic pigs. The pros and cons of applying such measures to a wild boar herd should be discussed with your veterinarian. Specifically, you must assess whether the benefits of an intervention outweigh the stress and risk of an accident associated with handling the animals.

Tableau 1. Vaccination bactérienne chez l'espèce porcine

Disease	Type of vaccine	Dose	Advantages-disadvantages
Neonatal diarrhea	Inactivated vaccine	• Sow : two doses of 2 ml (IM[1]), 3 to 6 weeks apart; then every year, 2 to 6 weeks before farrowing	• Withdrawal time[2]: 0 day • Used on sows (maternal transmission in colostrum) • Can be combined with a vaccine against clostridiums, which in some cases are associated with neonatal diarrhea and other less common conditions affecting sows
Porcine proliferative enteropathy	Attenuated vaccine	• Piglet over 3 weeks: 2 ml (IM)	• Withdrawal time: 0 day • Can be administered in water • Protection after 3 weeks; lasts 17 weeks
Glasser's disease	Inactivated vaccine	• Piglet over 5 weeks: two doses of 2 ml (IM), 2 weeks apart • Sow: two doses of 2 ml, 4 weeks apart; then every year, 2 to 4 weeks before farrowing	• Protection about 14 weeks • Important to immunize sows, since the disease mostly affects 2-week piglets • Withdrawal time: 0 day
Contagious pleuro-pneumonia	Inactivated vaccine containing APX toxins	• Two doses of 2 ml (IM), 4 weeks apart, for animals 6 weeks and over	• Withdrawal time: 0 day • Partial clinical protection
Enzootic pneumonia	Inactivated vaccine	• Piglet 5 days and up: two doses of 2 ml (IM), 3 to 4 weeks apart • Piglet 10 weeks and up: 2 ml (IM)	• Most effective at weaning, but ideally the entire herd should be vaccinated • Can be obtained in combined form with a vaccine against Glasser's diseaser
Atrophic rhinitis	Inactivated vaccine	• Piglet over 18 months: two doses of 2 ml (IM), 6 weeks apart • Sow: once a year, 2 to 6 weeks before farrowing	• Important to administer to sows (maternal transmission in colostrum) • Withdrawal time: 0 day
Swine erysipelas	Inactivated vaccine	• Piglet over 12 weeks: two doses of 2 ml (IM), 4 weeks apart • Yearly vaccination: 2 ml before each lactation	• Withdrawal time: 0 day • Protection for 6 months • Can be combined with vaccine against parvovirus (see Table 2)

1. IM : intramuscular injection.
2. Withdrawal time: minimum time required between administration of the drug and slaughter of the animal.

Table 2. Viral vaccination in porcine species

Disease	Type of vaccine	Dose	Advantages-disadvantages
Porcine circovirus	Inactivated vaccine	• Two doses of 2 ml (IM[1]), 3 to 4 weeks apart; then 2 ml each year, 2 weeks before farrowing	• Withdrawal time[2]: 0 day • Used in the sow and piglets at weaning
Influenza	Inactivated polyvalent vaccine	• Two doses of 2 ml (IM), 3 to 4 weeks apart • Repeat each year, 2 to 3 weeks before farrowing	• Especially during fattening • Withdrawal time: 0 day
Parvovirus	Inactivated vaccine	• Two doses of 2 ml (IM), 3 weeks apart, then annually	• First dose given 6 weeks before breeding • Can be combined with vaccine against swine erysipelas (see Table 1) • Withdrawal time: 0 day
Porcine reproductive and respiratory syndrome (PRRS)	Live vaccine for piglets Inactivated vaccine for sows	• Piglet 4 to 5 weeks: 2 ml (IM) • Sow: 2 ml (IM), 3 weeks before breeding	• Withdrawal time: 2 days

1. IM: intramuscular injection.
2. Withdrawal time: minimum time required between administration of the drug and slaughter of the animal.

Depending on production conditions, parasites can cause a lot of problems in wild boar. In principle, de-worming efforts should focus on the periods of highest risk. Thus, it is strongly recommended that de-worming be done at the following times: in spring before the animals are put in pens; whenever they are rotated from one pen to another; in autumn before the first frosts; and in the case of sows, before farrowing. The various treatments available are listed in Table 3.

Table 3. Antiparasitic drugs that can be used in wild boar

Product	Dose	Withdrawal time[1]	Use
Amprolium	20 mg/kg (oral)	7 days	Coccidiosis
Doramectin Injectable	300 µg/kg (IM[2])	35 days	Intestinal worms Lungworms Lice, mites
Febendazole 20%	9 mg/kg for 3 days (oral)	7 days	Intestinal worms Lungworms
Ivermectin Injectable	300 µg/kg (SC[3])	28 days	Intestinal worms Lungworms Lice, mites
Ivermectin (oral)	100 µg/kg	7 days	Intestinal worms Lungworms Lice, mites
Levamisole 10%	2 kg of ration at 0.04% per 100 kg of weight	4 days	Intestinal worms Lungworms
Levamisole Injectable	1 ml/10-20 kg (SC)	28 days	Intestinal worms Lungworms
Sulfaquinoxaline	1 g/4 litres water	14 days	Coccidiosis

1. Withdrawal time: minimum time required between administration of the drug and slaughter of the animal.
2. IM: intramuscular injection.
3. SC: subcutaneous injection.

CERVIDS AND BISON

Many of the diseases to which cervids and bison are susceptible are similar to those seen in cattle. As a result, experience gained with bovines has provided many preventive measures that are applicable to game animals. However, since very few studies have focused on the vaccination of cervids and bison, its use is largely up to the experience of the veterinarian. The main preventive measures applying to large game animals (according to the literature available) are presented in Tables 4 and 5.

Table 4. Principal vaccines used with large game animals, particularly cervids and bison

Disease	Type of vaccine	Dose	Advantages-disadvantages
Neonatal diarrhea *E.coli*-Rotavirus-Coronavirus	Bacterin and inactivated vaccine	• Two doses of 2 ml (SC[1]), 1 month apart • Repeat annually	• Withdrawal time[2]: 60 days • Rota and corona viruses have not been proven in cases of diarrhea in deer and bison, despite having been isolated
Clostridium family	Bacterin with 8 serotypes	• Two doses of 5 ml (SC or IM[3]), 21 days apart • Repeat annually	• Used for several years now on deer and bison • Withdrawal time: 21 days
IBR-BVD-PI3-BRSV[4]	Modified live vaccine Inactivated vaccine	• Live vaccine (SC or IM): two doses of 2 ml, 1 month apart, then annually • Inactivated vaccine: two doses of 5 ml (SC or IM), 3 weeks apart, then annually	• Live vaccine used for bison during fattening • Inactivated vaccine used for females • Withdrawal time: 21 days • Despite the presence of antibodies in bison and deer, these diseases have not been diagnosed with certainty
IBR-PI3	Attenuated vaccine (intra-nasal)	• 1 ml/nostril	• Withdrawal time: 21 days • Can be used on the entire herd • Handling difficulties
Pasteurellosis	Bacterin	• Two doses of 2 ml (IM), 3 weeks apart • Then annually	• Use on bison farms in Montana seems to have given some protection • Withdrawal time: 21 days

1. SC: subcutaneous injection.
2. Withdrawal time: minimum time required between administration of the drug and slaughter of the animal.
3. IM: intramuscular injection.
4. IBR: infectious bovine rhinotracheitis; BVD: bovine virus diarrhea; PI3: parainfluenza type 3; BRSV: bovine respiratory syncitial virus.

Vaccines against leptospirosis, infectious keratoconjunctivitis, anaplasmosis and babesiosis are not recommended for these species.

Cervids and bison are susceptible to parasitic infection after being confined in pens, but with good production conditions and a de-worming program parasites can be controlled. Generally, de-worming is recommended in the spring to prevent pastures from being contaminated, and in the fall after the first frosts. The principal livestock medicines used are presented in Table 5.

Table 5. Principal antiparasitic drugs used with cervids and bison

Product	Dose	Withdrawal time[1]	Use
Albendazole	• 10 mg/kg (oral)	27 days	Flukes
Amprolium	• 5 ml per 100 lb (oral), once a day for 5 days	7 days	Coccidiosis
Cyfluthrin 1%	• 2 to 12 ml (pour-on[2]) depending on weight • Repeat after 21 days	1 day	Flies, lice
Doramectin	• 200 µg/kg (SC[3] and IM[4]) • 500 µg/kg (pour-on)	40 days (SC and IM) 55 days (pour-on)	Intestinal worms Lungworms Lice, mites
Eprinomectin	• 500 µg/kg (pour-on)	0 day	Intestinal worms Lungworms Lice, mites
Febantel	• 7.5 mg/kg (oral)	21 days	Intestinal worms Lungworms
Febendazole	• 7.5 mg/kg (oral)	14 days	Intestinal worms Lungworms
Ivermectin	• 200 µg/kg (SC) • 500 µg/kg (pour-on)	49 days	Intestinal worms Lungworms Lice, mites
Levamisole	• 7.5 mg/kg (oral and SC) • 10 mg/kg (pour-on)	10 days (oral and SC) 7-28 days (pour-on)	Intestinal worms Lungworms
Moxidectin	• 500 µg/kg (pour-on)	36 days	Intestinal worms Lungworms Lice, mites
Permethrin 1%	• 15 ml/45 kg up to a maximum of 150 ml (pour-on)	1 day	Flies, lice
Permethrin 10%	• Ear tags	0 day	Horn flies Face flies

1. Withdrawal time: minimum time required between administration of the drug and slaughter of the animal.
2. Pour-on: applied locally on the animal's back, the product being absorbed through the skin.
3. SC: subcutaneous injection.
4. IM: intramuscular injection.

CONCLUSION

Farm production of large game animals is still a recent phenomenon in Québec, and little research has been done on the subject. The veterinary medicine required, both preventive and curative, has yet to be developed and registered for use in game animals. As a result, the veterinary interventions currently practised on game farms in Québec are essentially based on experience gained with cattle and hogs.

Raising game animals in pens contributes to the development of disease because they are held together in greater concentration than in their natural environments. Good production conditions and practices are therefore very important for the herd's health. At the same time, since disease cannot be controlled by livestock medicines alone, regular preventive treatments are essential.

BIBLIOGRAPHY

Berezowski, J. *A Literature Review of Disease in Bison* [online]. Saskatchewan. Specialized Livestock Health and Production. http://www.usask.ca/wcvm/herdmed/specialstock/bison/ (accessed March 15, 2011).

CBIPvet. *Vaccination contre les maladies bactériennes chez le porc* [online]. Centre belge d'information pharmacothérapeutique. http://www.cbip-vet.be/fr/texts/FSUOOOL1BL2o.php (accessed May 6, 2011).

CBIPvet. *Vaccination contre les maladies virales chez le porc* [online]. Centre belge d'information pharmacothérapeutique. http://www.cbip-vet.be/fr/texts/FSUOOOL1AL2o.php (accessed May 6, 2011).

Haigh, J.C. and R.J. Hudson. 1993. *Farming Elk and Red Deer*. Mosby Yearbook, Missouri. 369 pp.

JFO. *Les pathologies du sanglier, ses maladies* [online]. http://jfo.chez-alice.fr/les_diseases_du_boar.htm (accessed May 6, 2011).

Pathologie des maladies parasitaires 2006-2007 [online]. Deuxième doctorat en médecine vétérinaire, Université de Liège. http://www.dmipfmv.ulg.ac.be/parasitovet (accessed May 6, 2011).

Woodbury, M. 2007. *The Control of Internal Parasites in Bison* [online]. Canadian Bison Association Annual Convention, November 17-20, 2007, Regina, Saskatchewan. http://www.canadianbison.ca/producer/documents/ParasitePresentation.pdf (accessed March 15, 2011).

Wright, B. 2003. *Withdrawal Times for Medicines Used in Deer* [online]. Ministry of Agriculture, Food and Rural Affairs, Ontario. http://www.omafra.gov.on.ca/english/livestock/alternat/facts/info_withdrawal.htm (accessed May 6, 2011).

