

AGRI-BIODIVERSITY INDICATORS USED IN POLAND

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Abstract

Monitoring of global changes and selection of target areas need a specific agri-environmental indicators. Concerning genetic diversity traditional indicators used for evaluation of progress in production and breeding can be apply. However they should be supplemented by more specific data. Universally available indicators capture only a part of genetic diversity. Though indicators which cover the diversity of crop varieties reveal that diversity has increased, data on genetic erosion suggest significant losses of its indigenous part.

The total number of breeds and varieties within species may provide an indication on the species diversity maintained in the country. However the number of breeds alone is not sufficient to demonstrate the real situation regarding given species in the long-term perspective and should be always combined with breed distribution within the total population.

Key words

Agri-environmental indicators, biodiversity, genetic diversity, livestock, crops, genetic resources

Introduction

The areas of agricultural production which cover about 60% of Poland (18.650.00 ha) are subject of intensive ecological processes impacting upon the preservation of biological diversity. Recent years have seen agriculture transformed to meet to conditions of the market economy. Conservation of biodiversity in agricultural environment is very new task for biodiversity conservation in Poland. Monitoring of the environmental performance of agriculture and assessing the environmental effects of policies requires information on agri-environmental interaction. Indicators of genetic diversity are indispensable for selection of target areas and assessment of effects of applied methods.

The data regarding areas of particular crops and fields structure comes from an annual agricultural census carried out by the Central Office of Statistics. The National Register of Cultivated Plants provides information on number of registered varieties of agricultural plants. Surveys of seed market and farmers practise provide information on real utilization of effects of breeding in practice. Studies on distribution of landraces are carried on by the National Centre for Plant Genetic Resources.

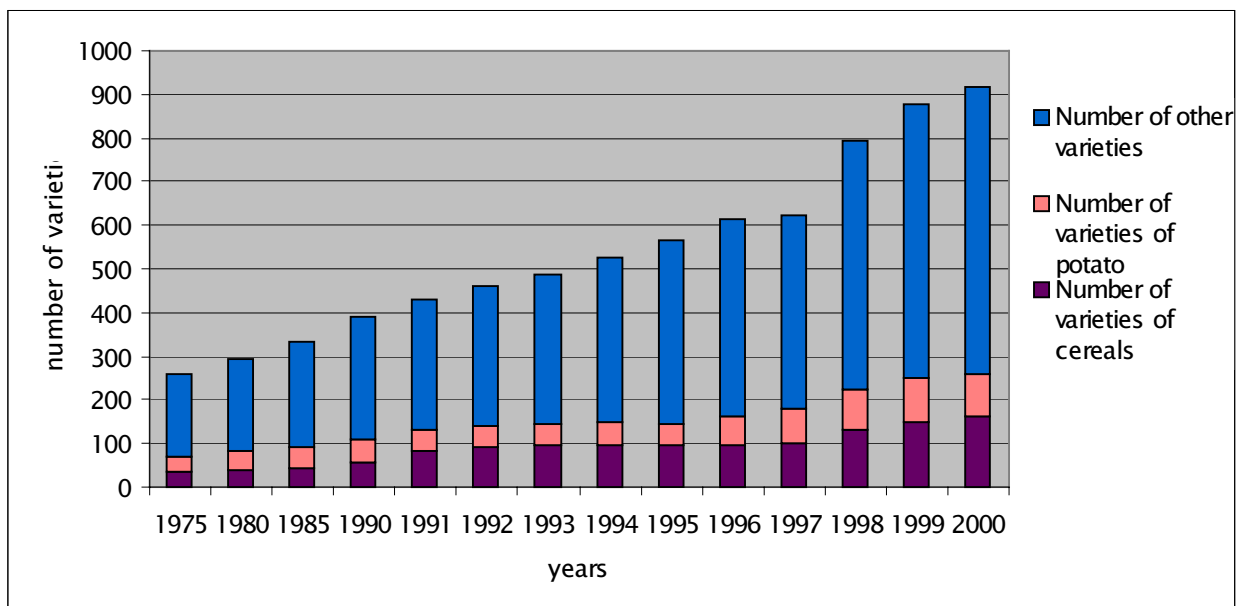
The census provides information on stock number of major farm animal species, and in case of large animals, also on the sex and basic age categories. The basic and the most reliable source of information on breed performance come from the official recording scheme carried out in the active animal population. The breed structure, observed in the pedigree sector, is transposed into the whole population of given species. In the case of cattle, pigs,

poultry, bees and fur animals, the National Animal Breeding Centre used to be in charge of recording and selection programmes, while the Polish Sheep Breeders' Society and Polish Horse Breeders' Association are responsible for performance recording and herd books in their respective species. Additional ways, which might be used to predict breed structure and population trends regard the production of breeding stock, the number of animals registered in a given region in the case of geographically restricted populations, or come from direct monitoring, when breed number is very small and animals are kept in several herds only.

