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Selected issues in innovativeness in forestry processes management

K e y w o r d s: forests, forestry, work environment, innovativeness, work processes, hazards, accidents, safety and ergonomics, machines

S u m m a r y: With the background of general characteristics of forests in Poland, the objective and scope of innovativeness has been discussed in economy, including forest economy, and in work safety management. Special attention has been paid to the specific nature of noxiousness of work in a highly varied work environment, which often times extremely unfavourably increases health risk, or even poses hazard to life of the employees in the forestry process. Implementing the issues of innovativeness in forestry should be related to the current achievements in science and to technical progress, with a view on the necessity of eliminating or effective reducing accidents in the works related to acquiring raw timber.

1. Introduction

The area of forests in Poland is 9,088 thou. ha, which means that the afforestation rate is 29.1%. It has to be noticed that the percentage ratio of the area of forests to the general geographical area of voivodeships is highly varied (Table 1):

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Table 1

Afforestation rate by voivodeships in 2009

Voivodeship	Afforestation rate (in %)
Lubusz	48.9
Subcarpathian	37.2
Pomeranian	36.1
West Pomeranian	35.1
Silesian	31.7
Podlaskie	30.4
Warmian-Masurian	30.4
Lower Silesian	29.5
Lesser Poland	28.5
Świętokrzyskie	27.8
Opolskie	26.5
Greater Poland	25.6
Kuyavian-Pomeranian	23.3
Lublin	22.8
Masovian	22.6
Łódź	21.0

Source: (1).

The structure of ownership shows dominance of public forests at 81.8% of forest areas, with 18.2% of private forests, which are additionally broken down into multiple small areas, i.e. resulting in about 1 ha per a single owner. In State Forests (Lasy Państwowe), the basic organisational units are forestry commissions with the average area of 17.5 thou. ha. Coniferous species prevail in 72.2% of forest areas (including pine in 62.2%), with deciduous species in 27.8% (including, among others, oak in 7.3%, birch in 7.0%, beech in 5.3%). In 2009, 32,702 thou. m^3 of large timber was acquired in Poland (the national forestry for the several dozen recent years refers to about 50% of log volume of timber.

It is noteworthy that, pursuant to the Forests Law of 1991, as amended, based on proven solutions in the system of organisation and management, State Forests manage a modern economy following the principles of continuous and expanded maintenance, emphasising continuity and further sustained multi-functional increase in resources.

The forests mostly meet the following functions:

- ecological, related to, among others, positive effect on the landscape and global and local climate, regulation of water circulation in the nature, protection of soil against erosion;
- production, which specifically consists in the capacity to produce renewable biomass, including industrial and power wood;

– s o c i a l, in the scope of modelling favourable health and recreation conditions, and related to the enrichment of the labour market (1). Since times immemorial, forests have been the places of rest and recreation (1).

2. General premises of innovativeness

The intense development of technique and technology has contributed to numerous objective difficulties, in their full adaptation in specifically varied innovations not ready for implementation under local work environment conditions. According to *Nowa encyklopedia powszechna PWN* (New common encyclopaedia) of 1996, innovations in the economy in the scope of new technologies and organisation and in products are classified by:

– releasing new goods and services for production,
– process application of new methods of obtaining these goods.

Process innovations result from scientific and technical progress, while organisational and institutional innovations are closely related to entrepreneurship and constitute its necessary item.

According to Ewa Okoń-Horodyńska (2), innovativeness of the economy means the capacity and motivation of business entities to operate with continuous conducting of scientific research and looking for new results, research and development work, new concepts and ideas, preparation and starting up manufacturing new or improved materials, goods, equipment, services, processes or methods dedicated for the market or for another practical application.

Joanna Wiśniewska (3, pp. 183–195) remarks that the most competitive and innovative economies in the world feature a perfectly developed sector of services, in particular services based on advanced know-how. The specific nature of services causes the companies functioning in this area implement organisational or marketing innovations considerably more often than innovations in products or processes. Indicating positive achievements in innovations, one cannot neglect the difficulties of the companies which introduce and execute innovations in services. Also, high costs of innovations and lack of capital are regarded the largest limitation factor in innovative activities in the sector of services. According to the Main Statistical Office research, economic obstacles are considered the strongest barriers for innovative activities in the services, especially those related to the costs.