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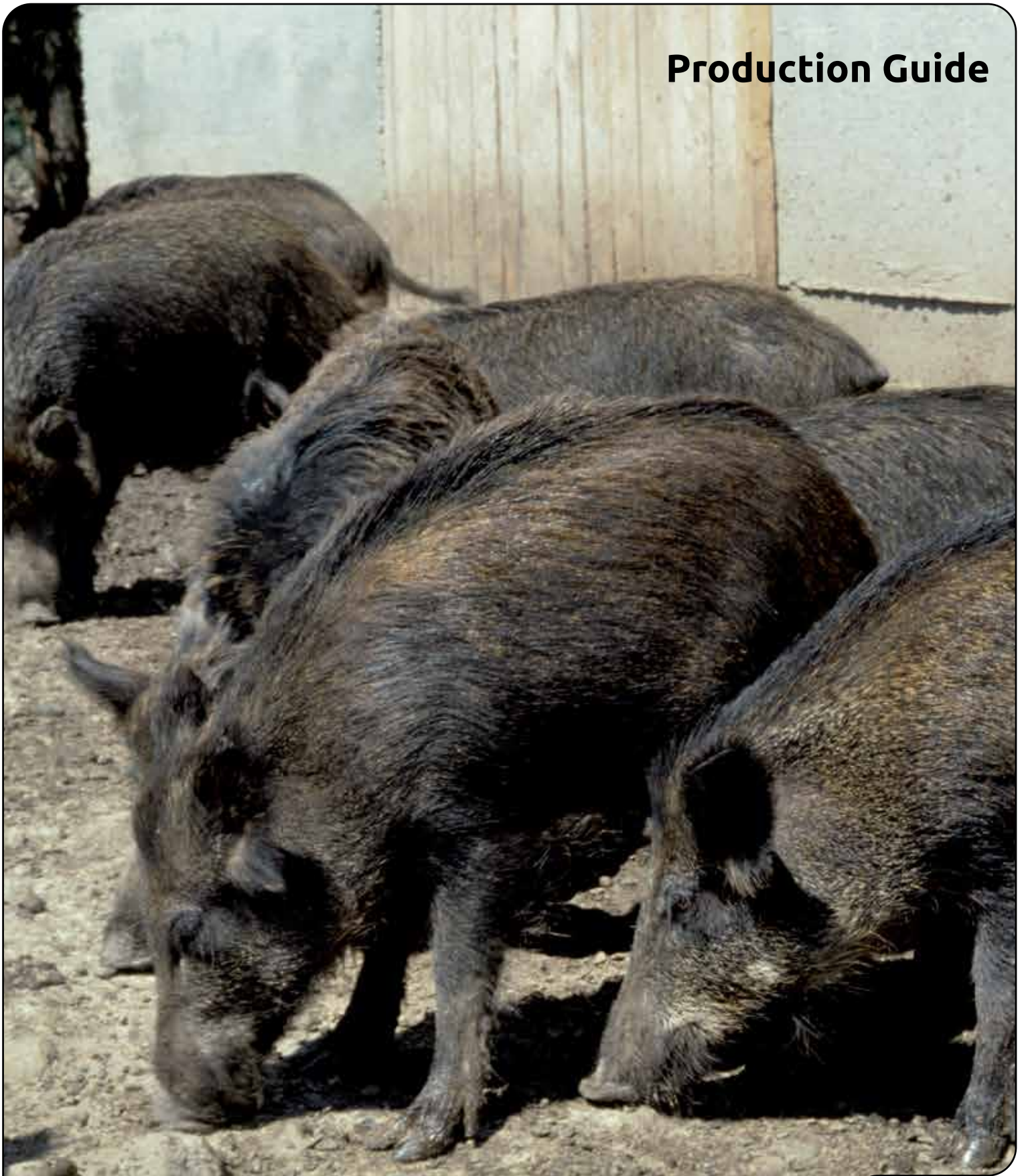

DOMESTIC GAME FARM ANIMALS

Principal Diseases of Wild Boar

CRAAQ
CULTIVER L'EXPERTISE
DIFFUSER LE SAVOIR

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INTRODUCTION

This section is provided as a summary of the principal diseases that may appear in a wild boar herd. It does not describe every possible problem, such as reproductive disorders in sows. It is important that the herd be seen regularly by a veterinarian, both for prevention and treatment if needed. The veterinarian will prepare a herd health program including advice on biosecurity, worming and vaccination, to avoid problems that can be costly or difficult to treat. The veterinarian can also provide advice on which animals to purchase or not, and can verify whether the health status of those being considered is compatible with the herd.

PARASITOSES

Parasitosis is an infestation or infection with parasites. Parasitic infection is the one problem most often encountered in wild boar, due to how they are raised: outdoors, where surfaces cannot be cleaned effectively. Infestations must be prevented by treating new animals infected with parasites (whether internal or external) before introducing them into the herd, to avoid contaminating other animals, enclosures or buildings. Good anti-parasite management is therefore essential from the start, before any infection has occurred.

Table 1. Causes, symptoms, treatments and prevention of the principal parasitic diseases affecting wild boar

Parasitic diseases	Causal agent(s)	Symptoms	General treatment and prevention
Pediculosis (fleas)	*Haematopinus suis* (specific to pigs)	Fleas visible to the naked eye Itching, hair loss, anaemia Serious growth loss if contamination is severe	Ivermectin in feed or injectable Ideally treat sows before farrowing to avoid contaminating piglets during lactation
Sarcoptic mange	*Sarcoptes scabiei var. suis* (specific to pigs)	Itching, hair loss, anaemia Serious growth loss if contamination is severe	Ivermectin in feed or injectable Ideally treat sows before farrowing to avoid contaminating piglets during lactation
Coccidiosis	*Isospora suis* (specific to pigs)	Diarrhea occurring after 5 days of age	Painting may be useful for certain types of floors Prevention: toltrazuril (Baycox®) orally at 3 days
Helminthiasis	Contamination from ingesting eggs (*Ascaris, Trichuris*) or larvae (*Oesophagostomus, Hyostrongylus*) Ingestion of the intermediary host (*Metastongyus, Stephanurus*) Penetration through skin (*Strongyloides, Stephanurus*) Transplacentary passage (*Strongyloides*)	Stunted growth Pneumonia Weight loss Skin rashes Vomiting Diarrhea Constipation	Ivermectin (Ivomec®, Bimectin®, Noromectin®) (or equivalent) to simultaneously treat external and internal parasites. Can be administered in feed or by injection. Pyrantel tartrate (Pro-Banminth®): product added to feed over 5 to 7 weeks to prevent migration of worms (*Ascaris* and *Oesophagostomum*) Fenbendazole (Safeguard®): in parasite larval stage and in adult form; can be administered in feed or water. Others: piperazine (in water, for adult roundworms only), fenbendazole (Safeguard®) or pyrantel tartrate (Pro-Banminth®) added on food (top dressing): for adult worms only
Trichinosis (zoonotic[1])	*Trichinella spiralis*	These roundworm larvae are found in muscles, notably at the tendinous insertion Polysystemic disease (affects various systems)	Transmission by uncooked, contaminated meat and occasionally by certain rodents (outdoors) Never feed with table scraps Prevention is the only possible recourse. If the problem is detected at the slaughterhouse, the animal will be condemned and the herd examined.

1. Disease transmissible to humans.

BACTERIAL DISEASES

Bacterial diseases can be treated with antibiotics, but often a lab analysis is required to identify the pathogen involved and prescribe the right antibiotic(s) to ensure effective treatment.

Certain bacterial diseases are polysystemic, affecting various systems (Table 2), while others specifically affect the digestive system (Table 3) or the respiratory system (Table 4). Digestive problems are relatively frequent in young animals.

Table 2. Causes, symptoms, treatments and prevention of the principal polysystemic bacterial diseases

Name	Causal agent	Symptoms	General treatment and prevention
Streptococcus suis infections	*Streptococcus suis*	Meningitis Arthritis Septicaemia Pneumonia	Antibiotic therapy: penicillin In meningitis cases it is also recommended to administer anti-inflammatory drugs
Glässer's Disease	*Haemophilus parasuis*	Polyserositis Arthritis Peritonitis Pneumonias Meningoencephalitis Decline and wasting with cyanosis of the extremities	Antibiotic therapy Prevention : Vaccination can be used for some strains
Erysipelas	*Erysipelothris rusiopathiae*	Diamond shaped red patches on the skin (difficult to see on wild boar because of the hair) High fever Joint problems Cardiac problems Stillborn	Antibiotic therapy Vaccination (injectable or in water)

Table 3. Causes, symptoms, treatments and prevention of principal digestive diseases due to bacteria

Name	Causal agent(s)	Symptoms	General treatment and prevention
Neonatal diarrhea			
Colibacillosis	*Escherichia coli*	Diarrhea appearing in piglets during the first week of lactation More frequent in less immunized litters (first litters and old mothers)	The ideal is preventive vaccination before farrowing Natural vaccination can be used (feed gestating mothers intestines from piglets that died of neonatal diarrhea in the first week) Potato starch Antibiotic therapy
Clostridium	*Clostridium perfringens* type C *Clostridium perfringens* type A *Clostridium difficile*	Neonatal diarrhea appearing in piglets during the first two weeks Occasional hemorrhagic diarrhea for type C	Vaccination of mothers for type C Potato starch An oral antibiotic (penicillin) or injectable one (spectinomycin) can work on piglets Natural vaccination is not recommended Preventive probiotics and prebiotics
Post-weaning diarrhea and fattening			
Post-weaning Colibacillosis	*Escherichia coli* with intestinal adhesion factor	Diarrhea in the piglets during the weeks following weaning, occasionally causing death in healthy subjects in the acute stage	Live oral vaccine (*E. Coli* strain F4, non-pathogenic) Antibodies from chicken egg yolks immunized to adhesion factor F4 Feed restriction High level of zinc oxide in feed Acidification of feed Probiotics Potato starch Antibiotic therapy

Table 3 (continued). Causes, symptoms, treatments and prevention of principal digestive diseases due to bacteria

Name	Causal agent(s)	Symptoms	General treatment and prevention
Dysentery and other spirochetoses	*Brachyspira hyodysenteriae* and other *Brachyspira*	Dysentery: diarrhea with blood and mucus between 7 and 18 weeks of age Chronic diarrhea during finishing	Antibiotic therapy A hygiene program and a control program against rodents are very important prevention factors
Salmonella[1] (zoonotic)	Salmonella	Occurs at 8 to 20 weeks, attacks the small and large intestine Causes slight diarrhea Occasional fever	Antibiotic therapy Prevention: vaccine in water
Proliferative enteritis	*Lawsonia intracellularis,* a bacterium that infects the epithelium of crypts in the ileum, caecum and proximal colon	Anorexia Apathy Stunted growth Tarry diarrhea	Antibiotic therapy Prevention: oral vaccine

1. Apart from the fact that Salmonella is transmissible to humans, another problem arises from the fact that a contaminated animal excretes the microbe for a short time but remains a healthy carrier. When subjected to stress (weighing, transportation, etc.) it will again start excreting the bacteria.

Table 4. Causes, symptoms, treatments and prevention of principal respiratory diseases due to bacteria

Name	Causal agent(s)	Symptoms	General treatment and prevention
Bronchopneumonia	*Mycoplasma hyopneumoniae*	Coughing (usually animals over 12 weeks old) Stunted growth	Vaccination Antibiotic therapy
Pasteurellosis	*Pasteurella multocida*	Coughing Pneumonia Weight loss	Individual antibiotic therapy in feed or water
Pleuropneumonia	*Actinobacillus pleuropneumoniae*	Pneumonia Anorexia Sudden death	Individual antibiotic therapy
Rhinitis	*Pasteurella multocida* serotype D toxigenic strain (toxin that destroys nasal passages) *Bordetella bronchiseptica*	Sneezing Groin deviation Stunted growth	Vaccination Antibiotic therapy

VIRAL DISEASES

Viral diseases cannot be treated, but a blanket antibiotic treatment can be administered to avoid secondary bacterial infections. Prevention by vaccination is possible for certain viruses.

Over the last few years, and as in pork production, wild boar production has suffered the ravages of porcine circovirus (see page 9). This virus is present in all herds and is impossible to eradicate. Often, vaccination is essential to avoid losses.

As with bacterial diseases, viral diseases can be polysystemic (Table 5), affecting the digestive system (Table 6) or the respiratory system (Table 7).