Plant Genetic Resources Indicators

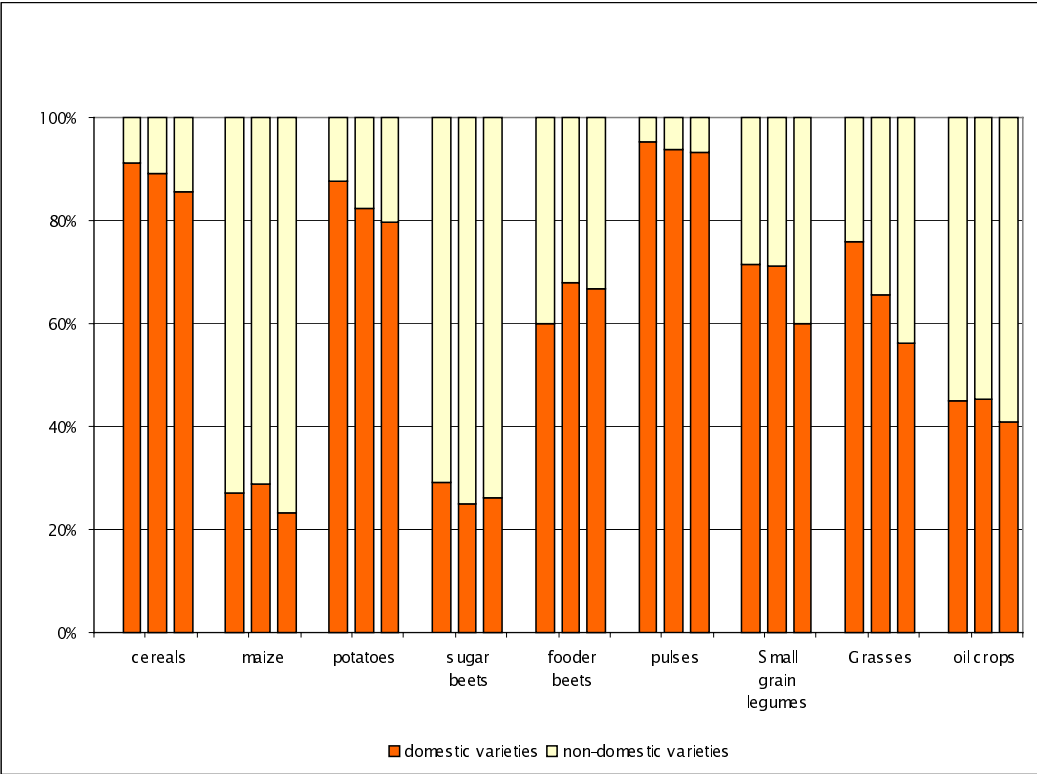
The number of registered crop varieties is an indicator widely used for evaluation of diversity in agriculture. In Poland, the number of registered varieties of agricultural plants is systematically increasing (fig.1). In 2000 year in register was found 917 of varieties. In period 1986-1995 during one year were registered about 30-32 varieties, when in the last period value this carries out 47. The positive tendency is only partially correlated with actual genetic diversity. The general opinion is that modern varieties are more related to each other than old varieties. Increasing of the number of varieties is also stimulated by higher participation of foreign varieties in the register. Interdependence and overflow of 'exotic' germplasm have been always typical for breeding process. However for some groups of crops is observed decrease of number of native varieties, particularly these which in the nearest past based on selection of local ecotypes e.g. grasses and small grain legumes.

