The predicted increase in the frequency and intensity of long-term episodes of drought may intensify the phenomenon of oak decline and mortality. Incidents of oak decline, mostly associated with severe drought, have been globally reported over a wide range of forests of the northern hemisphere, being a very important economic problem (Rodríguez-Calcerrada et al. 2017: Tree Physiology, vol 7. Springer, Cham). For instance, only recently in Poland more than 100,000 hectares of oak stands suffered from decline, and in Lublin, Piła or Warszawa forestry districts more than 50% of oak forest areas were affected (Gil and Paluch 2009: Notatnik Naukowy 1(81)/2009(XVII). Therefore, nursery practices must be specifically designed to minimize the negative effects of drought and other stresses by producing seedlings with a root system that is less susceptible to drying and capable of extracting water from deeper soil layers. Oaks taproots are capable of drawing sufficient water from deeper soil depths to maintain the health of the entire tree, and thus prevent the economic losses associated with the need to remove and replant trees that cannot survive episodic periods of drought.

Indeed, the architecture of acorn-sown oaks root system facilitates the ability of trees to survive long-term water shortages. However, the problem associated with direct sowing of acorns e.g. exposition the acorns to inevitable damage by rodents, wild boars, birds, is the main reason why this approach to tree cultivation is not widely used. Artificial regeneration of forest stands based on containerized seedlings is a widespread practice in Europe and has been a growing method of forest renewal in Poland. In contrast to acorn-sown seedlings, nursery management practices where seedlings are grown in containers, may alter natural taproot formation. The most common practice applied to seedlings grown in containers is the removal of their taproot by air pruning, which involves forming an air space between the bottom of a container and the surface it rests on. Increasing the planting of oak seedlings that are devoid of a taproot system may result in the mass extinction of oak stands.

Drought resistance in oak tree stands may be improved by planting oak seedlings growing in containers that are capable of drawing water from deeper soil layers. Considering the fragmentary state of our current knowledge on the consequences of agrotechnical treatments (seedlings production in containers) on the long-term growth and fitness of oak stands, it is essential to obtain and evaluate biological data that can potentially be used to improve nursery practices and thereby result in the production of higher-quality oak seedlings with an increased ability to persist and grow into mature trees suitable for timber harvesting. Understanding how container-oak production practices influence taproot development when seedlings are subsequently planted in a forest site, requires a perspective that takes into account the endogenous traits and ontogenetic growth patterns resulting from forest practices. An analysis of the factors conducive to the development of a taproot in containerized seedlings will be conducted through the integration of anatomical, physiological, and molecular approaches. Conducting research that includes aspects of tree biology and forest management could have a major impact on the production strategies used to generate containerized seedlings. Such knowledge will provide measurable benefits to tree nurseries by providing novel, innovative approaches to generate high-quality seedlings with improved resistance to biotic and abiotic stress.

The optimized procedures for oak cultivation that will be designed can be used by foresters and nursery managers to enable more intense production of high-quality, containerized seedlings with the desired root system architecture. The knowledge generated by the proposed project can have significant economic and social impact by creating improved sustainable nursery production systems for oaks, one of the most high-valued tree species. The knowledge and practical seedling production strategies gained from this project have the potential to enhance the amount and quality of oak timber to levels that exceed present forest management practices. Such products will have a high economic value. In conclusion, the application of the information derived from the proposed project will improve the effectiveness of stand establishment by ensuring the production of high-quality oak seedlings, as the use of containerized seedlings that retain their taproot system after planting will reduce the loss of economically and environmentally valuable oak trees.