Table 5. Causes, symptoms, treatments and prevention of the principal polysystemic viral diseases

Name	Causal agent(s)	Symptoms	Prevention
Porcine Reproductive and Respiratory Syndrome (PRRS)	Arterivirus (in saliva and nasal discharges, semen): predilection for microphages; induces their destruction, rendering animal susceptible to secondary infections There are numerous strains (the virus mutates easily) of variable severity, some causing mostly reproductive problems, others respiratory problems.	Reproductive problems in maternity: - anestrus (sows do not go back into heat after weaning); - lower farrowing rate, increased rate of return into heat; - abortion (generally in last third of gestation); - premature deliveries with weak piglets at birth; - presence of stillborn and mummified foetuses (different stages) Anorexia: many sows stop eating Hyperthermia: fever (> 40 °C or 104 °F) in sows and nursing piglets Nursing piglet: - presence of pneumonia (panting); - frequent increase in neonatal diarrhea In the nursery: increase in pneumonias and mortality Finishing: pneumonias, mortality, occasional partial anorexia	Supportive treatment with antibiotic therapy if needed for secondary infections Vaccination: modified live vaccine; it is not recommended to vaccinate sows at the end of gestation, nor males in service. Results may vary according to the strain present in the herd. Reduce adoptions (fostering to other sows) except at 1 day of age Washing and disinfection Avoid introducing new strains (biosecurity); do not change source of sires
Porcine Circovirus Associated Disease (PCVAD) New disease appearing in Western Canada in the early 1990s	Type 2 Circovirus (very resistant virus in the environment)	Progressive wasting of weaned piglets, or later at finishing: - weight loss; - diarrhea; - difficulty breathing; - jaundice This virus is often associated with other pathogenic agents (bacteria, viruses and protozoa). It causes interstitial pneumonia, sometimes accompanied by hepatitic and renal problems. Reproductive problems are also reported	Vaccination of piglets and reproducing animals

Table 5 (continued). Causes, symptoms, treatments and prevention of the principal polysystemic viral diseases

Name	Causal agent(s)	Symptoms	Prevention
Foot-and-mouth disease[1]	Aphthovirus (generally non-lethal) The incubation period (time between infection and the appearance of clinical symptoms) varies from 18 hours to 14 days depending on infectious dose, host's susceptibility and viral strain	Fever up to 41 °C (106 °F) Loss of appetite Sudden lameness (the animals refuse to get up and move around) Pain Vesicles on the hooves, groin, tongue, mouth or teats	Since this disease is subject to mandatory reporting[1], do not move or sell the animal before a diagnosis is made Prevention: - biosecurity measures: deny access to anyone from, or having visited, countries where these diseases are present; - never feed the animals table scraps containing meat
Swine vesicular disease[1]	Enterovirus The importance of this acute viral disease specific to swine is essentially due to the fact that it can be confused with foot-and-mouth disease, though the causal agent is less pathogenic	Fever up to 41 °C (106 F) Loss of appetite Sudden lameness (the animals refuse to get up and move around) Pain Vesicles on the hooves, groin, tongue, mouth or teats	See foot-and-mouth disease
Vesicular stomatitis[1]	Rhabdovirus This disease is of great importance by virtue of its resemblance to foot-and-mouth disease	Mild fever Vesicles inside the mouth, on the lips, groin, hooves and teats	See foot-and-mouth disease
Classic swine fever[1] (also known as swine cholera or swine fever)	Pestivirus Highly contagious disease that affects domestic and wild pig populations	Acute form: - fever up to 42 °C; - pathy, conjunctivitis, purulent tearing; - digestive, respiratory and nerve problems; - eath from 4 to 14 days after appearance of symptoms Benign or asymptomatic form: - reproductive problems; - high post-weaning mortality	See foot-and-mouth disease

Table 5 (continued). Causes, symptoms, treatments and prevention of the principal polysystemic viral diseases

Name	Causal agent(s)	Symptoms	Prevention
African swine fever[1]	Asfivirus Highly hemorrhagic and contagious disease in wild and domestic swine, transmissible by ticks or uncooked scraps	High fever (41-42 °C) Depression Loss of appetite Rapid respiration Vomiting Constipation to bloody diarrhea Signs of nervousness Abortion at different stages of gestation Death from 1 to 7 days after appearance of symptoms	See foot-and-mouth disease (page 10)
Pseudorabies (Aujeszky's disease)[1]	Herpes virus (porcine virus 1)	Animals less than 7 days old: high mortality Older subjects: fever, loss of appetite, signs of nervousness, respiratory troubles Finishing: respiratory troubles Reproductive troubles	See foot-and-mouth disease (page 10)

1. Mandatory reporting disease requiring swift notification of a district veterinarian of the Canadian Food Inspection Agency (CFIA) by owners, veterinarians and laboratories, whether for observation (stricken animal) or suspicions related to an animal. Such diseases have significant economic impact on international trade and present a danger to the population. Control or eradication measures will be taken immediately. The producer must notify the veterinarian if the herd has a high mortality rate or displays unusual clinical signs.

Table 6. Causes, symptoms, treatments and prevention of the principal viral diseases causing diarrhea

Name	Causal agent(s)	Symptoms	Prevention
Transmissible gastroenteritis (TGE)	Coronavirus	Diarrhea at any age, occasionally accompanied by vomiting. When it occurs in acute form in a herd that tested negative, morbidity and mortality of young piglets under 15 days is nearly 100%.	No effective cure. In the acute phase, the most effective treatment is natural vaccination (i.e. with intestines from piglets that died from diarrhea). To break the disease cycle, it is best to contaminate the entire herd to avoid having animals that have never encountered the virus.
Rotavirus diarrhea	Rotavirus	Occurs at 1 to 5 weeks, low morbidity and mortality	Preventive vaccination of sows before farrowing (this works well). Commercial vaccines or natural vaccination can be used.

Tableau 7. Causes, symptômes, traitement et prévention de l'influenza porcin (virus)

Name	Causal agent(s)	Symptoms	Prevention
Porcine influenza	Influenza H1N1 Influenza H3N2	Coughing Fever (> 40 °C or 104 °F) Decrease of appetite Spreads swiftly: less than 1 week	Aspirin in water Blanket antibiotic therapy against secondary bacterial infections, in feed or water Vaccination

CONCLUSION

Since wild boar are in the same family as pigs, they are subject to most of the diseases of their cousins. The risk of a herd being contaminated is therefore higher if it is located near a hog farm.

On wild boar farms, younger subjects (piglets) generally display more clinical signs than adult wild boar because their immune systems are weaker.

BIBLIOGRAPHY

Eich, K.-O. 1987. *Manuel pratique des maladies du porc*. France Agricole.

Martineau, G.P. and H. Morvan. 2010. *Maladies d'élevage des porcs, 2e édition*. France Agricole.

Straw. B.E. , S. D'Allaire, W.L. Mengeling and D.J. Taylor. 1999. *Diseases of Swine, 8th Edition*. Blackwell Pub.

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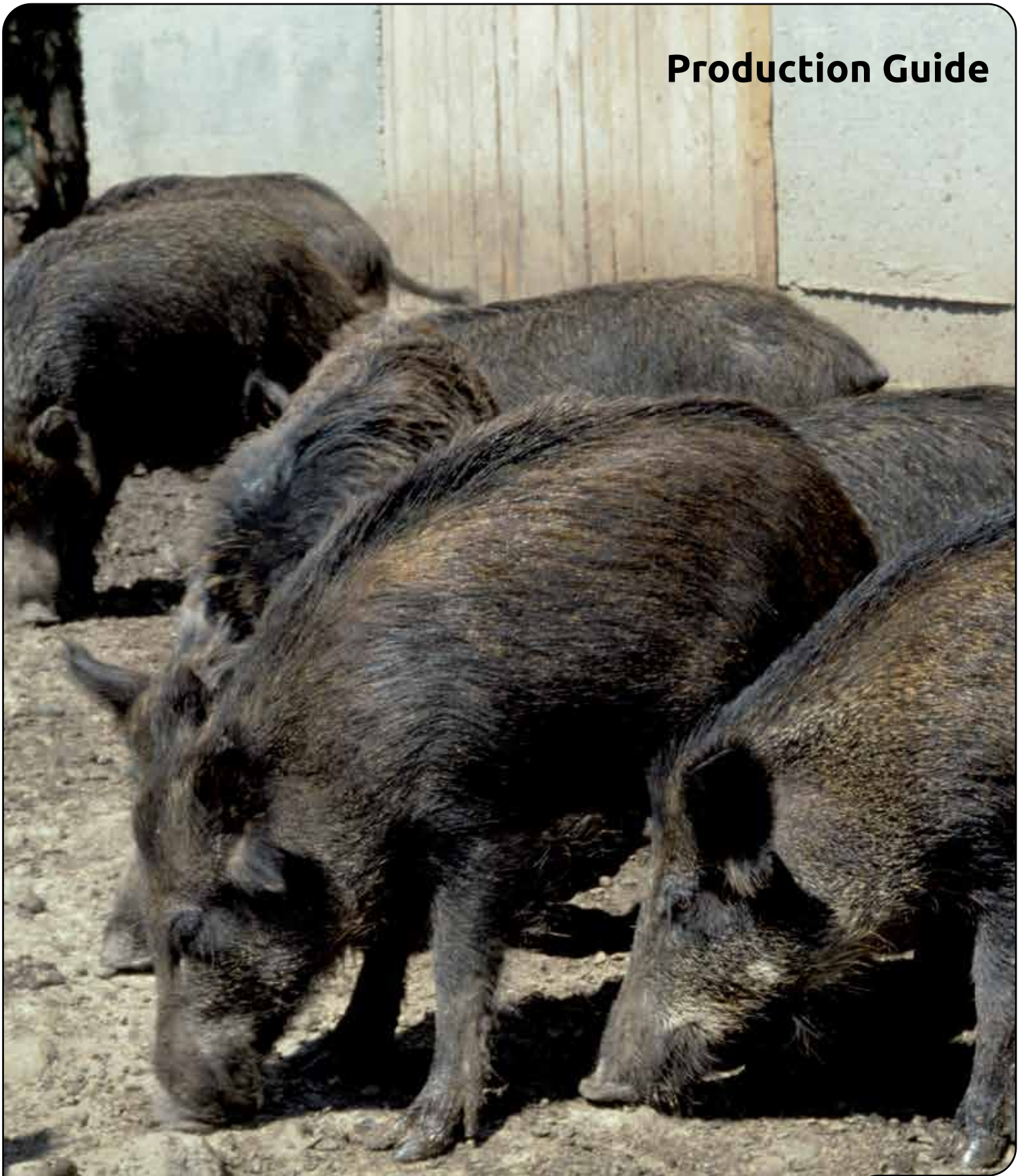

DOMESTIC GAME FARM ANIMALS

Wild Boar Facilities – Overview

CRAAQ
CULTIVER L'EXPERTISE
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INTRODUCTION

The wild boar is a close relative of the domestic pig, and much of the equipment designed for hog operations can be adapted to wild boar. The behaviour of wild boar is significantly different however (they are more nervous, more agile and quicker) and they spend most of their lives outdoors. Wild boar cannot be handled like domestic pigs, so for production facilities to be functional and safe they must be built for the particular characteristics of the species.

Generally speaking, wild boar facilities include breeding pens, growing pens and feeding and watering areas. Farrowing should take place in isolation. Producers must be able to handle wild boar safely, so it is essential to have a system, however simple, for receiving, sorting and shipping.

This document is based on comments from producers who have agreed to share their acquired expertise. Wild boar farming is a recent development compared to domestic hog production, and in Québec is still in its infancy. Many of the methods currently in use are the result of much trial and error. Improvements on the concepts outlined in the present document will undoubtedly become available in the coming years.

Visiting existing farms is a good way to benefit from the experience of other producers, to learn how one's own operation could be improved. Such hands-on information sharing is not always possible however. Another solution is to seek help from an advisor through the Agriconseils network, or to contact the Association des producteurs de sangliers du Québec (APSQ). A wealth of information on wild boar is provided in a DVD produced by the Fédération des éleveurs de grands gibiers du Québec (FEGGQ, 2008).

BEHAVIOUR

Designing appropriate production facilities for wild boar, and handling the animals properly, requires a good understanding of wild boar behaviour. The facilities as a whole must:

- minimize stress;
- maximize safety;
- increase efficiency;
- ensure the overall safety and well-being of animals and workers.

The main aspects of wild boar behaviour are described below.