Figure 1. Number of registrated crop varieties



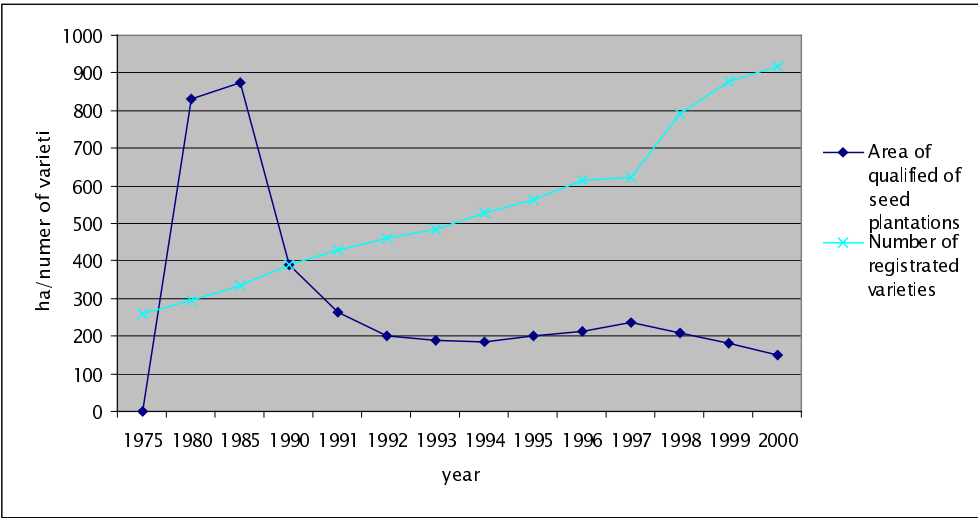
Participation of foreign varieties increased imperceptibly and carries out at present 31 %. Most of foreign varieties are sugar beet (75 % foreign and 16, 2 % in cooperation), corn and winter - rape. These are mainly hybrids, or as rape or sugar beet are closely connected with industry. Considerable is also participation of foreign varieties on the list of registered grasses – 34, 6 % (fig.2).

Figure 2. Number of domestic and non-domestic varieties of main crops registered in Poland



The number of registered varieties represents only the potential diversity, which does not always correspond with the real diversity in the fields. Together with height of offer of new cultivars does not grow up seed production (fig.3). Year 2000 is third in turn year of fall of production of seeds. In comparison to 1997 total area of seed-plantations of field crops decreased about 36, 5 %. Decisive factor of real utilization of effects of breeding in practice is supply of farmers in certified seeds. Year 2000 was following year, in which checked the negative tendencies in sale of seeds of cereals and certified potatoes. Fall this carried out in comparison with 1999 nearly 30 %. Even stronger was decrease of sale potatoes (48 %).

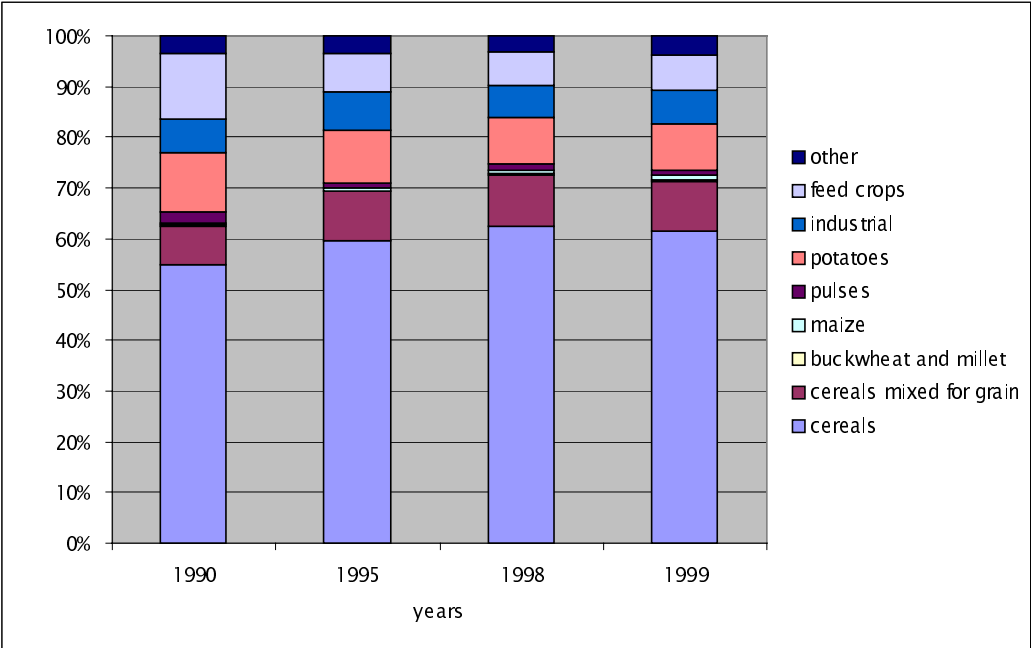
Figure 3. Number of registrated varieties and area of qualified seed plantations in Poland



Introduction of market rules to agriculture came together with general economic crisis in Polish agriculture, what in effect caused impetuous break down of seed market. In Poland participation of qualified seeds of cereals carries out about 15-30 % total amount of sowing material.

