

APPROVED
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of the Minister of Education and Science
of the Republic of Lithuania

**NATIONAL RESEARCH PROGRAMME 'SUSTAINABILITY OF AGRO,
FOREST AND WATER ECOSYSTEMS'**

CHAPTER I

GENERAL PROVISIONS

1. The purpose of the National Research Programme 'Sustainability of agro-, forest and water ecosystems' (hereinafter – the Programme) is to understand and be able to forecast the general effects of climate change and the intensive use of ecosystem resources, and to obtain new fundamental and empiric knowledge to enable the avoidance of threats related to these effects. A characteristic feature of Lithuania is an intensive and market-driven agriculture and forestry sector that contributes to soil degradation and creates a threat to the landscape, biological diversity, and the sustainability of agro-, forest and water ecosystems. The accelerating climate change also affects all the components of ecosystems in addition to their functions and will eventually create new environmental conditions unprecedented in the history of Lithuania. The emerging ecosystem degradation processes are complex and difficult to manage, and need to be examined in a comprehensive manner in order to obtain results which will constitute a basis for taking decisions and proposing the relevant measures.

2. The sustainability of the ecosystems and the continuity of the resources and the functions they provide is an essential condition for the sustainable development of society. The ever intensifying use of resources and the pace of climate change brings about the creation of threats not only for agro-, forest and water ecosystems, but also for the economic and social development of society. This has been noted on numerous occasions in recent international and Lithuanian strategic documents (Communication from the Commission of 3 March 2010 - Europe 2020. A strategy for smart, sustainable and inclusive growth (COM(2010) 2020), the National Sustainable Development Strategy approved by Resolution No.1160 of 11 September 2003 of the Government of the Republic of Lithuania 'On the approval and the implementation of the National sustainable development strategy', Lithuania's Progress Strategy Lithuania 2030 approved by Resolution No. XI-2015 of 5 May 2012 of the Seimas of the Republic of Lithuania.

CHAPTER II

ANALYSIS OF THE CURRENT STATUS OF RESEARCH

3. The intensifying exploitation of biological natural resources and climate change pose a significant threat to the sustainability of ecosystems. One of the most relevant and complex sustainable development challenges is to bring the ever intensifying use of agro-, forest and water ecosystems in line with the preservation of biological diversity and the functions of ecosystems under climate change conditions. Considering the shortage of knowledge in this area, Horizon 2020 – the framework programme for research and innovations in the EU approved by Regulation of the European Parliament and of the Council No. COM (2011) 809 of 30 November 2011 provided for three main themes related to climate change and the protection of natural resources and ecosystems: climate, the environment, resource efficiency and raw materials; food

security, sustainable agriculture and forestry, marine and maritime research and the bioeconomy; biodiversity and ecosystem services: active forces and the outcomes of changes.

4. Climate change has an effect on the condition of all ecosystems. The mathematical models proposed in the Fifth Report of the Intergovernmental Panel on Climate Change (IPCC, 2014) show that by the end of the century temperatures will have risen by not less than 2°C, and by 4°C in Lithuanian latitudes. Climate change has some adverse effects on ecosystems – an increased frequency of droughts, heat and cold waves, changes in snow cover or the depth of frozen ground. Climate change causes changes in seasonal development and the spread of many species, which in turn affects the structure and the functioning of ecosystems. Changes which are highly dependent on the composition of species in ecosystems and their geographical location need to be thoroughly examined.

5. Europe has dedicated significant attention to problems related to the adverse effect of economic activities on the natural environment. The problems of the preservation of biological diversity under climate change conditions have also been addressed by the international programme BiodiveERsA-2, the purpose of which is to coordinate national research activities on biodiversity across Europe. In the period 2010-2014 the programme was funded according to the ERA-NET scheme of the Seventh EU Framework Programme, and since 2015 it has been funded according to the ERA-NET COFUND scheme under Horizon 2020. The level of tolerance of organisms towards climate change factors and the outcome of economic activity depends upon the geographic location, as well as the species and the population. There is an obvious shortage of knowledge on how phenotypic plasticity and evolutionary adaptation will facilitate the adaptation of species to the new conditions in Lithuania.

6. It is projected that climate change will cause a decrease in the diversity of species and will essentially change their productivity (Walther GR, Post E, Convey P, Menzel A et al (2002) Ecological responses to recent climate change. *Nature* 416:389-395; Cleland EE, Chuine I, Menzel A, Mooney HA, Schwartz MD (2007) Shifting plant phenology in response to global change. *Trends Ecol Evol* 22:357–365.). It is highly probable that climate change will contribute to the extinction of species and the diversity of invertebrates, especially insects, in intensely exploited agro- and forest ecosystems while stimulating the increase of some other species. Surveys have shown that in the warming climate insects and other invertebrates find it easier to survive winters. The development and breeding period of organisms (micro-organisms, protists and invertebrates) shortens in view of the rising probability of an outbreak of parasites and pests. Climate change has already caused an increase in the populations of insects which eventually leads to the proliferation of insect-transmitted diseases. Lithuania needs to expand research into these issues.