Generating behaviours which allow maintenance of balance between cooperation and competition is the characteristic feature of the innovative environment. In the view of progressing globalisation and strengthening international competitiveness, efficient binding of companies with the R&D area determines innovativeness and competitiveness in companies (4, p. 34).

Technical progress according to Władysław Janasz (5, pp. 239–241) is one of the elements of broadly understood innovative process, as well as one of the factors of

increase in production of tangible items. It follows from the nature of this factor that it affects the production process indirectly, that is by the appropriate developing of work means and objects and stimulating to their effective use. It is significant for reduction of the unit costs of production, decrease of the share of material factors and live labour, improvement in the level of production quality, working conditions, work safety and hygiene conditions, protection of the natural environment and organisation, know-how and general technical culture of direct manufacturers.

It follows from the current discussion that innovativeness should be the main creative force in any organisation. Innovative are the companies which can create, absorb and win new products (services) and these which have the capacity of continuous adaptation to the changes in the economy (4, pp. 75–76).

The strategy of the European Union related to continuous, sustained development and the Lisbon strategy for the benefit of economic growth and employment are mutually supporting, thus giving the synergy effect due to their complementarity. In both strategies, the economic, social and environmental protection objectives are regarded as having mutually stimulating effect and that is why they should be executed jointly. Implementation of the necessary changes should contribute to creating conditions equal for all member countries, conducive to dynamic, innovative economic growth, social justice and continuous and sustained development of the natural environment (6, p. 46).

The theory of eco-innovations, just like that of the ecological economy, has recently become a new paradigm in the science. Its importance among many other types of theories of innovation is special due to the area of interest, that is environment and ecology. Ecological innovativeness means innovativeness which consciously strives to reduce load on the environment, and with its introduction intends mostly to achieve specific environmental effectiveness (6, p. 21).

According to Małgorzata Golińska-Pieszyńska (6, p. 176), business accepting, within the common sense limits, the principle that safety is more important than profit, has not only generated the market of products and services, but also gave the impulse to developing a new, broad area of knowledge of safety management.

3. Characteristics of work environment

Both national regulations and the guidelines of the European Union directives oblige employers to continuous improvement in the executed work process based on the latest achievements in science and in technological progress, including elimination or major reduction of the hazards for health and, under extremely dangerous employment conditions, life of the employees. The above activities should not be subjected to factors of economic nature only (7, pp. 5–9).

Employees should not be exposed in individual work stations to the effect of harmful health factors whose impact may be the cause of accidents, loss of health,

as well as chronic and incurable occupational illnesses or even permanent disability (Tables 2 and 3).

Table 2

Incidence of occupational diseases by type

Description		Total	Of which		
			Hearing loss	Infectious and parasitic diseases	Vibration syndrome
Forestry, logging and related service activities	2005	245	8	214	19
	2006	247	1	219	23
	2007	303	4	285	12
	2008	526	2	508	15
	2009	473	–	457	15

Source: (8).

Table 3

Persons working in forestry in hazardous conditions, exposed to agents harmful and hazardous to health, by groups of conditions, per 1000 paid employees

Hazard connected	2005	2006	2007	2008	2009
Work environment, including:	108.1	117	112.5	129.7	105.2
a) chemical substances	0.7	0.7	1.2	0.5	0.5
b) carcinogenic	0.4	0.2	0.6	0.0	–
c) hazardous industrial dusts	3.3	–	2.1	1.8	0.6
d) noise	38.4	40.3	39.5	41.6	31.1
e) vibrations	33.2	37.2	35.1	35.3	26.4
f) hot microclimates	4.9	7.3	6.5	6.3	3.4
g) cold microclimates	12.7	9.8	7.1	5.9	3.9
h) ionizing radiation	0.1	0.1	0.1	0.1	–
i) electromagnetic fields	4.6	3.8	3.6	2.1	1.5
Strenuous conditions, including:	52.6	51.5	51.2	61.2	55.8
a) excessive physical effort	29.5	34.8	30.9	34.2	33.0
b) hazards from insufficient light	1.6	4.5	2.4	3.4	2.0
Mechanical factors related to highly dangerous machinery	29.9	28.5	30.5	39.7	33.1

Source: (8).