Agricultural practice and economic condition of farms considerably modify the positive tendency concerning genetic diversity. Important indicator of agri-diversity is share of the individual crops in total area of cultivation (fig.4). In last period steps out strong domination of cereals in sowings. In country with cereals sows oneself 70, 3 % of arable grounds. In some places the participation of cereals in sowings exceeded 80 %. Between year 1990 and 1998, participation of cereals grew larger about 17 %, in this of wheat almost about 1/3 and of cereal mixtures over 40 %. Among many reasons of large participation of cereals in sowings the most important are economic conditions. Insufficient demand on many crop products such as potato, rape, flax, leguminous caused, that acreage of these crops became lesser. Simultaneously large fall of stock of cattle and sheep's, caused limitation of surface sown with fodder - plants, till about near 50 %. Simplification of crop rotation system has influence on diversity in whole agriculture and existence of minor crops especially annual fodder plants.

Figure 4. Crop area in Poland



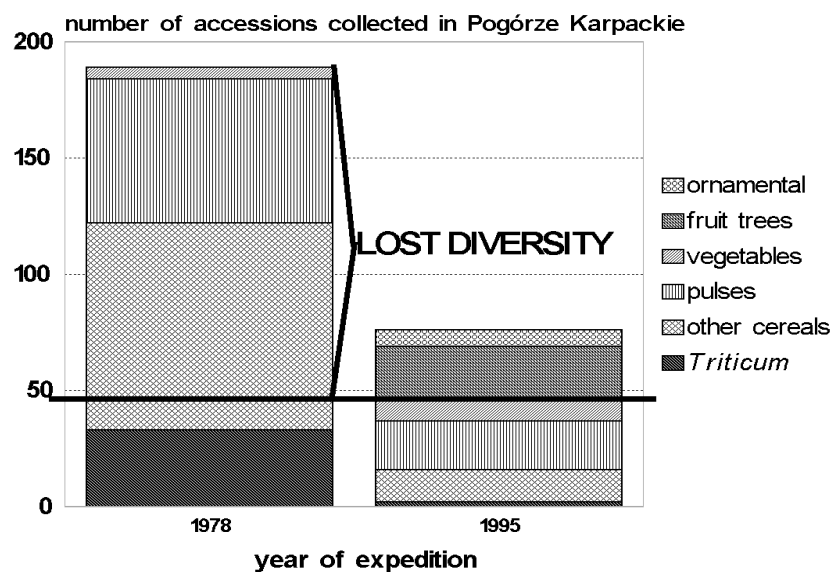
Landraces

Poland is a unique example of a country in Central Europe, where the old local forms of crop plants subsisted owing to the "crumbled" structure of farming. 70 % of agricultural lands was in private hands also during communism time. This factor supports continuation of tradition and indigenous knowledge. The main areas of landraces and old varieties occurrences were defined during missions conducted between 1976 and 1979 (Hammer and Hanelt, 1979; Hanelt and Hammer, 1977; Hanelt *et al.*, 1982; Kulpa and Jastrzêbski, 1986; Kulpa and Górski, 1986). They are situated in the southern part of the country and include the mountain regions of Beskidy, the Tatra and their forelands. Minor refugial regions have been discovered in eastern and south-eastern Poland in Polesie, Wyzyna Lubelska and in the basin of

Sandomierz. Because of climatic, ecogeographic, and edafic conditions as well as fairly primitive agricultural practices those areas for many years served as refuge for primitive forms of cultivated plants. It should be emphasized that local races competed successfully with new varieties in these regions. Well adapted to the specific environmental conditions, they guaranteed not high, but stable yields also in unfavourable years. The expeditions resulted also in the documented examples of active breeding activities of farmers e.g. on *Vicia dasycarpa*, which was selected for fodder purposes from weedy populations of the species (Kulpa and Hanelt, 1981). The mentioned regions were characterized by cultivation of some relic crops' e.g. *Camelina sativa*, *Raphanus sativus* var. *oleiformis*, *Panicum miliaceum* (Kulpa and Hanelt 1981), and were refugial places of distribution typical weeds related to cultivation as *Agrostemma githago* and *Bromus secalinus* or archaeophytes like *Avena strigosa*. At the present moment the local crop cultivars are available mainly as the materials stored in gene bank. According to our evaluations in the last decade the local populations of crop plants disappeared almost completely. Only in few regions local populations can be find. In agricultural crops such as potato old obsolete varieties such as 'Alma', 'Early Rose' or 'Wanta' were cultivated until recently in southeastern areas. Institutions engaged in trade, testing and control of seed material reported that local cultivars of timothy, clover and old varieties of clover ('Hruszowska' and 'Podkowa') are still grown by farmers. The alfa-alfa landraces 'Gubińska' and 'Miechowska' are another example of a landraces which have been widely cultivated for some time in Poland. Landraces of spring rye and barley are still grown at high altitude in mountains.