Herd mentality. Wild boar dislike being separated from the herd. Individuals should not be left alone for too long during handling; otherwise they become nervous and will try to escape by any means possible.

Agility. Wild boar can jump over 1.5 m obstacles with surprising ease. Their agility should be taken into account in designing facilities and planning transportation.

Rooting behaviour. Wild boar naturally root, digging up earth and uprooting obstacles. Their rooting behaviour should be taken into account in planning and building fencing, production, housing and transportation equipment.

BREEDING PEN

Wild boar should be raised in outdoor pens with access to shelter, meeting their behavioural needs while providing the optimum conditions for meat production.

The ideal stocking density (number of animals per unit of pen area) depends on how much vegetation cover is desired, the type of soil, and weather conditions (precipitation, wind, temperatures). Generally, with a density of 50 adults (or 125 young) per hectare, the vegetation cover will deteriorate rapidly, though it is adequate space for the animals' well-being. To maintain ground cover, the ideal density is no more than 35 growing animals or 15 adults per hectare. It is recommended to have extra pens available to reduce density when the soil is saturated (spring, fall and periods of heavy rainfall).

All-weather facilities

Remember that the facilities will be used year-round. To avoid having to shovel snow, either build roofed facilities or leave enough room for a tractor and snow blower to get around. A small heated room can be used for storing medication, records and so on.

Allowing wild boar to range in forested areas is possible, but at much lower densities, since the soil is more fragile. Meat production is more complex and expensive when the animals are kept this way. However, a copse of trees within a pen provides shade and protection from the wind. To protect the trees, fencing should be installed at least two metres from their base.

Fencing

In Québec, the *Regulation respecting animals in captivity* sets out provisions for the keeping of wild boar. Section 10 of the Regulation defines the required infrastructure as follows:

> *10. Anyone who keeps peccaries or boar in captivity without a licence shall erect and maintain an enclosure surrounded by a fence at least 1.8 m above ground level made of*
> *(1) steel chain links of minimum 13 gauge, 1.24 m high including 30 cm in the ground; the 86 additional centimetres may be made of game fence; or*
> *(2) steel chain links of minimum 13 gauge, from 92 cm to 1.24 m high and the 88 or 56 additional centimetres may be made of game fence; the enclosure must be fitted on the inside with an electric wire running between 15 and 45 cm above ground level situated 30 cm from the fence, and the minimum tension in the wire must be 10 joules.*
>
> *Furthermore, the perimeter fence of the enclosure must have no trap or barrier to capture animals outside the enclosure; in addition, the gates of the perimeter fence must remain close, even in the absence of animals.*

A chain-link Frost fence (Figure 1) is recommended, at least 1.8 m in height, ideally 2.4 m for perimeter fencing. The fence should extend at least 30 cm into the ground to prevent the wild boar from digging under it. At the top of a slope it should extend at least 60 cm into the ground, since the animals' rooting will tend to level the grade.

Figure 1. Chain-link fencing

Source: Juan Pablo Soucy

It is recommended to install one to three electrical wires at different heights from 15 to 40 cm above the ground, depending on the size of the animals, to prevent them from looking for weak spots in the fencing during the summer. Wires should be properly grounded and the electrical system checked regularly. If kept running over the winter, the posts should be tall enough for the height of the wires to be adjusted to the snow cover. It is possible to electrify rather than bury a fence, but this requires added vigilance when snow accumulates and before the ground is frozen.

FEEDING

Water

Clean, good quality water is the most important part of any animal's diet. In winter, wild boar can obtain adequate water by eating snow if there is enough of it. In a commercial operation however, fresh water is essential to achieving weight gain targets. In winter, readily available liquid water helps the animals conserve energy, while avoiding the consumption of soiled snow. An investment in quality, continuous-flow, heated water troughs will also save time and money, eliminating the labour of keeping water bowls filled, while preventing health problems caused by dirty water. The area around water troughs should be surfaced with stone, concrete or wood to avoid rooting and the accumulation of mud.

All watering systems, whether heated or not, should be regularly inspected throughout the winter to make sure they are working properly.

Tips

- In pens that are not used in winter, water supply pipes should be buried to 30 cm (or ideally below the frost line) to prevent the animals from digging them up. If they cannot be buried, run them along the base of the fence: growing forages will shade the pipe and keep the water cooler in summer.
- In areas that are used in winter, water pipes must be buried below the frost line (1.0 to 1.5 m, depending on the region).
- When designing pens, locate water troughs at the junction of two or more pens to lower costs: a single water pipe or even a single trough can serve multiple pens.
- Consistent flow along the pipe is necessary for all the animals to have ready access to water. Sometimes water can be very slow to reach the furthest point from the source. In hot weather, animals that are low in the hierarchy may lack adequate access to water.
- If standing water bowls are used, it is important to clean them regularly to avoid bacterial growth.

Feed troughs and feeding areas

If the feeding area is limited, animals that are low in the hierarchy will have difficulty accessing feed. To avoid this problem, it is recommended to allow about 40 cm of trough per head.

The most appropriate type of trough will depend on the feeding method chosen. A portable feed hopper (Figure 2) is best in a free-choice system, while a fence line trough is best for a mechanical or rationing system. Portable hoppers should be roofed to protect feed from the elements.

Figure 2. Portable feed hopper
Source: Juan Pablo Soucy

With a fully covered feeding area (Figure 3) the animals can be fed more easily, and monitoring the herd is simple. Watering facilities and fixed feed hoppers commonly used for hogs can be used for easier management and maintenance (Figure 4).

Feed troughs and hoppers are preferable to setting feed directly on the ground, where much feed would be wasted.

Figure 3. Covered outdoor feeding area
Photo: Juan Pablo Soucy

Figure 4. Fixed feed hopper
Photo: Juan Pablo Soucy

FARROWING

Sows must be separated from the rest of the herd during farrowing, and preferably sheltered. Simple outdoor shelters can be used (Figure 5) if they are well stocked with bedding (preferably straw) to allow the sows to nest. Access to a cold or heated barn (Figure 6) is the other option.

Figure 5. Simple outdoor farrowing shelter
Photo: Juan Pablo Soucy

Figure 6. Cold farrowing barn

Photo: Juan Pablo Soucy

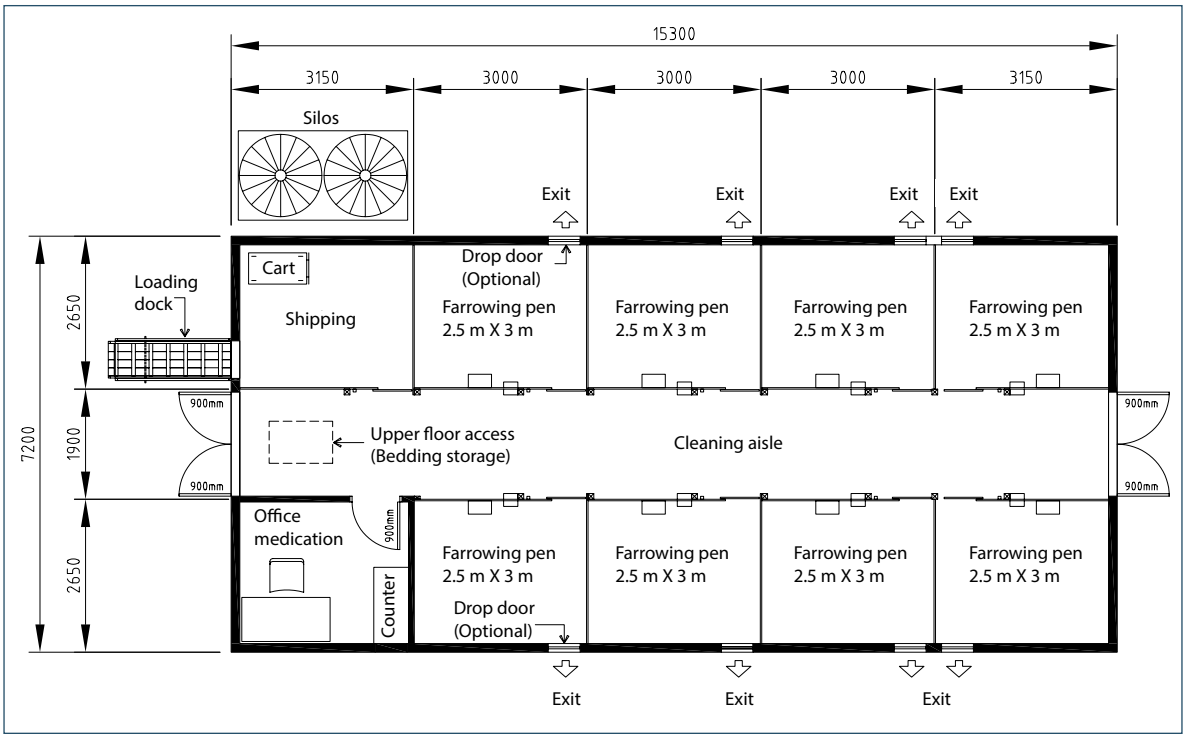


Figure 7. Farrowing barn

Source: Sébastien Cartier

The farrowing shelter or barn must include individual farrowing pens (Figures 7 and 8) providing at least 4 m² (ideally 6 m²) of floor space, with concrete, wood or plastic partitions at least 1.8 m high and 40 mm thick.

Floors should be sloped slightly, to ensure dry areas for piglets to lie down. The drinking trough or water bowl should be in the lower part of the pen. Whether heated or unheated, the trough or water bowl should be close to the door to allow for easier cleaning or ice removal in winter.

A wooden platform in the higher part of the pen will often encourage sows to nest there, especially since the ground will be warmer. The platform should be well anchored to prevent the sows from overturning it.

Providing access to outdoor runs and pens gives the animals an opportunity for exercise, but could increase drafts. With a small swinging door, they can go in and out at will while drafts are kept to a minimum.

In the farrowing barn, aisles can be narrow if they will cleaned by hand, but should be wide enough for a small tractor bucket if they will be cleaned mechanically.

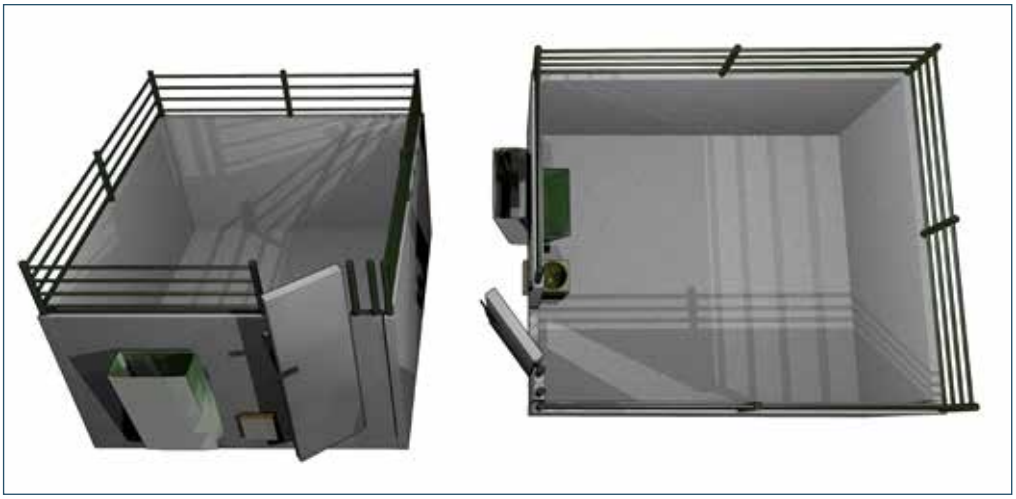


Figure 8. Farrowing pen
Source: Juan Pablo Soucy

NURSERY

A partially sheltered outdoor pen (Figure 9), or a cold barn opening onto one, can be used as a nursery for piglets between weaning and fattening. Since the piglets will be handled frequently (for tagging, treatments, etc.), the nursery should be designed to facilitate gathering the piglets and performing these interventions.

At this stage in the animals' life it is especially important that they have access to lots of good quality water, along with bedding and a dry resting area.

Figure 9. Basic outdoor shelter
Photo: Juan Pablo Soucy

HOLDING CRATE

The holding crate (Figure 10) immobilizes the animal for handling (tagging, vaccination, veterinary examination, etc.). Though some crates lack a stanchion and openings for handling, they may be suitable for weighing (Figure 11). Several models of hog crates can be adapted for use with wild boar, but so far none are available that were designed for that purpose.

