

Long-term productivity and sustainability of crop-livestock systems through integrated soil fertility management

Productivity in Crop-Livestock Systems can be maximized using Integrated Soil Fertility Management (ISFM). ISFM combines (i) improved germplasm (ii) mineral fertilizer application (iii) organic matter management and (v) adapted agronomy.

CIAT established a long-term trial in Western Kenya in the village of Murumba Yiro in 2003 to assess ISFM technologies. Maize is the dominant crop in this region, followed by food legumes such as common beans and, more recently, soybean. The area has two rainy seasons enabling farmers to plant crops twice a year.

Objectives of the trial:

1. Assess the impact of contrasting crop rotations in response to the addition of farm yard manure and green manure grown on site
2. To promote integration of organic and mineral fertilizers as a means to restore the productivity of degraded soils

The following technologies are tested every season:

- Nitrogen (N) and/or phosphorous (P) mineral fertilizer (optimum level of application from 0 to 90 kg/ha)
- Farm yard manure 4 ton/ha (FYM)
- Crop residue (R) maize stover 2 ton/ha
- Tephrosia (T)—a fast growing leguminous shrub that is incorporated into the soil
- Micronutrients
- Lime application
- Cropping systems
 - Continuous maize (M-M)
 - Rotation with Tephrosia (M-T)
 - Intercrop with soya bean (Intercr)
 - Soybean and maize



Treatment in the middle includes only mineral fertilizer inputs



One of the best bet combinations with farm yard manure and Tephrosia in rotation without any mineral fertilizer

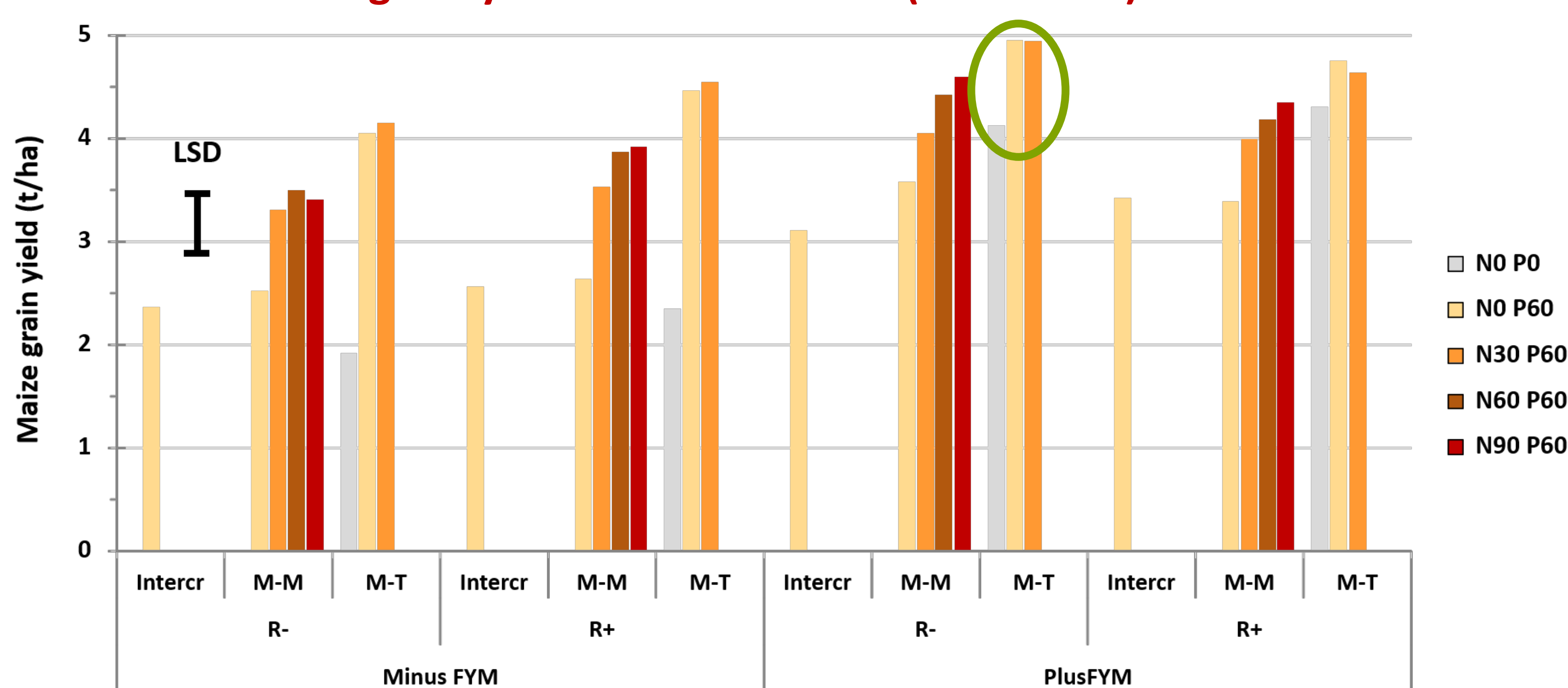


Control treatment without any mineral or organic inputs



One of the best performing treatments with farm yard manure, maize-Tephrosia rotation, maize stover residue, micro-nutrients, lime

Maize grain yield – all treatments (2004-2014)



Maize-Tephrosia rotation plus farm yard manure and without crop residue addition produced the highest maize grain yields per season. The treatment (circled above) looks like a good option for farmers. However, over two seasons the same treatment did not produce high enough yields to match those of continuous maize-maize cropping. Therefore dedicating only a small portion of the field to Tephrosia for a split M/T- M rotation could prove more profitable for farmers.



Soybean – maize rotations and intercropping have potential to improve soil fertility where soils are degraded

Long-term lessons:

Organic matter management

- The Tephrosia-maize rotation is very interesting as it improves soil fertility and sustains yields, but it needs better fine-tuning, which is ongoing with an additional maize/Tephrosia-maize rotation
- Soil organic matter enhances nutrient cycling and availability, performs important biological functions and improves soil physical conditions
- Organic matter application is crucial to generate yield increase
- Soils with low organic matter content are commonly unresponsive to mineral fertilizers and need to be rehabilitated by adding organic resources
- Organic matter can be produced from soybean or green manure such as Tephrosia and added to the system through farm yard manure
- Nitrogen fixation by legumes increases above ground biomass yield

Improved germplasm

- Crop tolerance to drought, soil acidity, low soil P and diseases are important traits. For example, maize variety DH04 tolerates drought conditions and namsoy soybean variety tolerates rust disease
- Improved germplasm should be responsive to nutrient application and have a high yield potential to maximize returns to investment in mineral fertilizers or organic inputs

Mineral fertilizer application

- Mineral fertilizer application alone, without organic matter input (manure and/or Tephrosia), is **not** sustainable, even at 90 kg N, 60 kg P and 60 kg K per hectare and season
- Legumes are responsive to phosphorous-containing fertilizers. Phosphorous application enhances nodulation and nitrogen fixation
- Timely planting and weeding are essential to maximize fertilizer use efficiency

Combining organic matter management, improved varieties, appropriate mineral fertilizer application, and adapted agronomy can double net revenue of the system

Our partners and donors: KALRO, Kenya MOALF, GIZ, SOFDI, CGIAR, CCAFS,



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