7. The decrease in biological diversity may have either a direct or indirect impact upon the productivity of ecosystems or their functioning. Lithuania does carry out some research in the area of natural ecosystems; however, there is a clear lack of knowledge about the interaction between species and their complexes in the agro-, forest and water ecosystems transformed and damaged by ever intensifying human activities; it is still not known how those intensely used ecosystems will respond to climate change and the anthropogenic change in the environment and the overall effect upon the relationship between species and the productivity of ecosystems in the future. There is a lack of scientific research explaining how the preservation and restoration of biological diversity can contribute to an increase in agro-, forest and water ecosystems, their adaptability to climate change, and the extreme natural phenomena it causes.

8. Climate change stimulates the proliferation of alien species. Due to an extended period of vegetation and the activity of animals there has been an observable proliferation of southern origin prokaryotes and eukaryotes in the ecosystems of Northern countries. Mild winters and wet summers create conditions conducive to the proliferation of pathogenic micro-organisms and pests. The proliferation of new diseases and pests will adversely affect the productivity of some plants or animals. This may cause changes in the species composition or structure of agro-, forest and water ecosystems, the development cycles of different species, and the status of populations in Lithuania. The currently available knowledge about the overall impact of climate and environment change upon the processes in agro-, forest and water ecosystems is not sufficient.

9. The selective exploitation of some of the species in agro-, forest or water ecosystems diminishes inter-species competition while stimulating an increase in the population of part of the species which eventually can alter the current balance between the foodstuff metabolism and the interrelations of organisms. This causes changes in the structure of the ecosystem, trophic relations and other difficult to predict developments. A comprehensive assessment of the impact of climate change and the increasingly intense exploitation of ecosystems upon agro-, forest and water ecosystems requires detailed, long-term and interdisciplinary studies in the dynamic changes of biological diversity.

10. The results of different surveys have shown a very varying impact of climate change upon the productivity or competitiveness of different types of species of plants. An important factor to consider is a possible change in the competitiveness of agricultural plants and weeds. It has been established that the increasing amount of carbon dioxide in the air stimulates the growth of agricultural plants rather than weeds; however, in view of the warming climate weeds become increasingly resistant to the impact of herbicides and the different other environmental impacts. To date there have been very few studies in the response of agricultural plants and weeds (growth, synthesis of primary and secondary metabolites, activity of the antioxidant system) towards changes in environmental factors (UV radiation, increase in the ozone concentration, eutrophication, heavy metals, etc.), and the different technological means (fertilising, pesticides, etc.) in the context of the warming climate.

11. The relationship between micro-organisms and macro-organisms is an important factor in the sustainability of ecosystems as a significant part of the synthesis and decomposition process depends on the activity of micro-organisms. Not only macro-, but also microbiota components are heavily affected by excessive use of pesticides and fertilisers, as well as pollution in general; therefore, some micro-organism and protist species are being driven out from agro-, forest and water ecosystems. Micro-organisms are the least studied components of Lithuanian ecosystems. New, breakthrough methodologies in molecular studies make it possible to easier detect and describe micro-organisms, assess their abundance and dynamics parameters. It is necessary to determine and find ways to reconcile new farming technologies with the aim of preserving biological diversity and abundance.

12. The results of different experimental and modelling studies have shown that an increase in the concentration of CO₂ in the atmosphere may enhance the efficiency of the use of plant photosynthesis and water and the productivity of plants. Other climate change-related impacts, such as droughts and heat and cold waves, act as stress factors as a result of which the aggregate impact of climate change upon productivity of plants may be negative. Ecosystems are heavily affected also by other anthropogenic processes – increases in the concentration of

underground ozone, the intensity of UV radiation, ozone depositions, and the resulting eutrophication of land and water ecosystems. The interaction of all those factors and the intensive use of ecosystems and its overall impact on ecosystems is a complex phenomenon which has not been sufficiently studied.

13. The adaptability of plants to changing climate and environmental conditions and the physiological and biochemical mechanisms affecting plants have been studied to a very limited extent only. It has been established that the adaptation potential of plants is related to the activity of phytohormones, enzymatic and non-enzymatic antioxidants, stress proteins, a more active gene expression and the overall activity of the antioxidant system. In view of the different adaptive potential of the different plant types, their populations, families, species and genotypes the changing climate and environmental conditions may modify the competitiveness of species, which eventually may cause changes in the biological diversity of ecosystems and their productivity. In Lithuania these issues have so far only been so far addressed in a fragmented manner.

