

WHEATAMIX
Increasing within-field wheat diversity
to foster ecosystem services
in the Parisian basin

THE WHEATAMIX CONSORTIUM¹

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Summary: Crop genetic diversity should play an essential role in the context of global change, as it can promote various ecosystem services essential for yield stability, adaptation to climate change and resistance to pests and diseases. In this context, the National Agency for Research project WHEATAMIX investigates mixing wheat genotypes to reinforce the sustainability of agricultural production in the Paris Basin, France. WHEATAMIX analyses the interactions among genotypes and with the environment, to develop new methods for breeding and/or combining wheat varieties to obtain blends performance, in terms of yield and quality, as well as other ecosystem services.

Background

During the 20th century, agriculture experienced major gains in productivity via homogenization and intensive use of inputs, two key components of the dominant model of agriculture in developed countries. This model is jeopardized by the awareness of rapid global change, increased environmental stochasticity and the need for greater agricultural sustainability. A new paradigm is emerging in which biodiversity is considered as a crucial asset for sustainable agriculture, relying more on ecological functions within agroecosystems. Crop genetic diversity should play an essential role in this context, as a key element contributing to agricultural multi-functionality and to the resilience of agroecosystems under rapid climate change and decreased chemical inputs. However, the use of genetic diversity within agroecosystems faces ecological, socio-economic, organizational and regulatory challenges.

Variety Mixtures for wheat production in the Paris basin

The main goal of the WHEATAMIX, a four years project started in January 2014, is to better evaluate the possible roles of within-crop genetic diversity to reinforce the multi-functionality and resilience of cropping systems under global change. WHEATAMIX focuses on a major cereal, wheat, in a central area of production, the Paris basin. The research is based on a highly multidisciplinary approach involving geneticists, agronomists, ecophysiologicals, ecologists, economists and management scientists, as well as key stakeholders (“Chambres d’Agriculture”, farmers). It is structured in four complementary work-packages (fig. 1):

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- WP1 characterises key morphological/ecophysiological traits and genetic variability of wheat genotypes. We examine the plastic response of these traits to plant-plant interactions and test how trait complementarity affects the performance of wheat genotypes in blends through experiments and modelling.
 - WP2 quantifies multiple ecosystem services provided by variety diversity within wheat fields: yield (including grain quality) and its stability, regulation of foliar diseases, insect pest and weed biocontrol, maintenance of soil fertility, along with biodiversity conservation. We analyse trade-offs and synergies among ecosystem services, as well as links between particular groups of services and bundles of variety traits.
 - WP3 studies the techno-economic performances of blends and associated groups of services for -and their acceptability by- key stakeholders. We explore the organisational and economic bases of blend choice by the wheat chain (from seed companies to millers), with a focus on the Paris basin. Existing lock-in to the use of associations of wheat varieties will be analysed.
- These three WPs use common, complementary experimental approaches: i) individual plant phenotyping to characterize traits and their plasticity for 50 wheat varieties; ii) a main diversity experiment (sixty-five 100m² wheat plots with 1, 2, 4 or 8 varieties, under low input) to quantify variety diversity effects on ecosystem services; iii) replicates of the same diversity experiment in 5 sites across France using smaller (7m²) plots, under low and high inputs, to test the robustness of wheat diversity under a wide range of environmental conditions; iv) a network of 50 farms, encompassing agro-climatic variability in the Paris basin, to compare the ecological and techno-economic performance of blends with that of monocultures, using direct links with key stakeholders.
- WP4 combines results from WPs1-3 and mobilizes key stakeholders to build scenarios for the development of wheat variety blends in the Paris Basin considering various future climatic and economic contexts. Opportunities offered by and impacts of the introduction of wheat variety blends in the Paris production basin will be assessed on the basis of these scenarios. Furthermore, new breeding methods will be developed for an efficient selection of genotypes with high combining ability in mixtures.

Figure 1:

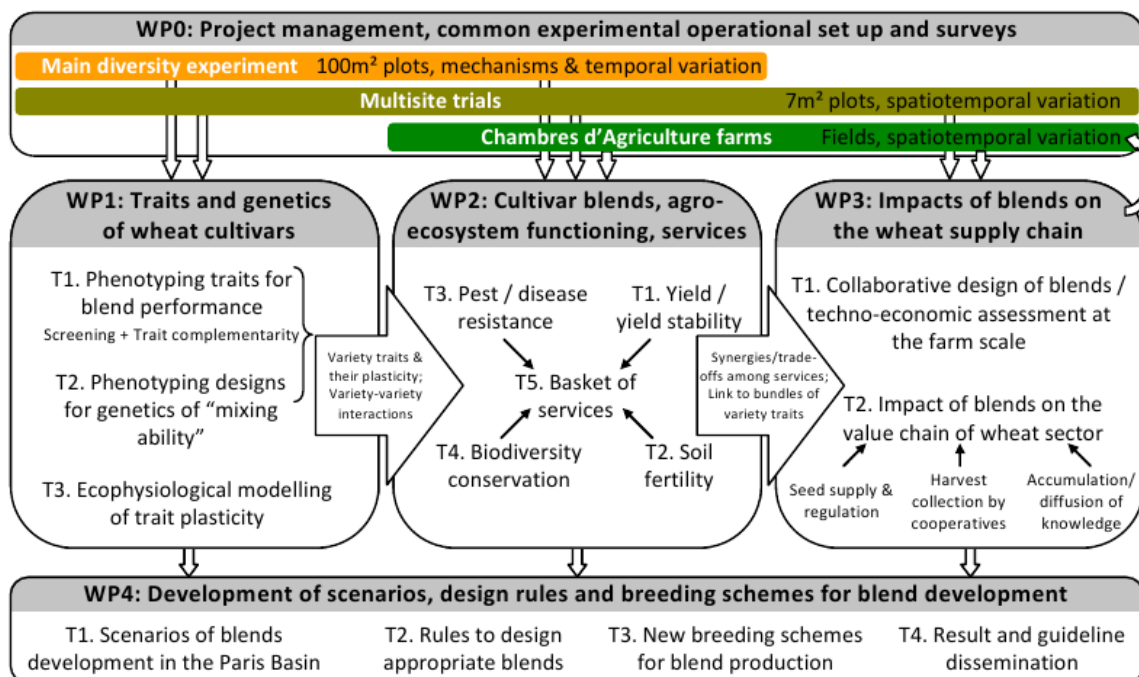


Figure 1: General organisation of the WHEATAMIX project.

Description of the three common experimental designs – Measuring ecosystem (dis)services associated with blends necessitates parallel work of the different teams on shared experiments. Three main designs will concentrate our experimental efforts: 1) one central diversity experiment, 2) a related multi-site experiment, 3) a network of on-farm experiments.