Observing recommendations of ergonomics is intended to maximise harmony in human activities with the executed work, not only in the scope of ensuring work safety and hygiene, but also in order to minimise strenuous working conditions, as well as achieving the best possible comfort and stress-free employment. It is commonly known that providing hard and strenuous physical work with high level of effort constitutes a factor enhancing the degree of occupational hazard exposure. Direct hazard to life or health is always present in the environment which exceeds the

highest allowed concentrations (Polish abbr. NDS) or intensities (Polish abbr. NDN). Despite perceivable improvement in working conditions with each year, in forestry only, in 2009, among 1000 persons employed under hazardous conditions and environmental factors harmful for health and strenuous working conditions, 92 were employed in the public sector and 370 in the private sector (Tables 4 and 5).

Table 4

Persons working in forestry in hazardous conditions by groups and intensity of danger in the surveyed community, per 1000 paid employees of the total surveyed

Hazard	2005	2007	2008	2009		
				Total	Public sector	Private sector
Work environment	57.7	65.8	77.8	65.6	50.6	177.9
a) impact of agents from one group	28.3	34.9	47.1	38.6	36.0	57.8
b) two and more groups	29.4	30.9	30.7	27.0	14.6	120.1
Strenuous conditions	35.9	34.5	38.0	35.1	31.8	59.6
a) impact of agents from one group	25.5	23.3	26.0	25.8	26.0	24.3
b) two and more groups	10.4	11.2	12.0	9.3	5.8	35.3
Mechanical factors	22.7	21.9	30.1	24.4	9.9	133.1
a) impact of agents from one group	7.5	7.4	11.0	7.9	1.8	53.5
b) two and more groups	15.2	14.5	19.1	16.5	8.1	79.6
TOTAL	116.4	122.2	145.9	125.1	92.3	370.6

Source: (8).

Table 5

Accidents at work and accident absence in forestry by ownership sectors

Years	Occupational accidents		Fatal accidents		Accident absence in thou. days	
	Public sector	Private sector	Public sector	Private sector	Public sector	Private sector
2005	260	109	6	6	11 954	6823
2008	330	150	4	8	15 304	8650
2009	226	142	–	5	9695	8157

Source: (8).

Mechanisation of work, implemented in forestry for long years, gradually and effectively eliminates heavy physical effort. However, mechanisation of work is not always based on machines and equipment developed in accordance with criteria of ergonomics. Work is particularly harmful for health in the environment where physical effort and expenditure of energy are high, and emitted noise and mechanical vibrations exceed the allowed values, particularly in operation of sawing machines, cutting machines, barking machines, harvesters, processors, as well as tractors or cable railways.

Relatively high accident rate in forestry comes also from highly varied conditions of work environment. Significant fluctuations, not only seasonal, but also over the twenty-four-hour periods, are the feature of atmospheric conditions, and their variation affects the health of the employees and the number and scale of accident rates. It is noteworthy that climatic conditions, mostly during the late-autumn, winter and early-spring periods, also expose the fellers to the combined effect of chill, humidity and wind. These factors in many cases hinder the course of thermal regulation processes and may lead to cold-related ailments, which means increased accident rates.

Preliminary analyses proved that some correlation may be drawn between accident rates in forestry and biological and meteorological factors, especially with variables atmospheric conditions and when mental and physical abilities are reduced (which may be seen in reaction time variations and attention deficits).