Figure 10. Holding crate
Photo: Juan Pablo Soucy

Figure 11. Basic weigh crate
Photo: Juan Pablo Soucy

The ideal holding crate should:

- be of variable width to accommodate different-sized animals;
- have multiple openings in the top to allow handling without opening the top of the crate;
- lock automatically;
- have a self-latching door with an open section for light to get in and to allow the animal to see out;
- have multiple, easily accessible levers, for quick access by those working around the crate.

SORTING PENS

The sorting pen is an important component in any wild boar operation. In Québec, sorting pens usually consist of a single narrow aisle with one or two openings through which the animals can be directed toward handling pens and loading chutes.

A more advanced sorting pen is recommended in operations where a larger number of animals must be sorted, or where more contact with the animals is required.

LOADING DOCK

To facilitate shipping and receiving, producers should invest in a well-designed loading dock (inside width at least 45 cm; maximum floor slope 20 degrees). The loading dock must:

- be easy to access from the sorting pen;
- have anti-skid flooring to prevent slipping and falling;

- be adjustable to different vehicles (small trucks, semis, etc.);
- be well lit, since shipping is often done in the early morning;
- be curved if longer than 3 m;
- have high sides and a roof that lets light in (to avoid frightening the animals);
- be covered, or easy to clear of snow in winter.

SHIPPING CRATE

Not all shippers are equipped for wild boar. Producers should have their own shipping crates, whether of wood or metal, large enough to accommodate one or more wild boar, and easy to load on a van or trailer (Figure 12).

Figure 12. Shipping crate on a trailer
Photo: Juan Pablo Soucy

GATES, DOORS AND LOCKS

Doors and gates on all buildings and fences must be easy to open, and should latch automatically when closed. Gates must close quickly to prevent animals from returning or escaping.

Gates must:

- be visible to the wild boar;
- be located in the corners of pens;
- be adjustable in height so they can swing open over snow;
- open toward the outside of the pen, or ideally in both directions. If there is snow in the pen, start by removing snow from the outside, then open the gate to get in, close it, and finish snow removal inside.

Gates and drop doors are effective and easy to build, but should be equipped to lock into position securely whether open or closed. Always remember that wild boar are extremely strong and can lift heavy objects or pry open doors.

A variety of latches are available, but whichever you choose they should:

- latch securely as soon as the gate closes;
- open and close with one hand, even with gloves on;
- be designed so they cannot be opened by wild boar;
- continue to work properly despite frost or rust.

SHIELD

The use of a shield is strongly recommended when moving wild boar, for ease of handling and for the handler's protection. Shields can be made from 12 mm (½") thick plywood, with handles on both sides or on the back as preferred. Shield dimensions can vary depending on the width of aisles, but 60 to 90 cm (width) by 1.2 to 1.5 m (height) is usually effective, and light enough to be easy to use.

CONCLUSION

At first glance, all of the foregoing may seem very complex. But it is precisely these small, down-to-earth details, combined with a design that takes into account the natural behaviour of wild boar, that will make for safe equipment and an efficient, satisfying work environment.

BIBLIOGRAPHY

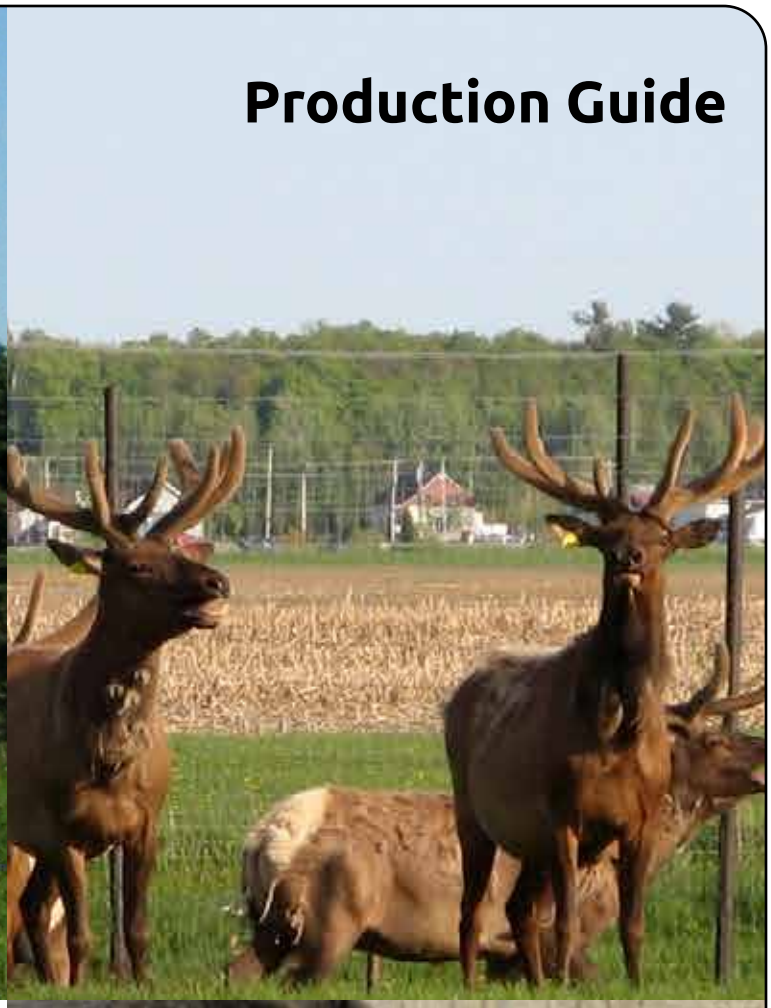
CPAQ. 1997. *Le Sanglier: guide d'élevage*. Conseil des productions animales du Québec. 113 pp.

FEGGQ. 2008. *La manipulation du sanglier*. DVD (42 min). Fédération des éleveurs de grands gibiers du Québec. Distrib. : Centre de référence en agriculture et agroalimentaire du Québec.

Gazette officielle du Québec. *Regulation respecting animals in captivity*. Act Respecting the Conservation and Development of Wildlife, Chap. C-61.1.

Keuling, O. 2009. *Managing wild boar – Considerations for wild boar management based on game biology data*. Ph.D. diss., Dresden University of Technology, Dresden, Germany.

Pinet, J.M. 2005. *L'élevage du sanglier de race pure*. ADEPRINA, Paris. 170 pp.



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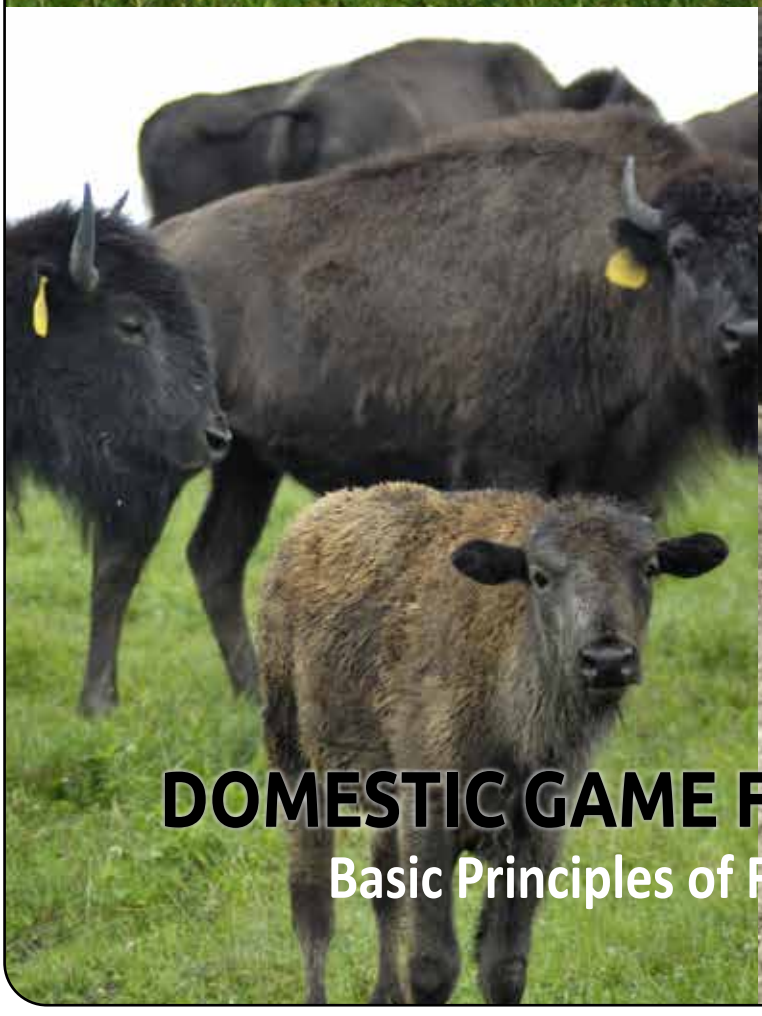

DOMESTIC GAME FARM ANIMALS

Basic Principles of Feeding and Nutrition

CRAAQ
CULTIVER L'EXPERTISE
DIFFUSER LE SAVOIR

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Juan Pablo Soucy (red deer and wapiti)
© **Etienne boucher**, MAPAQ (bison)
© **Michel Langlois**, MAPAQ (wild boar)

INTRODUCTION

Bison, wapiti (often called elk outside of Québec), red deer and wild boar are four species of large game that are raised in Québec for meat and other purposes. The same basic nutritional principles apply, whether to monogastrics like wild boar or to ruminants like bison, wapiti and deer: the animal ingests a given quantity of food composed of water and dry matter, the latter providing nutrients (energy, protein, minerals and vitamins). The importance of drinking water must be emphasized.

"DRY MATTER," "AS FED," "VOLUNTARY DRY MATTER INTAKE"

The percentage of water and dry matter (DM) in food varies widely. Hay for example is made up of 15% water and 86% DM. Ten kg of hay is therefore 8.5 kg of DM (the hay minus its moisture content), plus 1.5 kg of water, for a total of 10 kg. Concentrates (grain and commercial feed) contain less than 12% water, and thus over 88% DM. In contrast, forage can contain up to 80% water, for only 20% DM.

In animal nutrition, particularly for herbivores, nutritional value is expressed on a 100% DM base. A herbivore diet can include grazing, grass silage and hay, all of which have different moisture contents. Different food sources are therefore more easily comparable on a common basis of 100% DM.

Nutritional values can also be expressed on an "as-fed" basis (i.e. the nutrient content of the feed as it is fed). As for food intake, it is defined in terms of voluntary dry matter intake (VDMI), i.e. the quantity of dry matter voluntarily ingested by the animal over a given period.

NUTRIENTS

Energy

Food provides animals with energy essential to maintenance, growth and activity. The energy is obtained from food through the body's digestion of various elements, such as structural and non-structural carbohydrates (cellulose, hemicellulose and starch), fats (lipids) and proteins.

The energy content of food is expressed in calories (cal) or joules (J). One calorie is equivalent to 4184 joules. The terms kilocalorie (kcal), megacalorie (Mcal), kilojoule (kJ) and megajoules (MJ) are often used:

1 Mcal (or MJ) = 1000 kcal (or kJ) = 1 000 000 cal (or J).

Total energy intake is called gross energy (GE), and is not fully used by the body. Subtracting the energy excreted in the feces leaves the digestible energy (DE), which is used to calculate rations for wild boar. Apparent metabolizable energy (ME), which is used to calculate deer rations, is the digestible energy minus the energy lost in urine and gas. Lastly, the measurement used for calculating bison rations is net energy (NE), which takes into account the thermic effect, or "specific dynamic action" (SDA) of digesting food. Particularly in ruminants, a significant amount of heat can be produced during digestion. The efficiency with which NE is produced depends on the food source. NE can be subdivided in terms of how

the animal uses it; for example, NE can serve for maintenance (NEm), lactation (NEl), weight gain (NEg), and so on (Figure 1).