14. Agro-ecosystems are subject to the largest anthropogenic impact. Recent years in Lithuania have been characterised by the new trend of the non-sustainable use of agro-ecosystems and farming, in which the areas of winter wheat and rape violate proper plant rotation principles. Seeking to maximise yields the use of nitrogen and chemical plant protection measures is rapidly increasing but without respecting the actual plant nutrition and health status and good farming practice. There have been only a few studies on the impact of the intensification of agro-ecosystems upon their sustainability and biological diversity, as well as on the rural landscape. The incumbent European Union Member States have been intensifying studies related to the impact of the different agricultural technologies on the environment throughout their life cycle. Such studies are also relevant in Lithuania.

15. An important component in determining the sustainability of agro-ecosystems and their productivity is soil. The level of degradation of soil in Lithuania is extensive – about 20 % of soil areas in Central Lithuania are of very low or low humus content, and this number is as high as 74 % in Eastern Lithuania. The rapid increase in the use of nitrogen fertilisers also causes an imbalance between nitrogen and other macrolelements, especially phosphorus and potassium. In the long term the abundant use of fertilisers without their adequately balancing causes the degradation of soil, thus impairing its productivity. It is necessary to initiate detailed and comprehensive surveys on the impact of the ever intensifying exploitation of agro-ecosystems upon the sustainability of soil.

16. Nitrogen is being used increasingly intensely both in Lithuania and globally. Plants directly absorb only up to 50 % of nitrogen, which means that large quantities of nitrogen fertilisers are deposited in ground and surface waters. According to the data of the Environmental Agency, between 2003 and 2010 the volumes of inflow of nitrogen compounds into the Curonian Lagoon and the Baltic Sea more than doubled. The ever increasing eutrophication of surface waters creates a serious threat to the sustainability of water ecosystems. It is absolutely necessary to intensify studies in fertiliser leaching and water bodies eutrophication processes.

17. Lithuania has accomplished a number of agronomic experiments studying the impact of agro-technical elements and technologies on the productivity of plants and soil. However, the peculiarities of the global climate change challenges or the nature or the scope of

its impact upon the national crop production has still only been examined to a limited extent. The complexity of agricultural systems and the variety of other management measures requires an evaluation of plant, soil and water resources and their quality both at the level of a specific measure or a function, as well as on the level of the agro-ecosystems and the landscape. Up to now there has been no one answer to the question of how to ensure that the ever intensifying agricultural production does not destroy the agro-ecosystems and their biological diversity. One of the major challenges of modern research activities is to find ways to preserve the functions of ecosystems and optimise the services provided thereby by intensifying the use of agro-ecosystems.

18. In the course of the past two decades the soils used for agricultural purposes have been rarely limed, thus making it increasingly acid. The areas of relatively acid ($\text{pH} < 5.5$) soil areas now already exceeds 25 % of the total area. In view of the increase in the use of biological fuel as well as the volumes of its waste – ash, the use of ash for de-acidification of soils, as well as an appropriate regulation of the means, is becoming an important scientific and practical problem. One of the tasks is to study the impact of ash on soils of different types and of varying acidity, and also upon its structure and pedobiotas, which will facilitate drawing up the standards and the technologies for using ash. Another task is to establish how much of the waste of agricultural activities (straw) could be reasonably used without causing any damage to agriculture. In that relation it is important to promote studies in the possibilities of the use of herbaceous perennial plants for biofuels.

19. In view of the rapidly intensifying agricultural activities large-scale mono-crop areas are becoming predominant in the country, thus essentially changing the rural landscape of Lithuania. The fragmented landscape traditionally characteristic of Lithuania is gradually deteriorating, and regions of intensive agricultural activities are gradually acquiring the characteristics of a steppe. These complex processes and their outcomes have been only studied in Lithuania to a limited extent.

20. Studies in climate change and its impact on forest ecosystems have been devoted exceptional attention in the course of the past decades. In view of global warming it is forecast that vegetation will move towards areas of higher latitudes and more continental regions. The extinction of northern species and an increase in southern species is an already observable phenomenon. In theory, the increase of CO_2 should accelerate the synthesis of primary metabolites, and enhance the productivity of stands; however, the results of studies carried out in different countries are controversial. Hardly any studies of this nature are being carried out in Lithuania.

21. The different studies on the impact of climate change and the related phenomena (draught, heat and cold waves) on forest ecosystems, as well as in other factors (the increase in the concentration of underground ozone, ultraviolet radiation, eutrophication, etc.) ordinarily focus upon the impact produced by specific factors. The actual threats created by climate change and other changes in the environment upon the sustainability of forest ecosystems and their biological diversity can be identified only by studying the consequences of the interrelationship between the different factors and their overall impact.