During collecting missions organized in the period 1985-1990 a systematic decrease in number of samples of field crops was observed. In 1995 we decided to return to some places that were visited during the mission in 1978. Nearly all local field crops have disappeared. Fifteen samples of cereals were collected in comparison to the previous mission, when 111 samples of cereals were gathered. Only one sample of wheat was found whereas in 1978, 33

Figure 5. Samples collected during missions in Pogórze Karpackie in 1978 and 1995



variable accessions were collected (Fig. 5). Local forms of *Hordeum vulgare* and *Avena sativa* are still grown on fields located above 1000 m a.s.l., while at lower elevation cultivation of

local spring rye populations were also recorded. Landraces well adapted to the specific environmental conditions could successfully compete with modern cultivars here. The observations made during the last expedition, as compared to those of earlier years, indicate an almost complete eradication of old cultivars and landraces. The modernization of Polish agriculture, exclusion of marginal areas from cultivation and wide access to seeds of new varieties are menacing the local populations of all crops.

Conservation of fruits tree deserves specific words about. A lot of varieties are not of Polish origin, but they were wide used for about 200 years. We can find also some modifications or trees derived directly from seedlings. Traditional fruit trees orchards have been preserved in little scale until present time. The orchards were planted to cover individual needs of farmer family, and only surplus of fruits were sold at local market or were distributed among neighbours. On farm orchards were grown mainly apples and pears. Other species (cherries, plums) were planted in smaller amount. However there are some regions were plums and cherries were grown for local market and were sold as fresh fruits or processed (dried, cooked). The most often one or two trees of one variety have been grown, but number of varieties was high with differed terms of maturity. So traditional orchards were rich with different types of trees. Additionally different climatic condition and cultural differences influence increased variability of fruit trees. Currently the old orchards are endangered with extinction because of their age and lack on the market varieties suitable for small orchards. Though information on genetic erosion is incomplete, the evidence suggests significant losses of genetic resources in agriculture over recent decades.

Plant germplasm conservation is mainly the task of agricultural institutes. The National Crop Plant Genetic Resources Conservation Programme has a long experience of *ex situ* conservation of crop plants, includes genebank facilities, and has developed standards for storage, documentation and evaluation (Bulińska-Radomska *et al.* 1990; Podyma 1998). For several reasons, genebanks are generally not equipped or funded to deal with *in situ* conservation and monitoring of diversity in the sense of the Convention on Biological Diversity. However in cooperation with other partners surveying and inventoring plant genetic resources for food and agriculture has been started (Podyma 1999). In regards mainly landraces, represented in limited number and grown on small areas a direct monitoring of their occurrence is most appropriate.

Present seed legislation also limits landraces maintenance on farm. Landraces seed commercialisation is discouraged by Intellectual Property Right on varieties and by the need to meet the International Union for the Protection of New Varieties of Plants (UPOV) standards (especially considering uniformity) to obtain the status of variety.

The present Seed Industry Law introduced in 1995 is more restrictive with regard to the commercial use of local and obsolete varieties than the previous one. In Poland any variety, in order to be used commercially, has to enter the Register (Polish National List). Criteria for registration are well known - distinctiveness, uniformity and stability. These requirements in practice preclude other than breeding material from registration. New amendment of Seed Industry Law, currently enforced includes new category of varieties "local populations". A list of local populations will be published by Ministry of Agriculture. This is first step to official recognition of landraces and obsolete varieties in our agricultural systems. However it need building a framework for their registration and marketing.