It has to be noticed that, especially in the State Forests, the goal is to limit and eliminate hazards present during execution of strenuous and dangerous work in forestry (Table 6). Even though new, less hazardous and innovative machines, techniques and technologies of acquisition of raw timber are introduced on the ongoing basis, the group of persons forced to perform dangerous work is still numerous, especially when related to the work environment in mountain forest stands.

Table 6

Elimination or limitation of hazards in forestry (per person)

Hazards	Year	Persons working under hazardous conditions				
		In relation to which hazards were over the year				As at 31 Dec
		Eliminated or limited			Reported (including new hazards)	
		Total	Eliminated or limited up to acceptable norms	Limited		
working environment-related hazardous factors	2005	1523	733	790	360	3015
	2007	1743	842	901	586	3128
	2008	1995	972	1023	526	3692
	2009	1435	619	816	381	2901
hazards caused by strenuousness	2005	520	203	317	126	1466
	2007	498	235	263	184	1423
	2008	680	314	366	227	1743
	2009	590	226	364	218	1538
hazards caused by mechanical factors related to highly dangerous devices	2005	334	156	178	81	835
	2007	471	216	255	132	847
	2008	553	233	320	157	1130
	2009	**386**	**167**	**219**	**177**	**914**

Source: (8).

It has to be noticed that the employer is legally obliged to ensure safe and ergonomic conditions of work for all employees, however, due to highly complex situations, fellers undertake works which are hazardous to their health, or even life.

These days, not only in Poland, the degree of hazard from the work environment is enhanced. The above problem in forestry is related to, among others, unprecedented for many years damages in forests due to natural disasters. Significant damages to forest stands, in the form of windfalling, breaking, as well as other hurricane disasters, definitely make working conditions more difficult in the given area. The strength of these factors depends on both size and type of the affected forest.

The data given in Tables 7 and 8 show that more fatal accidents occur in the private sector. Inappropriate behaviour of the employee is definitely the most frequent cause of accidents. At the same time, accidents at work, although classified as resulting in one event, most often are caused by several simultaneous causes (Tables 7 and 8).

Table 7

Accidents at work in forestry: persons injured

Accidents		Year						
		2005	2006	2007	2008	2009		
						Total	Public sector	Private sector
Fatal accidents		12	4	9	12	5	–	5
including men		11	4	9	11	5	–	5
Serious accidents		7	15	9	10	6	3	3
including men		7	12	8	9	6	3	3
Light accidents		350	405	388	458	357	223	134
including men		318	374	355	424	335	208	127
TOTAL		369	424	406	480	368	226	142
including men		336	390	372	444	346	211	135
including the resulting inability to work	1–3 days	2	5	5	6	6	2	4
	4–20 days	94	95	107	125	113	80	33
	>20 days	251	311	271	313	223	126	97

Source: (8).

Table 8

Accidents at work in forestry by cause of accident

Cause of accidents		Year						
		2005	2006	2007	2008	2009		
						Total	Public sector	Private sector
Improper condition of material objects/ agents		56	54	54	75	55	26	29
Improper organisation of	work	24	26	20	36	24	7	17
	work post	22	42	22	36	33	20	13

Lack or wrong use of material objects/ agents	41	31	35	45	28	11	17
Protective equipment not used	12	11	7	13	11	7	4
Inappropriate deliberate behaviour of employees	34	71	63	57	53	29	24
Inappropriate mental and/ or physical condition of employees	27	23	39	44	25	22	3
Incorrect action of employees	339	454	406	506	386	205	181
Other	66	76	74	82	80	63	17
TOTAL	621	788	720	894	695	390	305

S o u r c e: (8).

4. Selected issues in innovative work

A number of processes has been undertaken in recent years to adjust the Polish law to, among others, the Geneva conventions of the International Labour Organisation and to the currently recommended European Union directives, especially in the scope of:

- Introducing measures to increase safety, improve health and limit accident hazards;
- Define the minimum requirements for work safety in operation of machines used in forestry;
- Use new generations of means of personal protection, including head, hearing, arms, hands, feet, legs, etc. protection;
- Avoid or reduce hazards, particularly those which cause spine injuries with the employees performing manual handling operations;
- Define the basic requirements and recommendations in the scope of ergonomics during designing and production of machines used in forestry.

