Field Crops Research 156 (2014) 272–280

Contents lists available at ScienceDirect

Field Crops Research

journal homepage: www.elsevier.com/locate/fcr

Maize-mucuna (*Mucuna pruriens* (L.) DC) relay intercropping in the lowland tropics of Timor-Leste

Marcos Vidal Correia[a], Leandro C.R. Pereira[a], Luis De Almeida[b,c], Robert L. Williams[b,c], Joseph Freach[b,c], Harry Nesbitt[b,c], William Erskine[b,c,d,*]

[a] *Ministry of Agriculture, Forestry and Fisheries, Comoro, Dili, Timor-Leste*
[b] *Seeds of Life, PO Box 221, Dili, Timor-Leste*
[c] *Centre for Legumes in Mediterranean Agriculture (CLIMA), School of Plant Biology, The University of Western Australia, 35 Stirling Highway, Crawley, WA 6009, Australia*
[d] *Institute of Agriculture, The University of Western Australia, 35 Stirling Highway, Crawley, WA 6009, Australia*

ARTICLE INFO

Article history:
Received 15 October 2013
Accepted 16 October 2013

Keywords:
Velvet bean
Intercropping
Weed management
Legume fallow
Soil fertility

ABSTRACT

Timor-Leste is a small predominantly agrarian society based on subsistence agriculture with maize as the key staple crop and food. Maize cropping is predominantly shifting in a slash and burn system with weed management and soil fertility key issues to farmers. An increasing population and farmer reluctance to use inorganic fertilizer drive the need to find improved cropping systems. This experimental series from 2007 to 2012 was designed to evaluate relay-sown intercropped mucuna (*Mucuna pruriens* (L.) DC var. *utilis*) with maize as a low-input legume intercropping system for its potential in the management of weeds and soil fertility. Factors investigated include legume species, optimum sowing time for inter-crop with maize, comparison of maize sown sole v. maize intercropped with mucuna, weeding regimes, and the effects of crop sequences with mucuna. Delaying mucuna sowing time to approximately one month after maize planting is particularly critical. Comparing continuous sole-cropped maize with maize relay-sown with mucuna, intercropping significantly reduced the weed burden on maize – often completely eliminating weeds. In the South of the country over five rotational cycles the percentage maize yield advantage of cropping with mucuna v. sole-cropping was 132%, lifting maize yield from a mean of 0.94 t ha^{-1} from successive mono-cropped maize to a mean of 2.19 t ha^{-1} with mucuna. Participatory research with farmers is now required to encourage Timorese farmers to (re-)adopt this agronomic system in appropriate parts of the country.

1. Introduction

Timor-Leste is a small, young tropical country with a rapidly growing and primarily rural population. Farmers in Timor-Leste have developed agricultural systems based mainly on shifting cultivation on the coastal plain and upland areas. Maize (*Zea mays* L.) is the key staple food and crop complemented by the root crops sweet potato (*Ipomoea batatas* L.) and cassava (*Manihot esculenta* Crantz) and rice (*Oryza sativa* L.) (da Costa et al., 2013). Traditionally soil management consists of the continual use of land for crops during a short period of two–five years followed by its abandonment for a long period of up to 20 years. A rural household typically crops 0.5–0.8 ha at any one time. With an increasing population and pressure on the land, the fallow period is reducing, and farmers are also reluctant to use inorganic fertilizer to maintain fertility, primarily from their belief that added chemicals are detrimental to soil, crop and human health, and also from the expense. The climate in Timor-Leste is predicted to become about 1.5 °C warmer on average by 2050, further stressing food security, and about 10% wetter (Molyneux et al., 2012). Additionally, labour is either expensive or scarce.

The pattern seen in Timor-Leste of soil fertility reducing with land pressure is very common throughout the humid tropics and has spurred the search for improved fallows with legumes in many places. In parts of Africa and Central America improved fallowing with legumes has gained popularity. Among legumes, mucuna (*Mucuna pruriens* (L.) DC var. *utilis*) – sometimes known as velvet bean – has often been chosen as a green manure crop for its exceptional vigour. It consistently shows superior agronomic performance compared to other annual legumes, having green forage yields of up to 15 t ha^{-1} per season and seed production ranging from 200 to 2000 kg ha^{-1} (Wulijarni-Soetjipto and Maligalig, 1997).