The number of endangered crops can be applied as another crop genetic diversity indicator. Nevertheless, after reception it sound implementation would need a list (Register) of existing

landraces to be compiled after extensive regional surveys to investigate and evaluate the situation. The Register would firstly permit to acknowledge the existence of autochthonous material belonging to different agriculture areas which are peculiar for biodiversity and local knowledge, traditions and history of inhabitants, secondly to offer a basis for taking appropriate safeguard measures. The difficulties of establishment of such list are coming not only from incompleteness of data, but also problems with description of landraces and establishment of the criteria of endangerment.

Animal Genetic Resources indicators

The total number of breeds and varieties within species may provide an indication on the species diversity maintained in the country. However the number of breeds alone is not sufficient to demonstrate the real situation regarding given species in the long-term perspective and should be always combined with breed distribution within the total population.

Such conclusions can be supported by the example from sheep sector in Poland, as presented in Table 1. In 60-thies and 70-thies sheep population size was about 3-3.5 ml heads, with major share of Polish Merino then Lowland and Longwool local sheep varieties. The total number of breeds/populations separately recorded was only 9 in 1976, when the first official performance scheme results were published. Since early 80-thies, the sheep population was growing, due to increased export opportunities of prime lambs to Western Europe. It has resulted in importing many breeds, both meat and prolific ones and highly increased within-species diversity. In 1986, when total sheep number reached the peak of almost 5 millions heads, recording included 26 different sheep populations, including backcrosses. Grouping within active population that time was based on origin of sheep and combined all imported breeds together. The high sheep number of mid 80-thies was dropping slowly till 1990, getting into a full speed after introduction of the market economy. In last ten years the total population decreased from 4.158,5 to 361,6 thousands heads, it means only 8.7 % of stock number was left. In the same time, the number of genotype groups increased, due to the new importations and development work. So at present, the active ewe population, covering 48% of total ewe number is divided into 33 breeds, varieties and lines, some of them of very low number. In last 25 years the breed number changed from 9 to 33, however, some of the breeds recorded in 1976, like Linclon, are not kept any longer in the country.

The same observation can be made in the case of pigs – 4 lines originating from landraces imported from different countries and recorded separately in 1982 were gradually combined together, while the same time new, typical sire breeds were imported (Tab. 2). Although there are now 10 different purebred genotypes recorded, their share in active sow population differs very much.

In the case of cattle, genetic diversity used to be very limited, with prominent position of Black and White, being used as dual-purpose animals. Since 1980, the trend to decrease population size of other breeds like Red and White or Polish Reds was clearly seen and related to market forces. Since early 90-thies, efforts to divide dairy production and beef production increased, what led to establishment Beef Cattle Development Programme in 1994, based on imported genetic resources. So at present cattle breed number is 15, 6 in dairy and 9 beef sector, but one breed represents as much as 93.8 % of total active dairy cow population.

The next immediate question regards accuracy in transferring breed composition observed in active population into commercial population. One has to be extremely careful doing so, as in many cases simple calculation doesn't provide true results. First of all a lot depends on the active population share in the total stock number in given species – when the percentage is low, the estimation is less accurate. The second problem relates to imported animal genetic resources which, especially during first years after importation have no commercial population developed, therefore the active population represents their total population.

The number of animals registered in given region in the case of geographically restricted populations is another issue to be considered, like the case of Polish Mountain Sheep, kept in well defined area, so in estimating the total population structure such situations have to be taken into account. When breed number is very small and animals are kept in several herds/flocks only a direct monitoring of stock number is most appropriate. It regards mainly indigenous breeds, limited in number, often classified as endangered and very often included in conservation programmes. Additional option, which might be used to predict breed structure and population trends are based on production of breeding stock.

In Poland, data regarding livestock number comes from annual agricultural census, carried out by the Central Office of Statistics. The census is usually based on the sample and includes 0.75% of private farms in case of cattle, sheep and poultry and 0.5% of pig farms. Every ten years a full census, covering all agricultural farms is carried out, the last one taking place in June 1996. The census provides information on stock number of major farm animal species, and in case of large animals, also on the sex and basic age categories. However, the information on breed structure within each species is not available within the present system. Adding such information should be considered in preparation of implementation of EU Directive 92/102/EEC on Identification and Registration of Animals, so called “animal passport”.

The basic and the most reliable source of information on breed performance come from official recording scheme carried out in active population. In the case of cattle, pigs, poultry, bees and fur animals, the National Animal Breeding Centre used to be in charge of recording and selection programmes, while Polish Sheep Breeders' Society and Polish Horse Breeders' Association are responsible for performance recording and herd books in their respective species. All these organizations publish Annual Reports where performance results from ongoing recording programmes, as well as the structure of pedigree population is provided.

