



DIVERFARMING

Crop diversification and low-input farming across Europe: from practitioners' engagement and ecosystems services to increased revenues and value chain organisation





CASE STUDY NUM 3

**Irrigated and rainfed field crops in
Spain**





CASE STUDY NUM. 3

Partners involved

CSIC, ARENTO

Authors

Jorge Álvaro-Fuentes, José Luis Arrúe, Carmen Castañeda (CSIC)

Eduardo López Gomollón (ARENTO)

E-mail of principal author

jorgeaf@eead.csic.es



Case study 3: field crops

- Pedoclimatic región: MEDITERRANEAN SOUTH
- Country: SPAIN
- Location: Zaragoza (REGION OF ARAGON)
- Geographical coordinates: 41° 43' 25" N, 0° 48' 50" W
- Mean annual temperature: 14.8 °C
- Mean annual precipitation: 340 mm



Zaragoza

Rainfed case study

Irrigated case study



Case study 3: Main characteristics rainfed

- Farm extension: 100 ha
- Diverfarming experimentation area: 1 ha
- Current crop: rainfed winter cereal
- Crop final use: Food and feed
- Current cropping system: conventional monocropping
- Harvest time: July
- Current management practices:
 - Intense tillage
 - Mineral fertilizers
 - Pesticides
 - Herbicides
- Current value chain:
 - Producer
 - Distribution
 - Agro-industry
 - Wholesaler
 - Supermarket





Case study 3: Main characteristics irrigated

- Farm extension: 40 ha
- Diverfarming experimentation area: 1 ha
- Current crop: Maize (*Zea mays* L.)
- Crop final use: Food and feed
- Current cropping system: monocropping
- Irrigation system: Flood
- Harvest time: October
- Current management practices:
 - Intense tillage
 - Mineral fertilizer
 - Pesticides
 - Herbicides
- Current value chain:
 - Producer
 - Distribution
 - Agro-industry
 - Wholesaler
 - Supermarket





Case study 3: Main environmental problems

- Low soil biodiversity
- Low soil organic matter content
- Weak soil structure
- Soil, air and water pollution





Case study 3: Diversified cropping systems in rainfed

- A. **Monoculture** (M): Wheat (*Triticum durum*) monocrop
- B. **Diversification** (D): wheat – barley (*Hordeum vulgare*) – vetch (*Vicia sativa*) rotation for food (wheat) and feed (barley and vetch) during 2018, 2019 and 2020. All the three phases of the rotation will be present each experimental year.



Case study 3: Diversified cropping systems in irrigated

- A. Maize (*Zea mays*) monocrop (MC)**
- B. Diversification 1 (D1):** barley – maize multiple cropping for food (maize) and feed (barley) during 2018, 2019 and 2020.
- C. Diversification 2 (D2):** pea – maize multiple cropping for food (maize) and feed (pea) during 2018, 2019 and 2020.



Case study 3: Low input management practices

In rainfed conditions:

- Reduction in tillage intensity

In irrigated conditions:

- N fertilization optimization





Case study 3: Experimental design in rainfed

- **Factors of study:** 1. Crop diversification, 2. Tillage
- **Experimental design:** Randomized complete block design
- **Replications:** Three field replicated plots.
- **Plot size:** 6 x 40 m, 240 m².
- **Crop monitoring and sampling:** at harvest for every crop and plot. Three samples per plot will be taken.
- **Soil sampling:**
 - Time and frequency: every October during three crop cycles.
 - Soil depth: arable layer (0-10 and 10-30 cm).
 - Number of samples: three composite samples per plot (nine samples per treatment) in WP5. For WP4, five out of the nine samples per treatment will be selected.



Case study 3: Experimental design in irrigated

- **Factors of study:** 1. Crop diversification, 2. Optimization of fertilization
- **Experimental design:** Randomized complete block design
- **Replications:** Three field replicated plots.
- **Plot size:** 6 x 30 m, 180 m².
- **Crop monitoring and sampling:** at harvest for every crop and plot. Three samples per plot will be taken.
- **Soil sampling:**
 - Time and frequency: every October during three crop cycles.
 - Soil depth: arable layer (0-10 and 10-30 cm).
 - Number of samples: three composite samples per plot (nine samples per treatment) in WP5. For WP4, five out of the nine samples per treatment will be selected.
- **Greenhouse gas emission measures:** 25 measures per year in the plots where soil is sampled.