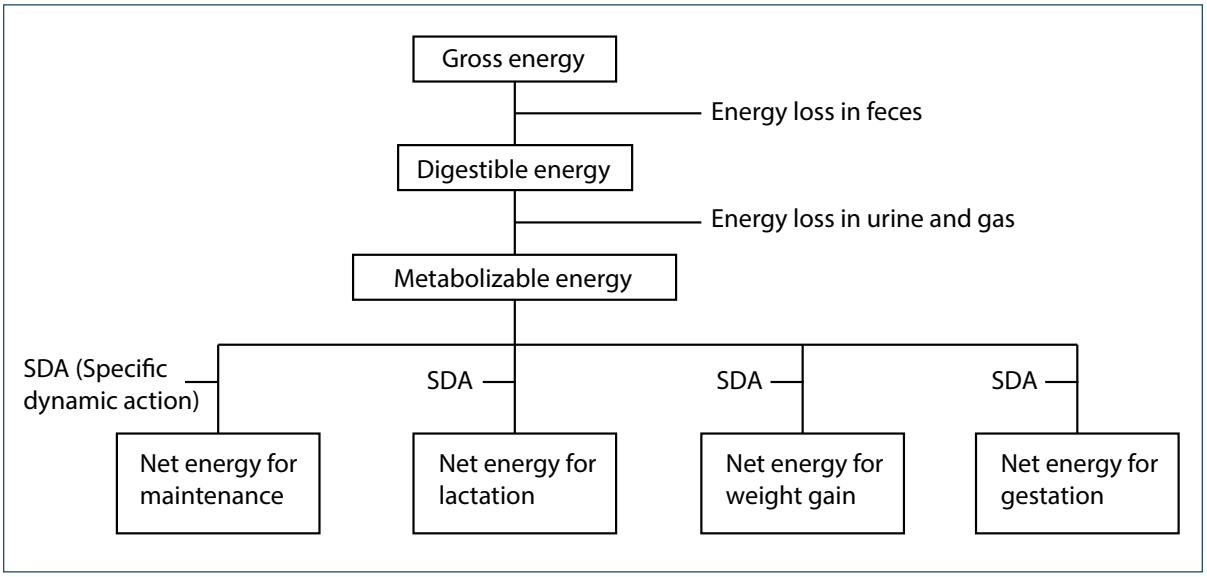

Figure 1. Energy use

Adapted from St-Pierre and Bouchard, 1980

Protein

Like energy, proteins are essential to maintenance, as well as for muscle and bone growth and for tissue repair. Besides playing a structural role, proteins also serve metabolic functions (enzymes, immunoglobulin, etc.). All proteins are composed of a series of peptides, which in turn are made up of combinations of the 20 amino acids involved in protein formation:

Aspartic acid	Isoleucine
Glutamic acid	Leucine
Alanine	Lysine
Arginine	Methionine
Asparagine	Phenylalanine
Cysteine	Serine
Cystine	Threonine
Glutamine	Tryptophan
Clycine	Tyrosine
Histidine	Valine

Monogastrics like wild boar digest the protein in food to extract amino acids, which are then absorbed and reassembled according to the animal's needs. While the body can synthesize some amino acids,

others (known as "essential" amino acids) are only available from food. "Limiting" amino acids are those that are not present in food in sufficiently high quantities (as in the case of lysine, for wild boar).

Gross protein (%GP) refers to the protein content of a given food. In ruminants (deer and bison), a significant portion of the gross protein can be degraded by rumen bacteria, and is therefore referred to as rumen degradable protein (RDP). The resulting microbial proteins then supply the animal's protein requirements. Other proteins, called non-degradable proteins, arrive intact in the abomasum (or rennet-bag), and are digested as they are in monogastrics. Finally, proteins that are not degraded in the rumen or digested in the abomasum are eliminated in the feces. Rumen bacteria can also transform nitrogen from non-protein sources such as urea into microbial protein.

Minerals

Major minerals and trace elements (i.e. dietary minerals that are needed in very small quantities) are integral nutritional components involved in structural and metabolic functions (Table 1). Most minerals are obtained from food sources. Intake of calcium and phosphorus, significant amounts of which are needed by the body, must be monitored particularly closely. Deficiencies in iodine and selenium may also occur, due to the low levels of these trace elements in Québec soil.

Note that there are both positive and negative interactions between various elements, and that cervids are sensitive to copper deficiency.

Table 1. Basic functions of minerals

Mineral	Primary functions
Major minerals	
Calcium (Ca)	Bone and tooth formation, muscle contractions, milk production
Phosphorus (P)	Bone and tooth formation, energy metabolism, enzyme activity, DNA
Magnesium (Mg)	Bone development, enzyme activator (reduction of blood pressure)
Sodium (Na)	Cellular acid/base balance, muscle contractions, bile production
Chlorine (Cl)	Cellular acid/base balance, gastric juices (HCl)
Potassium (K)	Cellular osmotic pressure, muscle tone, enzymes, carbohydrate metabolism
Sulphur (S)	Sulphur-containing amino acids, lipid and carbohydrate metabolism
Trace elements	
Cobalt (Co)	Ruminants: vitamin B_{12} synthesis by rumen bacteria
Copper (Cu)	Hemoglobin formation, enzyme activity, hair, bone development
Iodine (I)	Thyroxin production by the thyroid
Iron (Fe)	Transports oxygen in the blood (hemoglobin)
Manganese (Mn)	Bone formation, growth and reproduction, enzyme activity, amino-acid and energy metabolism
Selenium (Se)	Antioxidant (with vitamin D), fertility, immune system
Zinc (Zn)	Enzyme activity for protein synthesis

Adapted from Saskatchewan Agriculture, 2000

Vitamins

Vitamins are organic compounds classified as either water-soluble (vitamins C and B-complex) or fat-soluble (vitamins A, D, E and K). Vitamins serve various metabolic functions (Table 2). Most are obtained from food, while some are synthesized by the body (notably vitamin D, synthesized with the help of sunlight, and vitamin K). In ruminants, rumen bacteria synthesize the B-complex.

Table 2. Basic functions of vitamins

Vitamins	Primary functions
Fat-soluble vitamins	
A	Vision, integrity of mucous membranes, immunity
D	Calcium and phosphorus metabolism
E	Cellular respiration, antioxidant, membrane integrity
K	Normal blood clotting
Water-soluble vitamins	
Thiamine (B_1)	Nervous system, carbohydrate and protein metabolism
Riboflavin (B_2)	Antioxidant, ligament integrity
Niacin (B_3)	Carbohydrate, protein and lipid metabolism, cellular respiration, skin integrity
Pantothenic acid (B_5)	Amino-acid metabolism (coenzyme A), skin integrity
Pyridoxine (B_6)	Protein metabolism
Biotin (B_7)	Carbohydrate, protein and lipid metabolism
Folic acid (B_9)	Methyl-group reactions
Choline	Phospholipid metabolism
Cobalamine (B_{12})	Protein metabolism
Ascorbic acid (C)	Antioxidant, Vitamin D metabolism

Sources: Nutrient Requirements of Swine (NRC, 1998); Nutrient Requirements of Beef Cattle (NRC, 2000)

Water

Water is essential to life, milk production and nutrient absorption. Free access to good quality water at all times is crucial, and all the more so in the warm summer months. Troughs should be cleaned as often as possible. Creeks, ponds and dugouts should not be used as sources of water, since animal activity along the edges causes erosion (increasing the risk of injury to limbs), and pollutes the water (increasing the transmission of water-borne disease). It is prohibited in Québec for livestock to have access to bodies of water.

Water should be monitored frequently for clarity, odour and taste. If any of these become abnormal, and/or as part of the annual prevention protocol, chemical and bacteriological analyses should be done. Table 3 outlines the basic water quality guidelines for livestock.

Water pH is also important. On a scale from 1 to 14, with neutral pH being 7, acidity increases as pH drops (from 7 to 1), while alkalinity increases as pH rises (from 7 to 14). The acceptable range for water pH is 6.5 to 8.5.

For sound water management, the flow of water in the troughs should be monitored regularly, and their height adjusted if the animals are on accumulated litter. Troughs that are too low will become contaminated, which will ultimately reduce performance.

Daily water consumption varies depending on the water content of feed, water temperature, ambient temperature, animal weight, trough type, etc.

Table 3. Water quality guidelines for livestock

Substance	Maximum recommended amount (mg/L)
Aluminium (Al)	5.0
Arsenic (As)	0.5
Beryllium (Be)	0.1
Boron (B)	5.0
Cadmium (Cd)	0.02
Calcium (Ca)	1 000.0
Chromium (Cr)	1.0
Cobalt (Co)	1.0
Copper (Cu)	0.5 - 5.0[1]
Fluorine (F)	2.0
Mercury (Hg)	0.003
Molybdenum (Mo)	0.5
Nickel (Ni)	1.0
Nitrate and nitrite	100.0
Nitrite alone	10.0
Lead (Pb)	0.1
Selenium (Se)	0.05
Sulphate	1 000.0
Uranium (U)	0.2
Vanadium (V)	0.1
Zinc (Zn)	50.0
Total Dissolved Solids (TDS)	3000.0

1. 0.5 mg/L for sheep; 1.0 mg/L for cattle; 5.0 mg/L for swine and fowl.

Sources: Manitoba Agriculture, Food and Rural Initiatives; FAO, 2002

CONCLUSION

It is important to understand that an animal ingests a certain quantity of food on an "as-fed" basis, and the dry matter contained in that food is what provides the nutrients it needs (energy, protein, minerals and vitamins). Also, we must always remember that water is an essential nutrient, one to which producers must pay special attention.

BIBLIOGRAPHY

Deerfarmer.com. 2003. *Nutrition requirements for deer and elk* [online]. http://www.deer-library.com/artman/publish/article_117.shtml (accessed December 1, 2010).

FAO. 2002. *Agriculture drainage water management in arid and semi-arid areas* [online]. ftp://ftp.fao.org/agl/aglw/docs/idp61e.pdf (accessed April 1, 2011).

Manitoba Agriculture, Food and Rural Initiatives. *Evaluating water quality for livestock* [online]. http://www.gov.mb.ca/agriculture/livestock/nutrition/bza01s06.html (accessed March 31, 2011).

NRC. 2000. *Nutrient Requirements of Beef Cattle*. 7th Revised Edition (updated 2000). Washington, DC: National Research Council, The National Academies Press. 248 pp.

NRC. 1998. *Nutrient Requirements of Swine*. 10th Revised Edition. Washington, DC: National Research Council, The National Academies Press. 212 pp.

Saskatchewan Agriculture. 2000. *Basic Nutrition of Bison* [online]. http://www.agriculture.gov.sk.ca/Default.aspx?DN=a9cc6e39-55ae-4a69-8cc9-4e9f03cab44f (accessed December 1, 2010).

St-Pierre, N. and R. Bouchard. 1980. *Nouveaux concepts utilisés dans le calcul de la ration laitière*. Dairy Cattle Symposium. Conseil des productions animales du Québec. pp. 53–67.