22. Forest ecosystems create a large part of the primary land production, and by assimilating extensive volumes of carbon dioxide materially affect the overall carbon cycle and its balance. Forests absorb about 15 % of the global anthropogenic carbon dioxide, and thus

make an essential contribution to mitigating climate change processes. The ability of trees to assimilate, extensively accumulate, and isolate carbon is related to the impact produced by external factors and their overall synergy effect which have not yet been extensively studied. There are significant gaps in data about the ability of characteristics of Lithuanian forest ecosystems (different age, species composition, structure or capacity) to absorb and accumulate carbon.

23. In making an assessment of the impact of climate and environmental change on ecosystems it is of utmost importance to have data representing a significant period of time. An analysis of tree rings allows the retrospective identification of the annual growth in the diameter of trees within the past decades, or even centuries, and, by applying the different forecasts of the climate change, an assessment of the possible changes in the growth and productivity of the different species of trees can be made. It is for this reason that studies of the remains of tree species which thrived in different periods in the past and which are still extant in the abiotic environment are significant. Different research including monitoring and measurement of the different meteorological and environmental indicators, tree growth, intensity and the composition of the flow of materials, or the intensity of other physiological indicators is increasing globally. No such interdisciplinary research has been carried out in Lithuania yet.

24. Some valuable information about the seasonal changes of trees and other plants may be derived from the data of the long-term phenological observations. In view of the intensifying climate change the reviving phenology science is being adapted for the assessment and forecasting of the outcomes of climate change. It has been proven that as a result of climate warming in the course of the last several decades the vegetation period of different tree species has lengthened by 2-3 weeks. Different plant species respond differently to climate warming, thus causing changes in their competitive behaviour which in turn leads to material modifications in the biological diversity, structure and productiveness of ecosystems. In Lithuania data of phenological observations are still rarely used in studies on the impact of climate change on plant growth and development, and for forecasting changes in their seasonal development.

25. There is a shortage of studies regarding the adaptation of tree populations and tree genotypes to progressing climate and environmental changes. The genetic diversity of the tree population is one of the main factors which ensures the resilience of stands and their adaptability to the impacts of the external stress factors. In the course of evolution forest tree populations have adapted themselves to continuous climate and environment changes, therefore any sudden anthropogenic climate change may cause a threat to the genetic degradation of local tree species. There have only been a limited number of studies on the impact of forests exploitation on genetic diversity, forest stability, plasticity and adaptability.

26. The exploitation of forest ecosystems is constantly increasing: with a view to meeting the growing need in biofuel, forest felling also involves the removal of not only tree stems, but also felling waste and tree stumps. This disrupts the natural metabolism, thus destroying ecological niches for different organisms, impoverishing the entire forest ecosystem, including soil and its fauna, and the live surface. A number of countries have engaged in studies on the impact of the intensive removal of biomass from forest ecosystems on their sustainability, biological diversity and productivity. Some countries have introduced stringent restrictions related to the intensity of the removal of biomass from forests. It is absolutely necessary to launch studies on the possible degradation of forests in Lithuania and set clear limits for the intensity of exploitation of forest ecosystems.

27. In the course of the past several decades the vast abandoned agricultural areas have naturally become overgrown with forest thus forming new forest ecosystems. It is important to study the sustainability of these newly created forest ecosystems and the formation of their biological diversity. Surveys of the artificial afforestation of the second half of the 20th century with conifers and, in particular, pines showed that artificially cultivated plantations are not sustainable. The stands self-planted in former arable land are characterised by a much wider biological diversity, meaning that they could be assumed to be more resilient; however, the patterns of formation of their biological diversity, their productiveness and carbon absorption capacities still need to be studied.

28. The changing climate and environment conditions heavily affect water ecosystems. The warming climate changes and often worsens the reproduction conditions of water organisms; some fish species cannot spawn matured roe, or the roe already spawn find itself in an environment not favourable for hatching. The maximum water temperature rising above the usual values in the warmest period of the year may damage organisms not tolerant to warm waters. Other contributing factors are the eutrophication of water bodies; therefore it is necessary to continue to study the complex responses of water ecosystems to climate change and the ever intensifying economic activity, eutrophication and chemical pollution phenomena.