The number of endangered breed can be used as another animal genetic diversity indicator. However to use this indicator, the criteria of endangerment should be agreed upon. At present different proposal regarding endangerment/risk categories have been developed by several organizations for instance the European Association on Animal Production, FAO, Rare Breeds Survival Trust and recently by the EAAP Working Group on Animal Genetic Resources. At national level, the number of breeds, which are identified to be included in conservation programme might provide additional indicator, beside the formal endangerment categories.

In Poland, the National Animal Genetic Resources Conservation Programme was developed, setting conservation objectives and priorities as well as conservation methods, activities and organizational framework. The separate breeding programmes on conservation of animal

genetic resources of specific populations, which constitute the integral part of the National Programme, were also prepared. The Minister of Agriculture and Rural Development has accepted these programmes for implementation in May 2000. Each of such programmes presents origin and history of the breed in question, justification for its conservation, defines conservation goals and provides timetable of activities, as well as determines the scope of *in-situ* and *ex-situ* conservation methods. The programmes also set up recording and selection procedures and identify organisations in charge of their implementation.

In total, 32 breeding programmes on conservation of animal genetic resources were accepted and these programmes include 75 breeds, varieties and strains of farm animals, as follows:

Cattle	Polish Red;
Horses	Polish Koniks and Hutsul Horses;
Pigs	Pulawy, Zlotniki Spotted, Zlotniki White;
Sheep	Polish Heath sheep, Swiniarka, Olkuska sheep, colour variety of Polish Mountain sheep, Wielkopolska sheep, Polish Lowland sheep of Zelazna and Uhrusk variety, Corriedale, Pomorska, Kamieniecka, colour variety of Polish Merino, Leine, Booroola;
Hens	programme covers 10 breeds and strains: Green-Legged Partridge ZK and Z11, Yellow-Legged Partridge, Polbar, Rhode Island Red R11 and K22, Rhode Island White A33, Sussex S66, Leghorn G99 and H22;
Geese	programme covers 16 breeds and varieties: Zatorska, Bilgoraj, Lubelska, Kielecka, Sub-Carpatian, Kartuska, Rypinska, Suwalska, Garbonosa, Pomeranian, Roman, Landes SD01, White Italian WD02, ND12, Slovak, Gorkowska;
Ducks	programme covers 13 breeds and strains: Polish Pekin P11, P22 and P33, Mini Duck K2, Khaki Campbell Kh1, Danish Pekin P8, English Ducks A1, A2 and A3, French Pekin P9, Orpington O1, KhO1, synthetic group A;
Fur animals	White Necked Fox, Polish Pastel Fox, Domestic Polecat, Polish Beige Recessive Chinchilla, Popielno White Rabbit;
Bees	lines of <i>Apis mellifera mellifera</i> including North Bee, Asta, Kampinos Bee and Augustow Bee;
Fish	Rainbow Trout strains of spring and autumn spawn; Carp lines of Golysz, Knyszyn, Ukraine, Lithuania, Starzew and Zator.

Implementation of animal genetic resources conservation programmes has been entrusted to Polish Sheep Breeders' Society (sheep and goats), Polish Horse Breeders' Association (horses) and the National Animal Breeding Centre (all remaining species). It is expected that in the nearest future other breeders' associations/ organizations will take over responsibilities regarding herd books keeping and implementation of breeding programmes. The first step, being done last year, regarded all three native pig breeds.

Table 1.Changes in breed structure in sheep population between 1976 and 2000.