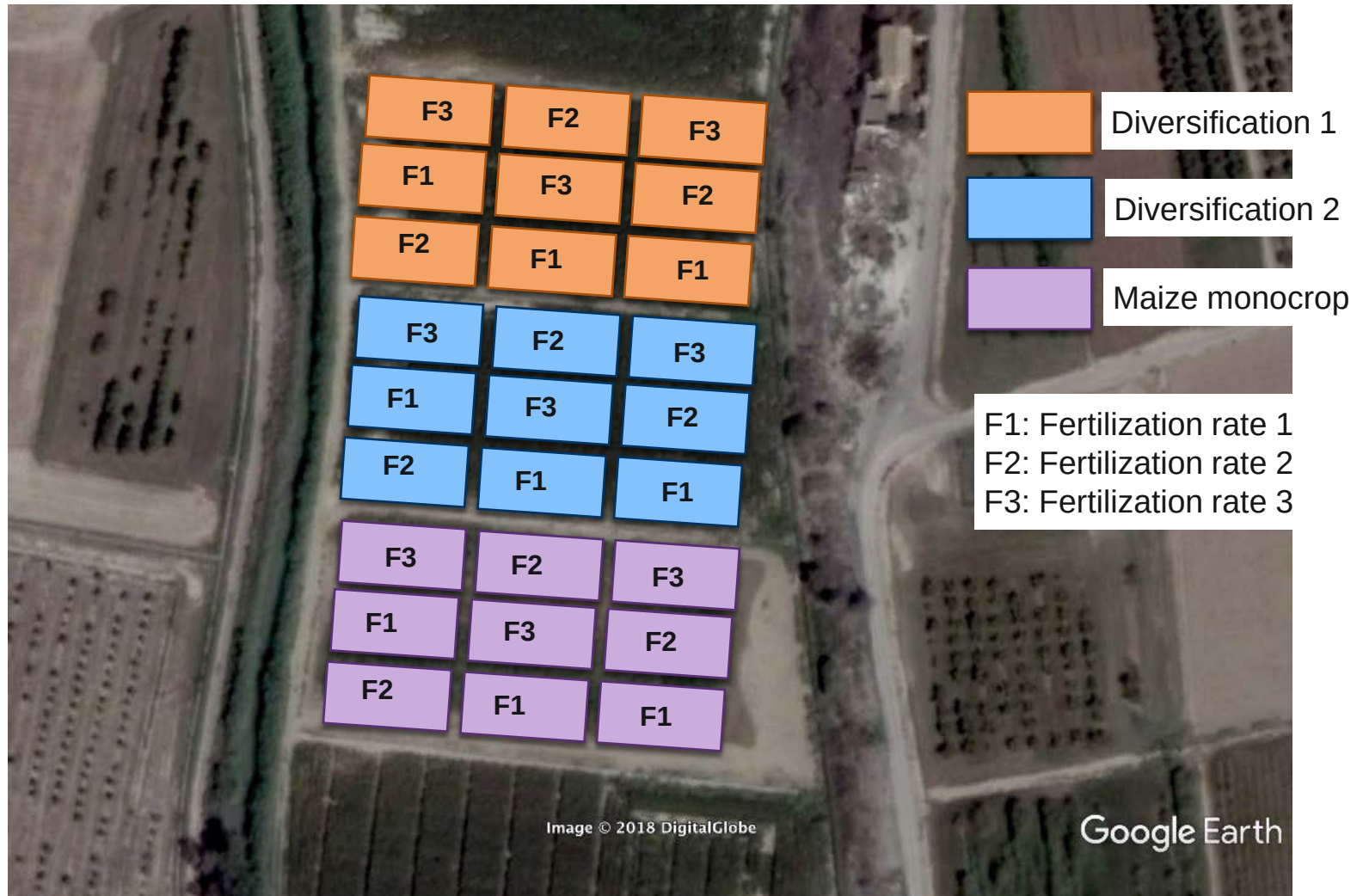


Case study 3: Experimental layout (rainfed)





Case study 3: Experimental layout (irrigated)





Case study 3: Environmental variables

- Elevation.
- Mean annual temperature.
- Mean annual precipitation.
- Mean annual ETP.
- Solar radiation.
- Maximum daily temperature.
- Average daily temperature.
- Maximum daily temperature.
- Cumulative daily rainfall.
- Air humidity.
- Wind speed.



Case study 3: Crop properties

1. Crop growth

- Crop establishment.
- Above-ground biomass.

2. Pests and diseases incidence

- Damage proportion.

3. Crop yield

- Crop yield.

4. Crop quality

- Thousand kernel weight, specific kernel weight, grain humidity.
- Protein, gluten (wheat).

5. Nutritional evaluation

- None



Case study 3: Soil biological properties

1. Microbial community structure and soil-borne diseases

- Soil DNA extraction, amplification and next generation sequencing.

2. Enzyme activities and functional genes

- Dehydrogenase, β -glucosidase, leucine-aminopeptidase, alkaline phosphatase and arylsulfatase activities.
- Potential nitrification.
- Transcriptome of active microbial populations by qPCR and RNA sequencing.

3. Earthworms

- Species identification, density and mass.
- Density and mass by ecological groups.
- Total density and mass.
- Only measured at the beginning and the end of the experimental period.



Case study 3: Soil physicochemical properties

1. Soil fertility and pollutants

- Total N, ammonium, nitrate and available P, K, Ca, Mg.
- pH, electrical conductivity, cation exchange capacity and sum of bases.

2. Soil structure and carbon sequestration

- Bulk density, soil water content at wilting point and field capacity, actual field moisture, texture, total organic carbon, carbonates, organic carbon functional fractions, aggregates stability, aggregates size distribution.

3. Greenhouse gas emissions (for the irrigated case study)

- Soil CO₂, N₂O and CH₄.
- Overall emissions by Life Cycle Assessment.



Case study Num. 3 Coordinator



JORGE ÁLVARO-FUENTES

SPANISH NATIONAL RESEARCH COUNCIL (CSIC)

jorgeaf@eead.csic.es

Tel.: +34 976 71 6123