29. Dams compromise the integrity of the diversion of the river – the principal quality ensuring the integrity of rivers. When a river is impounded, its natural diversions are replaced by artificial water bodies, thus creating obstacles for the natural migration of fish and other organisms, changing their living conditions, diminishing biological diversity, causing fluctuations in the water level and causing the erosion of the river bed. Any sudden and frequent fluctuation in the water level is detrimental to fish roe and fry. Studies have shown that even small dams adversely affect fish populations and water plants, invertebrates and other components of river ecosystems. The ecological conditions in the water bodies of small hydroelectric plants has been established as being bad or very bad, while although the conditions of the water ecosystems below the dams is better, it still remains bad. It is necessary to expand studies on the impact of dams upon water ecosystems and propose measures for mitigating the adverse impact of dams.

30. More than 4 000 km of river beds were straightened in the course of the land reclamation processes. The process destroyed embankments and creeks which are vitally important ecological niches for water micro-organisms, plants and animals. The decreased areas of habitats for the organisms and the impoverished biological diversity of river ecosystems created conditions conducive for the proliferation of parasite diseases. Without having carried out the relevant studies it is not clear how the water ecosystems will be affected by the deepening of the bottoms of water bodies, or the establishment of piers, including on the shore of the Baltic Sea. Resolution No. 787 of 23 July 2008 of the Government of the Republic of Lithuania 'On the approval of the Annex to the cohesion promotion action programme' provides for a measure of the action programme 'Improvement of the condition of water bodies', the purpose whereof is to improve the ecological and/or chemical condition of surface water bodies. However, a comprehensive evaluation of the impact of climate change and pollution factors on water ecosystems and their biological diversity requires complex interdisciplinary research and forecasting.

31. The economic and social environment directly and indirectly affects the traditions and methods of the ecosystem resource exploitation, form the need for the assumptions for the

concept and criteria of sustainability and sustainable development, and their integration into the strategies of the national, regional and global policy. The Millennium Ecosystem Assessment entitled 'Living Beyond our Means: Natural Assets and Human Well-Being' (2005) promoted a rapid development of theoretic and empiric research; however, most of the research focused on one or merely several aspects of sustainability and so attempts to produce a consistent integrated approach which would enable the application of the ecosystem sustainability concepts in practice – when planning, managing and adopting political decisions – were not successful. There is a shortage of research revealing the impact upon the individual functions (services) of ecosystems produced by ecosystem management decisions, and upon their entirety at landscape and regional levels. In Lithuania such research has been yet carried in a fragmented manner only.

CHAPTER III

OBJECTIVE AND TASKS OF THE PROGRAMME, IMPLEMENTATION MEASURES

32. The objective of the Programme is to obtain, analyse and generalise, through integrated scientific research, new scientific knowledge about the impact of climate change and the use of ecosystem resources on the ecosystems of Lithuania, their adaptability to the changing climate and environmental conditions, and, having acquired new fundamental and empiric knowledge about the overall consequences of the use of ecosystem resources, to propose measures to avoid threats related to such consequences and draw up new guidelines for controlling and restoring the sustainability of ecosystems.

33. The tasks of the Programme are to:

33.1. study the effects of climate change and other environmental stress factors on agro-, forest and water ecosystems, their productivity and biological diversity;

33.2 study how the intensive exploitation of resources affects agro-, forest and water ecosystems, identify the long-term consequences and the possible damage caused by such impact, and propose measures for the restoration of sustainability.

34. Five measures have been envisaged to address the task referred to in sub-item 33.1 of the Programme:

34.1. Measure 1 – identify patterns of the development, productivity, competitiveness and the formation of the biological diversity of agro-, forest and water ecosystems in view of the changing climate, as well as the mechanisms and the consequences of the interrelationship between cultural plants and their competitors, symbionts, and pests. The research intended under the Programme will study the all-around impact of climate change and other factors, such as the increasing concentration of CO₂ and rising temperatures, the increased frequency of droughts, heat and cold waves, seasonal changes, the increasing concentration of underground ozone, the increasing intensity of UV radiation or eutrophication on the productivity of ecosystems and their biological diversity. The tasks to be accomplished under the Programme include studies of the different environmental factors on the structure and populations of agro-, forest and water ecosystems, and on the conditions of individuals and their habitats. An output of the studies will be a set of recommendations regarding the preservation of rare species and their populations in view of the intensifying exploitation of ecosystems. The activities under the Programme will seek to obtain new knowledge about long-term development patterns, the relationship between communities of different species (mutualistic, competitive, parasitic, etc.) within ecosystems

perceived as a set of closely interactive sets of different species. Another area of research will involve studies in the trophic relationship between ecosystems, changes in the competitive relationship between populations and communities, an assessment of the trends of parasite and pest outbreaks in view of the changing climate, and studies on the impact of biological diversity on the functioning and sustainability of agro-, forest and water ecosystems. These studies will involve simulations of carbon flows and forecasting of changes in the accumulations in the agro- and forest ecosystems exploited at different intensities, studies in the carbon absorption and accumulation capacity of forest stands of different ages, species composition, structure and productivity, and the dependence of the process on the different external factors; recommendations will be made regarding the measures designed to optimise the carbon cycle on the ecosystem and landscape levels. Furthermore, the activities under the Programme will involve complex studies in tree increment, and the dependence of its seasonal development and the determining physiological processes on the changes in climate and the environment, eventually producing the forecasts of changes in the productivity, condition and species diversity of indigenous stands.