In the scope of adjusting the environment to human psychological and physical needs and possibilities, in the process of work under conditions of special hazard to health or even life of the employees, there are many issues which require further examination and solution.

During development of the technological and organisational progress, it is necessary to adjust all the efforts, in particular in reference to the actions related to optimisation of mental and physical comfort, in all work stations, specifically those which feature conditions harmful for health of the employees.

For example, new-generation combustion engine sawing machines feature not only high performance but also proper comfort of operation. The optimum shape of the universal grip allows control over all functions of the sawing machine with one hand. The proper location of the centre of gravity facilitates control, and the employed shock-absorbing system ensures easy, relatively light, less fatiguing and safer

work, in many cases meeting the recommendations of ergonomics. Lower volume of emitted exhaust gases makes them more friendly for the environment with catalysts. Chain sawing machines are fitted with the appropriate braking devices activated automatically, stopping the chain saw in a wink of the eye with too strong rebound of the sawing machine, irrespective of its location. Fitting the sawing machines with systems of trouble-free start-up and electronic ignition modules guarantees easy operation of the sawing machines.

One of the basic tasks of ergonomics is systematic improvement in working conditions with implementation and application of the principles of optimum adjustment to the average anthropomorphic features (somatic and functional) of the employee.

The appropriate decisions resulting from interdisciplinary recommendations are helpful and, in most cases, simply absolutely necessary, not only during work management processes, but also during modification of work places.

5. Conclusions

With the background of the analysis of introducing innovativeness and its impact on safety of work in forestry, the following conclusions may be drawn:

1. A relatively numerous group of employees is still employed under conditions of hazard to health or even life, under extremely dangerous conditions, e.g. in removing trees after natural disasters.
2. Strenuous and hazardous work executed manually should be, wherever possible, effectively eliminated or limited in the maximum scope by introduction of modern technologies of machine work.
3. Machine acquisition of timber with universal machines provided forestry with a new, innovative system of safer work. Operator's work stations in these machines are loaded with unknown (as yet) ailments, mostly in the muscular and bone system, which may be effectively prevented with the proper technique and organisation of the work process.
4. Introduction of new innovative techniques and technologies and further mechanisation of chipping work should not be dependent solely on the achieved temporary economic effects, but should take into consideration safety of work which, in the long run, contributes to achieving better economic results with, among others, higher quality of work done under good conditions.
5. The chain saws used should be modernised from the point of view of ergonomics and HS&E premises, including special work on reducing mechanical vibrations and noise.
6. In effecting technological and organisational progress, it is necessary to adjust all efforts to the psychological and physical human needs in all work stations, specifically those which feature conditions harmful for health of the employees.

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Wybrane zagadnienia innowacyjności w zarządzaniu procesami użytkowania lasu

S t r e s z c z e n i e: Na tle ogólnej charakterystyki lasów w Polsce omówione zostały cel i zakres innowacyjności w gospodarce, w tym w gospodarce leśnej i zarządzaniu bezpieczeństwem pracy. Szczególną uwagę zwrócono na specyfikę uciążliwości wykonywanych zajęć ze strony zróżnicowanego środowiska pracy, które niejednokrotnie w sposób szczególnie niekorzystny wpływają na wzrost zagrożenia zdrowia, a nawet życia pracowników w procesie użytkowania lasu. Wdrażanie problematyki innowacyjności w leśnictwie powinno nawiązywać do bieżących osiągnięć nauki i postępu technicznego, zwracając przy tym uwagę na konieczność eliminowania względnie znacznego ograniczania wypadkowości w pracach związanych z pozyskiwaniem surowca drzewnego.

S ł o w a k l u c z o w e: lasy, użytkowanie lasów, środowisko pracy, innowacyjność, procesy pracy, zagrożenia, wypadkowość, bezpieczeństwo i ergonomia, maszyny