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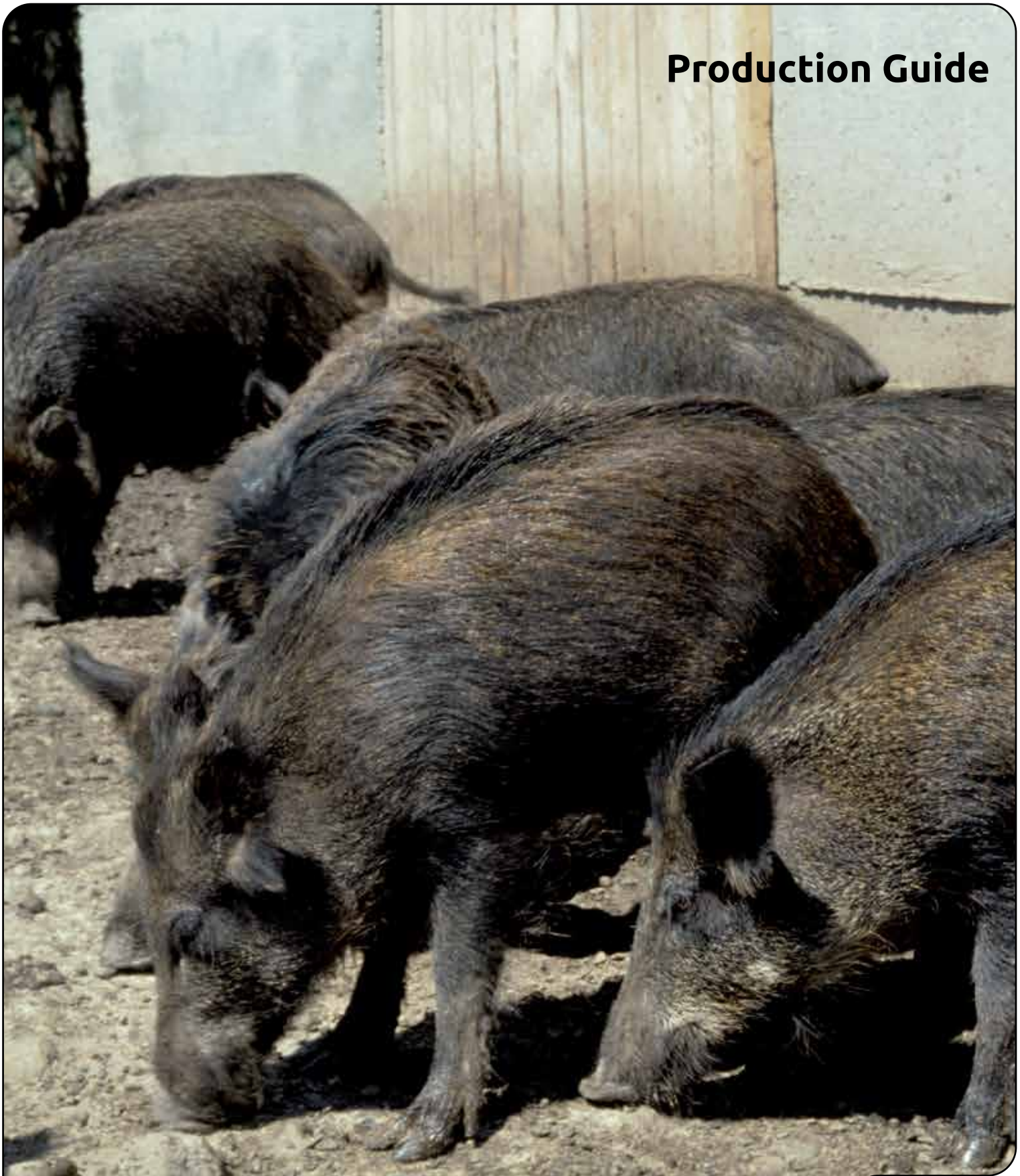

DOMESTIC GAME FARM ANIMALS

Feeding and Nutrition – Wild Boar

CRAAQ
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INTRODUCTION

The information and recommendations in this leaflet were produced by a committee, based on the authors' expertise in animal nutrition and wild boar farming in Québec, and drawing from various publications on wild boar nutrition.

WILD BOAR AND FARMED WILD BOAR

In their natural habitat, wild boar are opportunistic omnivores. Depending on seasonal availability and what they find, their diet may include acorns, beechnuts, nuts, bulbs, mushrooms, fruit, grain, potatoes, roots, greenery, insects, worms, bird eggs, amphibians, reptiles, small mammals and even animal carcasses.

In Québec, for the most part wild boar farming is practised intensively on farms with outdoor pens, for meat production. Occasionally wild boar are also raised for hunting. The feeding of wild boar must prioritize muscle development, carcass quality (lean, fat) and gain rates (growth). Because the animal is omnivorous, unlike ruminants its ability to digest fibre is extremely limited. Wild boar must therefore be fed grain primarily, with protein supplementation. Forages should not be used as a complement, and should only account for a small portion of the total ration.

GROWTH OBJECTIVES AND ZOOTECHNICAL PERFORMANCE

There is little information about the nutritional needs and feeding protocols for wild boar. Data are often extrapolated from the needs of domestic pigs. However, over the past few years the monitoring of wild boar operations in Québec has allowed a growth curve to be determined (Figure 1).

Currently, the target slaughter weight for wild boar is about 90 kg, which is reached at 450 to 550 days. Some producers achieve their targets at 450 days, suggesting an average gain of 200 g/day between weaning and slaughter, with dual phase feeding and weaning at around 40 days. This target is realistic in a commercial production context. For hunting, the target weight is 45 kg to 50 kg, reached at approximately 250 days (from 200 to 300 days depending on genetics and nutrition).

Growth and performance data from three different lines were assessed at the Deschambault research facility, and compared until slaughter at approximately 70 kg (Cormier and Bergeron, 2002). Animals achieved average daily gains of 320 g per animal between weaning (5.3 kg) and 70 kg (Table 1). This information provides producers with a basis for comparison, while giving nutritional experts the basic information needed to develop nutritional programs and feed specifications. The results also suggest that in ideal conditions, producers should be able to achieve gain improvements.

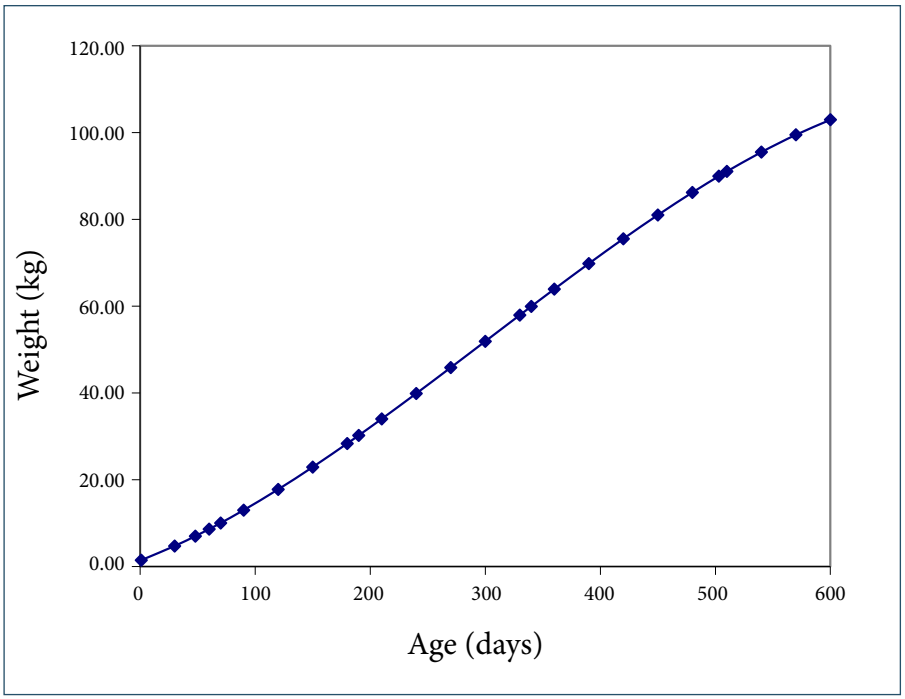

Figure 1. Growth curve derived from wild boar farming operations in Québec (based on 473 data points from six farms)

Source: Soucy, 2008

Table 1. Growth of three wild boar lines[1]

Criterion	Line		
	San Diego	Peter Kalder	Scandinave
Food intake (kg/day)	1.44[b]	1.32[b]	1.65[a]
Average daily gain (kg/day)	0.29[b]	0.29[b]	0.39[a]
Feed efficiency (kg food/kg weight gain))	4.94[a]	4.60[b]	4.20[c]

1. In the same line, the monitored values vary significantly ($P<0.05$).

Adapted from Cormier and Bergeron, 2002

Table 2 outlines current zootechnical performance in Québec.

Table 2. Current zootechnical performance of wild sows and boars in Québec

Performances	
Lactation	
Birth weight	1.4 kg
Weaning weight (42 to 50 days)	5 à 7 kg
Weight of sows at farrowing	125 kg
Average daily food intake of lactating sows	3 à 5 kg/day
Average daily food intake of pregnant sows	1.6 - 2.2 kg/day depending on season and gestation stage
Growth	
Weight at slaughter	90 kg
Average daily intake weaning-to-slaughter	1.2 kg/day
Age at slaughter	450 à 550 days
Average daily gain weaning-to-slaughter	165 à 200 g/day
Feed efficiency weaning-to-slaughter	4.6 kg feed/kg weight gain

NUTRITIONAL RECOMMENDATIONS

The nutritional needs of wild boar vary depending on their stage of development, and feed should be adapted to the needs of each. Table 3 outlines the recommended feed for each stage.

Fresh-cut grass may be fed to pregnant sows to complement high-quality meal. Fibre-rich feed (herbage) fed at weaning will ease the transition to breeding rations or to a moderate diet. Practical experience has shown that it is challenging for producers to manage more than three separate rations. In this case, wild boar piglets and juveniles should be fed wild boar piglet rations, growers and finishers should be fed finishing rations, and all breeding animals should be fed breeding rations. However, this feeding spectrum will not lead to optimum performance.

Current observations suggest that sows may experience significant weight loss during lactation. As with other lactating females, such weight loss can be expected to interfere with reproductive capacity (return to estrus, litter size) for subsequent litters, as well as hierarchical position in the group. Lactating sows should therefore be given free access to feed designed for their needs, i.e. that is rich in energy and protein. Sows that are extremely underweight at weaning should be temporarily overfed.

While a complete feed incorporating vitamins and mineral concentrates will meet the animals' nutritional needs, salt or mineral blocks can be provided to wild boar that are on pastureland or in large pens. Urea-free blocks are preferable, as are those without molasses, which tend to promote over-consumption. Clean, good-quality water should always be available, in winter as in summer, whether the animals are housed indoors or kept in outdoor pens.

In Québec, certain feed mills offer complete boar rations, and some even sell tailor-made mixes on request when volumes warrant. The animal nutritional experts at these mills can help producers develop the best feed for their animals.

Table 3. Nutritional recommendations for farmed wild boar, by growth stage

Animal Category	Description[1]	Weight (animals)	Recommended feed	Feeding method
Unweaned wild boar piglets	Piglets with their mother until weaning (42 days)	Approx. 5 – 7 kg	Piglet prestarter Iron injections recommended	Free access
Weaned wild boar piglets	Weaning to 70 days	7 – 10 kg	Wild boar piglet rations	Free access
Growing juveniles	70 – 190 days	10 – 30 kg	Wild boar piglet rations	Two meals
Growth	190 – 355 days	30 – 60 kg	Growth rations	Two meals
Finishing	355 days to slaughter (approx. 450 days)	60 kg to slaughter (approx. 90 kg)	Finishing rations	Two meals
Pregnant sows and males	Between mating and farrowing		Breeding rations	Once per day
Lactation	Between farrowing and weaning		Breeding rations or ideally feed developed for lactating wild sows	Two times per day, free access

1. Depending on production conditions and genetics, growth rate may vary ±25%. The recommendations in this table apply to a target of 90 kg in 450 days.

FEEDING PROGRAM AND PERFORMANCE

Table 4 outlines a model weaning-to-slaughter feeding program for wild boar. It was developed on the basis of the growth objectives in Figure 1, but with a target weight of 90 kg after 450 days.

Table 4. Model weaning-to-slaughter feeding program for wild boar

	Unweaned wild boar piglet ration[1]	Wild boar piglet ration	Growth ration	Finishing ration	Total[2]
Starting weight (kg)		7	30	60	7
Weight at end of growth phase (kg)	7	30	60	90	90
Duration of growth phase (days)	Based on age at weaning	148	130	130	408
Age at end of growth phase (days)	42	190	320	450	450
Meal throughout growth phase (kg/animal)	8	78	140	165	383
Daily meal (kg/animal/day) (excl. waste)[3]	Variable	0.53	1.08	1.27	0.94
Average daily gain (kg/animal/day)	0.132	0.155	0.231	0.231	0.203
Feed efficiency (kg feed/kg weight gain)	Variable	3.40	4.67	5.50	4.62

1. Piglet prestarter.
2. Excl. unweaned wild boar piglet ration.
3. Approximately 5% to 20% of feed is wasted; rations should be increased accordingly.

Unweaned wild boar piglet rations should be offered to piglets and sows at about one week prior to weaning, to transition the piglets onto solid food. To adapt to solids, piglets need to see their mother eating the same food; this also seems to facilitate dry-up and promote a healthy return to sexual activity.

To be able to define nutritional specifications for each growth stage, one must first establish a deposition curve for lean and fat in carcasses throughout the animals' growth. Since there is no such information for wild boar, specifications must be derived from information currently available in the literature.