34.2. Measure 2 – study the potential of plants and other organisms to adapt to changing climatic, environmental and technological factors. The activities under this measure of the Programme will include studies of long-term changes in the productivity, structure and biological diversity of agro-, forest and water ecosystems, and an assessment of the adaptability of such ecosystems to the changing climate and other environmental conditions. The measure will involve studies of the way in which the preservation and the restoration of biological diversity affects the adaptability of the systems to climate change and the resulting extreme natural phenomena. An object of the studies under the measure will be the impact of species of plants and other organisms, and their genetic diversity, on the sustainability of communities and their populations, as well as their adaptability. Researchers will study the response of different types of plants and species to the impact of the different climate and environmental factors, the mechanisms determining their adaptability, the activity of phitohormones, enzymatic and non-enzymatic anti-oxidants and stress proteins, gene expression and the overall anti-oxidant system. Other research objects will be possible changes in the competitiveness of plants and other organisms and their impact on biological diversity, and the peculiarities of the pheromone communication of insects harmful to plants under the climate change conditions and studies of the adaptability of agricultural plants and segetal flora to the changing climatic and environmental conditions with a view to assessing modifications in their competitiveness. Activities under the measure will include studies of the effect on the adaptability of plants of agro-technical and forestry measures and technologies. The Programme will launch long-term studies of agro-, forest and water ecosystems to the ever intensifying exploitation. The measures implemented under the Programme will identify patterns for the formation of the biological diversity of naturally growing forests in derelict lands and evaluate the sustainability of those new ecosystems and their adaptability to the changing conditions, as well as their impact on the landscape.

35. Two measures have been envisaged to address the task referred to in sub-item 33.2 of the Programme:

35.1. Measure 1 – study the impact of the extended and intensive use of resources on soil and other components of agro-, forest and water ecosystems. The activities under this measure will include fundamental and applied research with a view to acquiring new knowledge which

will help ensure the sustainability of ecosystems, their biological diversity and will retain the functions under the conditions of the ever intensifying exploitation of resources, and climatic and environmental change. The research conducted will seek to study new methods of intensive exploitation of agro-systems, their impact on sustainability and productivity, and also examine the structure of the soil, its chemical composition in relation to the changes in the abundance of groups of pedobiota organisms and biological diversity. The studies will also include a simulation of the interrelationship between climate change and intensive crop and animal production, while assessing its impact on the biological diversity of agro-ecosystems, carbon and water balance and the quality of water.

Under the Programme researchers will study the impact of the disbalanced development agriculture and intensification of plant growing by violating the principles of good agricultural practice on the sustainability of agro-ecosystems. In addition, it is intended to renew and expand studies in the leaching of mineral fertilisers and pesticides from agricultural areas, the transformation and migration of fertilisers and pesticides to surface and underground water bodies, and the impact of such developments on the sustainability of ecosystems, as well as the efforts taken to specify their exchange models. Research will be undertaken to identify the possible impact of the removal of the biomass from ecosystems in relation to forest felling on the soils of forest ecosystems, substance exchange, biological diversity and the productiveness of stands. The researchers will analyse the extent of the preservation of biological diversity which may be useful for strengthening the sustainability of agro-, forest and water ecosystems, and for increasing their productivity under the conditions of the long-term intensive use of resources and climate change;

35.2. Measure 2 – identify the threats to ecosystems caused by the intensive employment of technologies and the measures needed for the restoration of their sustainability. The activities under the measure will include comprehensive studies in the impact of agricultural, forest and fisheries technologies on agro-, forest and water ecosystems. In addition, research will be undertaken in food product flows in agro-ecosystems, the peculiarities of their accumulations and balance under the conditions of the intensifying agriculture and concentrated livestock farming in order to establish possible ways of increasing the efficiency in food product absorption, recirculation and reduce the leaching of such products on ground and surface waters. Studies will be conducted on the threats of the intensive use of agro-, forest and water ecosystems on their sustainability defining the limits and the standards of the use of ecosystems, identifying ecological, economic and social criteria and indicators facilitating an assessment of the impact of the use of the different methods and technologies of the use of agro-, forest and water ecosystems on their long-term sustainability, and the submitting of proposals for an improvement of the models for monitoring and forecasting environmental impacts. Studies will be carried out on trends in the prevalence of pests, diseases and weeds in intensive crops, the immediate and indirect threats of the rapidly intensifying use of chemical control means on biological diversity, in addition to an assessment of the risk of a leak of pesticides and fertilisers into water ecosystems providing for their ultimate control measures. The research activities under the Programme will include complex studies on changes to the structure of the landscape caused by the intensifying of economic activities and the threats caused by such changes on ecological functions and biological diversity. Having regard to the intensifying use of biofuels and the increasing volumes of waste in fuel incineration, studies will be conducted on the impact of ash on the sustainability of soils of different types or acidity, with a view to developing ash use technologies and the drawing up of the respective regulations. The integrated