Breeds	Number of ewes under recording scheme and their share in total active population					
	1976		1990		2000	
	Number	%	Number	%	Number	%
Polish Merino	158.255	43.5	171.241	47.8	31.988	29.8
German Merino			1.861	0.5	97	0.1
Polish Lowland						
in Wielkopolska type	52.184	14.3	22.982	6.4	4.388	4.1
in Lincoln type	5.550	1.5	-	-	-	-
in Corriedale type			5.986	1.7	277	0.2
Other Polish Lowland	57.348	15.7	87.933	24.5	26.035	24.3
Polish Longwool :						
in Pomorska type	39.949	11.0	15.969	4.5	5.760	5.4
in Suski type	16.594	4.6	-	-	-	-
in Kamieniecka type			12.922	3.6	1.625	1.5
in Pogorze type			4.874	1.4	1.755	1.6
Olkuska			50	0	-	-
Other Polish Longwool	17.104	4.7	9.520	2.6	779	0.7
Polish Mountain Sheep	2.086	0.6	5.152	1.4	11.306	10.5
Other purebred sheep	15.015	4.1	-	-	-	-
Polish Heath Sheep			2.037	0.6	1491	1.4
Swiniarka			-	-	163	0.2
Purebred imported sheep (Kent, Leine, East Friesian, Finn, Lincoln, Booroola, Texel, Ille de France, Blackheaded Mutton Sheep, Suffolk, Berrichon du Cher, Dorset)			14.645	4.1	-	-
Purebred Longwool sheep (Kent, Leine)					431	0.4
Prolific sheep (East Friesien, Bergschaf, Finn, Olkuska, Romanov)					758	0.7
Meat sheep (Texel, Ille de France, Blackheaded Mutton Sheep, Suffolk, Berrichon du Cher, Dorset Horn, Charolaise, White Alpine)					14.988	13.9
Synthetic line			874	0.2	2.627	2.4
Backcrosses			2.532	0.7	2.524	2.3
Prolific crosses					476	0.4
TOTAL	364.085	100	358.578	100	107.468	100
Total population size (in thousands)	3.429,9		4.158,5		361,6	
including ewes	1.780,9		2.437,5		222,8	
% of the active population	20.4		14.7		48.2	

Table 2.Changes in breed structure in pig population between 1982 and 2000.

Breeds	Number of sows under recording scheme and their share in total active population					
	1982		1990		2000	
	Number	%	Number	%	Number	%
Polish Large White	8.522	49.5	8.598	38.9	10.797	34.6
Polish Landrace	6.570	38.2	8.565	38.8	16.590	53.1
Line 21	690	4.0	703	3.2	-	
Line 22	190	1.1	-		-	
Line 23	325	1.9	1.462	6.6	-	
Line 24	99	0.6	525	2.4	-	
Total Polish Landrace	7.874	X	11.255	x	16.590	x
Zlotniki White	216	1.3	105	0.5	67	0.2
Pulawy	348	2.0	368	1.7	307	1.0
Zlotniki Spotted	131	0.7	212	0.9	55	0.2
Duroc	131	0.7	1.324	6.0	1.033	3.3
Hampshire			137	0.6	641	2.0
Line 990			85	0.4	598	1.9
Pietrain					1.080	3.5
Belgian Landrace					69	0.2
TOTAL	17.222	100	22.084	100	31.237	100
Total population size (in thousands)	19.471,0		19.490,4		17.122,0	
Including sows	1.962,0		1.841,5		1.577,4	
% of the active population	0.88		1.12		1.98	

Table 3.Changes in breed structure in cattle population between 1980 and 2000.

Breeds	Number of cows under recording scheme and their share in total active population					
	1980		1990		2000	
	Number	%	Number	%	Number	%
DAIRY breeds						
Black and White	989.502	93.5	583.300	94.1	363.711	93.8
Red and White	61.149	5.8	34.034	5.5	17.789	4.6
Simentaler	3.280	0.3	1.085	0.2	3.711	0.9
Polish Red	4.245	0.4	1.187	0.2	1.456	0.4
Jersey	91		415		641	0.2
Other breeds	212		27		337	0.1
TOTAL	1.058.478	100	620.048	100	387.645	100
BEEF breeds						
Limousin					1.789	33.8
Hereford					1.440	27.2
Charolais					1.017	19.2
Red Angus					172	3.2
Black Angus					70	1.3
Piemontese					108	2.0
Salers					424	8.0
Simentaler					272	5.1
Welsh Black					1	0.2
TOTAL					5.293	100
Total population size (in thousands)	12.649,0		10.049,0		6.082,6	
Including cows	5.956,0		4.919,0		3.097,5	
% of the active population	17.7		12.6		12.6	

Conclusion

Sustainable development means harmony among all elements of agricultural system. In countries in transition, as Poland, the equilibrium can be very easily shaken by external factors as political and economic changes. Therefore analysis of parallel processes influencing overflow material from 'registered gene pool' to 'gene pool used in practice' is necessary. Direct indicators of genetic diversity of crops in agricultural communities have not been already developed and applied. Compilation of a list of existing landraces would be indispensable precondition for monitoring of genetic diversity of crops. A final judgement on the quantity of genetic erosion of livestock and crops is only possible when widespread measurements of genetic diversity are implemented.

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