Table 5 presents the main nutritional characteristics of wild boar rations. The crude protein levels are minimums, and assume ideal amino-acid intake. Table 6 outlines the vitamins and minerals usually added to feed, depending on growth stage. Table 7 provides recommended ratios between the primary amino acids and lysine for ideal lean growth (meat production) and milk synthesis (lactating sows). Protein (muscle, milk) has a relatively constant amino-acid composition, reflected by ideal protein. Due to its limited contribution to metabolic processes other than those involved in body protein, lysine serves as a stable reference to express relationships between amino acids.

Note that standards may vary between providers, and will be fine-tuned as new research results become available. It is always recommended that producers consult nutritional experts to verify feed specifications. Note too that many producers provide vegetables or grain as complements, in which case rations should be adjusted accordingly.

Table 5. Recommendations for wild boar feed, by nutritional profile

Food	Digestible energy, per kg feed[1]	Crude protein (%)	Total lysine / digestible energy	Calcium (%)	Phosphorus (%)	Sodium (%)
Start	3 200 kcal (13.3 MJ[2])	18.5	3.45	0.70	0.55	0.19
Growth	3 050 kcal (12.7 MJ)	15.5	2.80	0.60	0.50	0.17
Finishing	3 050 kcal (12.7 MJ)	13.0	2.20	0.52	0.45	0.15
Breeding-specific	3 050 kcal (12.7 MJ)	15.0	2.55	0.90	0.55	0.22
Lactation	3 150 kcal (13.2 MJ)	15.5	2.70	0.90	0.55	0.22

1. Minimum guidelines; may be exceeded depending on grain and other feed source market conditions.
2. Megajoule.
Adapted from Pinet, 2005 and CRAAQ, 2003

Table 6. Vitamins and minerals added to commercial feed[1]

Nutrient	Typical dosage – Growth	Typical dosage – Reproduction
Vitamin A (IU/kg)	7 500	10 000
Vitamin D (IU/kg)	1 000	1 500
Vitamin E (IU/kg)	30	50
Selenium (mg/kg)	0.3	0.3
Zinc (mg/kg)	100	150
Manganese (mg/kg)	40	60
Copper (mg/kg)	20	25
Iron (mg/kg)	75	100
Iodine (mg/kg)	0.5	2
Cobalt (mg/kg)	0.25	0.5

1. Other vitamins added: vitamin K, choline, thiamine (B1), riboflavin (B2), niacin, pantothenic acid, pyridoxine (B6), vitamin B12, biotin and folic acid.

Table 7. Lysine: amino acid ratios for protein deposition (meat production) and milk synthesis

Amino acids	Protein deposition	Milk synthesis
Lysine	100	100
Methionine	27	26
Methionine + Cysteine	55	45
Threonine	60	58
Tryptophan	18	18
Valine	68	85

Adapted from NRC, 1998

COMPLETE RATION RECIPES

Complete, milled rations include several ingredients: grain, protein-rich meal, fibrous by-products, minerals, vitamins and salt. In Québec, producers certified by the *Grands Gibiers du Québec certifiés*™ program must also comply with animal feed standards. For example, nutritional programs must be approved by a professional, and growth enhancers, sub-therapeutic (preventive) doses of antibiotics, flours, animal fats or urea are prohibited.

Though feed recipes can vary from one supplier to the next, an assortment of formulas for wild boar feed are presented here as a reference (Table 8), all being in line with the nutritional recommendations in Table 5. Producers who prefer to obtain their own grain and mix their rations themselves can work from the formulas below and use macro-premixes for hogs to add vitamins and minerals. Two energy levels are presented, to allow producers to lower feed costs by using less expensive ingredients when available and advantageous (good nutrient/price ratio). For example, for wild boar piglet rations either formula may be used, or combined 50-50 etc., to obtain an intermediate formula. Large quantities of energy-rich feed can help improve weight gain or produce fatter carcasses. Producers should adjust the formulas based on their own production targets, and if need be can discuss energy levels or nutritional program adjustments with a nutritional advisor.

Table 8. Examples of feed formulas for wild boar

	Piglets		Growing Boars		Finishers		Breeders	
	Low energy	High energy	Low energy	High energy	Low energy	High energy	Lone	Lactation
Ingredients per 1000 kg mix (kg)								
Corn[1]	361	677	163	755	437	817	228	393
Barley	361		675		436		600	393
Soybean meal	250	295	137	220	105	161	137	179
Macro-premix Grower 25	28	28	25	25	22	22		
Macro-premix Breeder 35							35	35
Typical nutrient profile (as-fed)								
Crude protein[2] (%)	18.6	19.4	15.4	16.0	13.1	13.6	14.9	15.7
Digestible energy per kg feed	3 210 kcal (13.4 MJ[3])	3 385 kcal (14.2 MJ)	3 060 kcal (12.8 MJ)	3 365 kcal (14.1 MJ)	3 055 kcal (12.8 MJ)	3 360 kcal (14.1 MJ)	3 055 kcal (12.8 MJ)	3 155 kcal (13.2 MJ)
Crude fibre (%)	3.6	2.7	4.3	2.7	3.7	2.0	4.1	3.6
Calcium (%)	0.7	0.7	0.6	0.6	0.5	0.5	0.9	0.9
Phosphorus (%)	0.55	0.55	0.50	0.50	0.45	0.45	0.55	0.55
Sodium (%)	0.20	0.20	0.17	0.17	0.15	0.15	0.22	0.22
Vitamin A (IU/kg)	8 400	8 400	7 500	7 500	6 600	6 600	12 000	12 000
Vitamin D (IU/kg)	1 125	1 125	1 000	1 000	880	880	1 500	1 500
Vitamin E (IU/kg)	38	38	35	35	30	30	65	65
Lysine (%)	1.11	1.16	0.86	0.95	0.70	0.77	0.78	0.85

1. One of corn, wheat or barley may be used in a feed formula as the sole source of energy.
2. Takes into account the synthetic lysine found in the premix.
3. Megajoule.

DEVELOPMENTS IN WILD BOAR NUTRITION

In swine production there is a clear connection between carcass quality and nutrition, and the same is almost certainly true for wild boar. Since feed accounts for a significant portion of production costs (50% to 75%), studies are being done in Québec toward developing rations that would lower feed costs without compromising carcass quality and meat yield. Over the next few years, precise recommendations should emerge that will benefit the entire industry.

BIBLIOGRAPHY

Animaux.org. Sanglier [online]. http://animaux.org/sanglier.htm (accessed April 15, 2011).

Baudet, E. 2007. *Alimentation naturelle ou artificielle: quels effets sur la dynamique de populations de sangliers?* [online]. Symposium on wild boar management, March 1 and 2, 2007, Reims, France. Office national de la chasse et de la faune sauvage et Fédération nationale des chasseurs. http://www.colloque-sanglier.com/documents/acte%20baubet%202.pdf (accessed April 18, 2011).

Belzile, M. 1991. *Généralités sur l'élevage du sanglier*. Working document. Ministère de l'Agriculture, des Pêcheries et de l'Alimentation.

Brandt, S., E. Baudet, J. Vassant and S. Servanty. 2006. *Régime alimentaire du sanglier en milieu forestier de plaine agricole*. Faune Sauvage 273: 20–26.

Cormier, I. and R. Bergeron. 2002. *Évaluation en station de trois lignées de sangliers au point de vue productivité, qualité de la viande et comportement*. Colloque sur les grands gibiers, February 16, 2002, Drummondville, Québec. Centre de référence en agriculture et agroalimentaire du Québec. p. 75–80.

CRAAQ. 2003. *Le sanglier*. Centre de référence en agriculture et agroalimentaire du Québec.

Fédération des éleveurs de grands gibiers du Québec. *La certification Grands gibiers du Québec certifiés*[MD] *(Résumé pour les éleveurs intéressés à adhérer au programme)* [online]. http://www.grandsgibiers.com/meganet/media/docs/pdf/resume_certification_eleveurs.pdf (accessed April 18, 2011).

Ferme d'élevage Sangliers des Bois [online]. http://www.sanglier.qc.ca/sangliersdesbois (accessed April 15, 2011).

Fillion, R. 1997. *Nutrition et alimentation*, in "Le sanglier: guide d'élevage". Collection grands gibiers domestiques. Conseil des productions animales du Québec. p. 73–86.

Hodgkinson, S.M., I.F. López and S. Navarrete. 2009. *Ingestion of energy, protein and amino acids from pasture by grazing European wild boar in a semi-extensive production system*. Livestock Science 122: 222–226.

Hodgkinson, S.M., M. Schmidt and N. Ulloa. 2008. *Comparison of the digestible energy content of maize, oats and alfalfa between the European wild boar (Sus scrofa L.) and Landrace x Large White pig* (*Sus scrofa domesticus*). Animal Feed Science and Technology 144: 167–173.

Kapela ski, W., L. Costanza, M. Bocian, K. Siemieniecka and G. Maiorano. 2007. *Nutritional and physico-chemical meat properties of wild boar (Sus scrofa ferus) x Duroc pig slaughtered to different live weights*. Ital. J. Anim. Sci. 6 (Suppl. 1): 691.

L'alimentation du sanglier [online]. http://www.chasseacrw.be/Gibier/Sanglier08.asp (accessed April 15, 2011).

Le sanglier [online]. http://www.jyrousseau.com/sanglier.shtml (accessed April 15, 2011).

Long, D.B., T.A. Campbell and G. Massei. 2010. *Evaluation of Feral Swine – Specific Feeder Systems*. Rangelands 32(2): 8–13.

Marché de fournitures courantes et services – Cahier des clauses techniques particulières (aliments pour les sangliers) [online]. 2010. Établissement public du Domaine national de Chambord. http://www.chambord.org/upload/pagesstatiques/fichiers//2009-26/ccpt2010_3.pdf (accessed April 18, 2011).

NRC. 1998. *Nutrient requirements of swine. 10th Revised Edition*. Washington, DC: National Research Council, The National Academies Press. 189 p.

Pépin, D. 1991. *Alimentation, croissance et reproduction chez la laie: études en conditions naturelles et en captivité*. INRA Prod. Anim. 4.2: 183–189.

Pépin, D., and R. Mauget. 1989. *The Effect of Planes of Nutrition on Growth and Attainment of Puberty in Female Wild Boars Raised in Captivity*. Anim. Reprod. Sci. 20: 71–77.

Pinet, J.M. 2005. *L'alimentation*, in "L'élevage du sanglier de race pure". Paris: Editions de l'ADEPRINA. p. 77–95.

Pinet, J.M. 1990. *Analyse stratégique de la filière venaison*. Institut national agronomique. Paris: Laboratoire de la faune sauvage.

Schley, L. and T.J. Roper. 2003. *Diet of Wild Boar Sus scrofa in Western Europe, with particular reference to consumption of agricultural crops*. Mammal Rev. 33(1): 43–56.

Soucy, J.P. 2008. *L'alimentation du sanglier* (*Sus scrofa*) [online]. Literature review. Agronor Services Agronomiques S.A. 15 pp. http://www.agronor.ca/media-agronor/uploads/files/revuecorr-feb2011.pdf (accessed April 18, 2011).

Teillaud, P. 1986. *Stratégies alimentaires et statut social chez le sanglier en captivité*. Behavioural Processes 12: 327–347.

Van Wieren, S.E. 2000. *Digestibility and voluntary intake of roughages by wild boar and Meishan pigs*. Animal Science 71: 149–156.

Weiler, U., R. Claus, S. Schnoebelen-Combes and I. Louveau. 1998. *Influence of age and genotype on endocrine parameters and growth performance: a comparative study in Wild Boars, Meishan and Large White boars*. Livestock Production Science 54: 21–31.

Wild boar production [online]. CALU Technical Notes. http://www.calu.bangor.ac.uk/Technical%20leaflets/040901%20wildboar.pdf (accessed April 18, 2011).

Wolkers, J., T. Wensing, G.W. Groot Bruinderink and J.T. Schonewille. 1994. *The effect of undernutrition on haematological and serum biochemical variables in wild boar (Sus scrofa)*. Comp. Biochem. Physiol. Comp. Physiol. 108(2/3): 431–437.

Wolkers, J., T. Wensing, J.T. Schonewille and A.T. van't Klooster. 1994. *Undernutrition in relation to changed tissue composition in wild boar (Sus scrofa)*. Comp. Biochem. Physiol. Comp. Physiol. 108(2/3): 623–628.