interdisciplinary studies will be conducted with a view to substantiating measures proposed for the purpose of restoration and enhancement of the sustainability of the intensively exploited agro-, forest and water ecosystems, and for identifying principles for the use of ecosystems and the development of respective models.

CHAPTER IV

PROJECTED OUTCOMES, THEIR ASSESSMENT CRITERIA AND THE POSSIBILITIES FOR USE

36. The projected outcomes to be achieved having successfully implemented the measures specified under Item 33.1 are:

36.1. to identify patterns of the impact of climate change and other environment stress factors on agro-, forest and water ecosystems, and make a long-term prognosis for the development in the productivity and biological diversity of ecosystems exploited at different intensity.

36.2. to obtain knowledge about the changes of biological diversity or the soil condition of the intensively used ecosystems, and identify the development trends and reasons for negative changes and threats, together with possible damage and protection means;

36.3. to identify new inter-species relationships between ecosystems, and establish the extent to which the complex protection of biological diversity may increase the productivity and sustainability of agro-, forest and water ecosystems;

36.4. to establish general mechanisms for the adaptability of plants and other organisms by making an assessment of the competitiveness and the adaptability of different species to the changing climate and the ever intensifying use of resources, as well as proposing research-based measures and recommendations for the enhancement of such ability.

37. The projected outcomes to be achieved having successfully implemented the measures specified under Item 33.2:

37.1. to identify the impact of the intensive use of biological resources on sustainability of agro- forest and water ecosystems, and also the long-term consequences, defined limits and standards for the use intensity, assessed potential damages and research-based recommendations on the ways to avoid any possible adverse impact on the sustainability of ecosystems;

37.2. to identify changes in the landscape, soil, biological diversity, migration of nutrition materials and harmful organisms related to the intensive use of ecosystems, assess the threats posed and define measures for mitigating the threats compliant with the national development strategy;

37.3. to develop principles and criteria for the planning and efficient management of economic activity, proposed measures and methods for the sustainable use of agro-, forest and water ecosystems, methods to restore damaged ecosystems under the conditions of the intensifying agriculture and forestry economic activity and the changing climate;

37.4. to add a stimulus to the innovative, economically efficient, environmentally-friendly and socially acceptable development of production and related technologies by setting preconditions for the development of business based on such technologies in regions.

38. Basis of the research carried out within the framework of the Programme:

38.1. no less than 50 scientific articles published on the subject of the Programme in peer-reviewed publications which have a citation index in the Thomson Reuters Web of Science database;

38.2. no less than three long-term prognosis for the changes in the productivity and biological diversity of ecosystems used at different intensity;

38.3. formulated principles for planning and efficient management of economic activity, recommended packages for public authorities, other institutions and business entities of no less than five research-based measures, methods and recommendations for ensuring the sustainability of ecosystems and avoiding potential adverse effects on them;

38.4. at least 5 scientific conferences, 5 scientific-practical seminars, practical training, no less than 30 popular scientific articles with information for specialists and society published in media;

38.5. no less than 10 (ten) doctoral students and master's degree students trained in the area and ensuring the continuity of the research on the subjects covered by the Programme;

38.6. no less than 3 technology prototypes developed and the respective patent applications filed.

39. The results of the research conducted under the Programme will be submitted to:

39.1. national public authorities – the Government of the Republic of Lithuania, the Ministry of Agriculture, a package of proposals 'Regarding the integration of the principles, criteria and indicators of a sustainable used of ecosystem resources into the developed agriculture, forest and renewable energy strategies and measures' for the Ministry of Environment'.

39.2. a package of recommendations for national economic entities 'Intensive and nature-friendly farming: climate change, landscape, biological diversity, ecosystems';

39.3. a package of recommendations for agricultural business 'Regarding the application of agricultural production technologies and technical measures compliant with the fundamental sustainability requirements';

39.4. methodological and visual material on ecosystem subjects for implementers and students of study programmes at high schools, such as 'Ecology and environment studies', 'Biological diversity', 'Agronomy', 'Parasitology', 'Landscape ecology' and 'Environment policy'.

