The Earth, being a shut-down ecosystem with limited natural resources, can only rely on solar energy. Every natural resource, such as food, water, timber, ores oil and natural gases, is restricted by the availability and absorption capacity of the ecosystem. In order to reach sustainable development, the self-subsistence and self-organization of ecosystems must coexist with anthropic processes, otherwise their imbalance will in turn lead to self-induced entropy. However, climate changes including a global warming has an increasing negative impact on natural and artificial ecosystems and further on polish and global economy, especially in terms of agriculture and forestry. “During the last two decades a significant slowdown in seed yield has been reported, especially for rice, wheat and maize” – says Michael Oppenheimer, bioclimatologist from Princeton, one of the authors of IPCC report for UN. The existing agricultural mechanisms and farming methods are largely exhausted. It is estimated that real yield, lowered by diseases, pests and weeds, as well as changing weather conditions, reaches in some regions up to 70%. In 2015 spring cereals yield also in Poland was reduced by 45% due to drought stress. Plants challenge constantly fluctuating environmental conditions such as changing light intensity, UV radiation, drought, salt stress, heat, cold, flooding or pathogen attack. These stresses are among top factors causing worldwide yield loss in global and polish agriculture.

The growing public demand for sustainable energy supply and to protect the global environment by reducing emissions of carbon dioxide (CO_2) indicates that photosynthesis and the production of plant biomass and plant seeds are again considered as the basic processes for agro-biotechnology to improve the global CO_2 assimilation. Productivity of photosynthesis is directly related to the loss of water by the plant (water use efficiency), and is in part a consequence of plants’ conservative response to sudden changes in their environment. Therefore, the aim of this project is to identify new features of signalling network in plants dependent on PsbS protein and mechanism of NPQ and on the newly discovered gene TACH1 and to study theirs impact on the productivity of plants in the field, on the induction of so-called cellular light memory in plants, acclimation and induction of cell death. Recently Dr. Scott Boden of the John Innes Center in Norwich, UK, whose laboratory genetics of crops together with his colleagues from Australia and Cambridge carried out a study of gene TEOSTINE BRANCHED1, which regulates the number of grains per spike of wheat, said that these studies carried out "from the field to laboratory and again to the field "are a breakthrough in the study of gene function.

Recently, the Long group from USA showed that plants with increased levels of PsbS and xanthophyll cycle enzymes (VDE and ZEP) resulted in accelerated acclimation to natural shading events in Nicotiana benthamiana, and this in turn gave increased leaf CO_2 assimilation and plant dry matter productivity increased by about 15% in fluctuating natural light conditions. However, it is not clear if the higher plant biomass production (higher growth rate) will or will not correspond to the higher seeds yield in the field condition. That's why our research and the potential results of these studies on the function of such genes as PsbS and TACH1, the latter discovered by the team of prof. Stanisław Karpiński, are scientifically competitive and fit into the latest research trend in the world.

The proposed OPUS project is based on a hypothesis that has broad cognitive and socio-economic implications. This project responds to the strategic priorities of the program "Horizon 2020", "food security", "Adapting to the changing environment" and to "abiotic stress". With more and more uncertain global food security, plant scientists are asked to transfer the test processes from model species in the laboratory to crop species in the field. Unfortunately, there are not many successful examples of this transfer of knowledge from plant breeding laboratories. JB Passioura has noted that the large number of patents filed in the field of crop stress biology is contradictory to the shortage of new tolerant plant varieties. The reason for this may be that molecular genetic laboratories and physiological laboratories are unable to correctly identify the genes and processes regulated by these genes to focus their resources on them. Our proposal research focuses on genes tested and identified in the field traits and for sure will lead in the near future to innovative agro-biotechnology for the improvement of crops like canola and corn.