40. The most important qualitative criteria for the assessment of the results of the Programme are the relevance, substantiation, reliability, innovativeness, and novelty of the results, the coherence of the results of the survey with the research objectives and the implementation measures of the Programme, the dissemination of the results of the research to the public, public authorities and society. The results of the research carried out within the framework of the Programme will be evaluated by experts.

41. The criteria for the evaluation of the implementation of the Programme tasks are the following:

41.1. the number of articles on the subject-matter of the Programme published in peer-reviewed publications which have a citation index in the Thomson Reuters Web of Science

database; the publication of research results will need to include an acronym and the number of the Programme project.

41.2 . the number of submitted packages of recommendations;

41.3. the number of master's, doctor's and post-doctoral students participating in the Programme;

41.4. the number of technology prototypes and patent applications;

41.5. the intensity of the dissemination of the results generated by the Programme: the number of presentations at international science conferences, practical training events and information for specialists, and the dissemination of the measures of the annual results of the Programme to the public through the media.

CHAPTER V

IMPLEMENTATION OF THE PROGRAMME, MONITORING AND REPORTING

42. The Programme shall be administered by the Research Council of Lithuania (hereinafter – the Council), in accordance with the Regulations of the National Research Programmes approved by the Government of the Republic of Lithuania, and the Description of the procedure for the preparation and the implementation of the National Research Programmes approved by the Council and agreed with the Ministry of Education and Science.

43. The Council will carry out the monitoring of the implementation of the Programme; while performing this function the Council will review the results of the Programme on an annual basis, and will draw up an interim and the final report for the Programme, publish the reports on the website of the Programme, and organise an evaluation and public discussion of the reports.

44. For the purpose of an interim evaluation of the Programme the Council shall evaluate an interim report submitted by the Programme implementation group; such interim report shall be submitted after four years of the Programme's implementation. Having evaluated the report on the Programme the Council may propose to specify the Programme, or, in the case that the Programme is implemented unsatisfactorily or insufficient funding has been allocated for the implementation of the Programme, propose the implementation of the Programme be terminated earlier than initially anticipated.

45. The reports of the Programme specifying the results of the projects implemented under the Programme, as well as the conclusions obtained and the recommendations submitted to the ministries concerned and other institutions which will be published at events, in relation to publishing the results in the media and other means of information.

CHAPTER VI

FINAL PROVISIONS

46. The Programme shall be funded subject to the financial capacities of the State by appropriations from the budget of the Republic of Lithuania committed for the Council and other legitimate funding sources. The projected period for addressing the tasks and the implementation

of the measures within the Programme is 2015-2021. A preliminary funding demand for the tasks and the measures in 2015-2018 is specified in the Annex to the Programme. Having examined and evaluated the results of the interim report of the Programme the Minister of Education and Science provides for the funding requirement for the implementation of the Programme in 2019-2021.

47. The implementation of the Programme is completed after the Research Council approves the final report of the Programme.

NATIONAL RESEARCH PROGRAMME
'SUSTAINABILITY OF AGRO, FOREST
AND WATER ECOSYSTEMS'
ANNEX

**NATIONAL RESEARCH PROGRAMME 'SUSTAINABILITY OF AGRO, FOREST
AND WATER ECOSYSTEMS'
MEASURE PLAN FOR 2015-2018**

Task of the Programme	Measures implemented with respect to the task of the Programme	Preliminary funding requirement EUR'000				
		2015	2016	2017	2018	Total:
1. To study the effects of climate change and other environmental stress factors on agro-, forest and water ecosystems, their productivity and biological diversity.	1.1. Identify the patterns of the development, productivity, competitiveness and the formation of the biological diversity of agro-, forest and water ecosystems in view of the changing climate, as well as the mechanisms and the consequences of the interrelationship between cultural plants and their competitors, symbionts, and pests. 1.2. Study the potential of the potential of plants and other organisms to adapt to climate, environment and technological factors.	390	530	530	530	1980
2. Study how the intensive exploitation of resources affects agro-, forest and water ecosystems, identify the long-term consequences of such impact and the possible damage caused by such impact, and propose measures for the	2.1. Study the impact of the extended and intensive use of resources on soil and other components of agro-, forest and water ecosystems. 2.2. Identify the threats to ecosystems caused by the intensive employment of technologies, and the measures needed for the restoration of their sustainability.	390	530	530	530	1980

Task of the Programme	Measures implemented with respect to the task of the Programme	Preliminary funding requirement EUR'000				
		2015	2016	2017	2018	Total:
restoration of sustainability.						
Total		780	1060	1060	1060	3960