* Corresponding author at: Centre for Legumes in Mediterranean Agriculture (CLIMA), The University of Western Australia, 35 Stirling Highway, Crawley, WA 6009, Australia. Tel.: +61 8 6488 1903; fax: +61 8 6488 1140.
E-mail address: william.erskine@uwa.edu.au (W. Erskine).

0378-4290/$ – see front matter. Crown Copyright © 2013 Published by Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.fcr.2013.10.011

Its abundant biomass production contributes to make mucuna able to reclaim land infested with weeds, including those dominated by spear grass (*Imperata cylindrica* (L.) Raeuschel) (Wulijarni-Soetjipto and Maligalig, 1997).

Mucuna is reported to grow in an annual rainfall ranging from 400 to 3000 mm, but in West Africa and Honduras it is successful in areas with long rainy seasons – similar to the lowland south coast of Timor-Leste. It has a shallow root system and is only moderately resistant to drought. Mucuna grows best at an average annual temperature of 19–27 °C and prefers well-drained sandy and clay soils with a pH of 5–6.5, but it can also grow vigorously on acidic sandy soils (Wulijarni-Soetjipto and Maligalig, 1997). Despite its fast growth rate, mucuna presents a low risk of becoming invasive in Timor-Leste as its leaves are highly palatable for feral and domestic animals, particularly goats.

Tarawali et al. (1999) and Douthwaite et al. (2002) in studying the dissemination of mucuna cropping in West Africa highlighted the lessons learnt while promoting the technology to small-scale producers. Mucuna was popularized in the Mono Province of south-western Benin in the period 1988–1992. By 1996 the number of testers of the innovation throughout Benin was 10,000 farmers. Suppression of the weed spear grass was perceived as the main benefit of mucuna fallows. Recommendations to increase the adoption of legume fallowing include the use of a participatory approach in problem identification, highlighting the immediate gains to growers, optimization of the multiple benefits of cover crops, management of the improved system, promotional strategies, and appropriate policies.

In eastern Uganda researchers worked with farmers to develop alternatives for soil management using mucuna and other legumes as green manures in short-term fallows (Fischler and Wortmann, 1999). Their participatory research was part of a community-based approach to improve systems. Grain yields of maize following a one-season fallow with Mucuna were 60% higher as compared with maize following maize. Mucuna and lablab (*Lablab purpureus* (L.) Sweet were successfully produced by inter-sowing into maize three weeks after sowing maize, although the yields of the associated maize crop were reduced by 24–28%. Farmers independently experimented on how these species can be integrated into banana (*Musa* spp.), coffee (*Coffea canephora* Pierre ex Froehner), sweet potato, and cassava production systems. Farmers reported that the beneficial effects of the green manures included higher yields of food crops; weed suppression; improved soil fertility, soil moisture, and soil tilth; and erosion control. Mucuna and lablab were preferred because of reduced labour requirements and increased net benefits compared with continuous cropping. Farmer participation in the green manure research resulted in efficient generation and adaptation of green manure technology now being promoted in eastern and central Uganda.

In northern Honduras in response to rising land pressure, farmers developed and diffused from farmer-to-farmer a maize cropping system using mucuna as a short-term fallow (Buckles and Triomphe, 1999). Under high rainfall with a bimodal distribution, two rainfed cropping cycles are completed annually with the first season dedicated to the production of mucuna and the second season dedicated to maize. Buckles and Triomphe (1999) recorded maize yields in fields with continuous rotation of mucuna as on average double those obtained without mucuna. The mucuna system was more profitable than the existing alternative bush-fallow system due to higher returns to land and labour resulting from higher maize yields, lower weeding and land preparation costs, and reduced risk of drought stress.

In Timor-Leste mucuna is known by the local name *Lehe*, while the wild form (*M. pruriens* var. *pruriens*) known locally as *Karalehe* (literally 'itchy velvet bean') grows in many areas of the island, but its skin irritating properties make it unsuitable for cultivation. A study of *Lehe* started in 2003 by UNTL/Oxfam provided evidence that mucuna was formerly intercropped with maize in Timor-Leste as a weed control and soil fertilizer, as well as a food crop at least as long ago as the Portuguese era. However, its cultivation was reduced as the seed became largely unavailable when farmers fled the Indonesian occupation, and has returned only relatively recently (Vidal and Williams, 2012). Today in most of the country mucuna is only grown as a minor source of food, often sown at the base of a tree or fence. Although the seeds contain the psychoactive drug L-dopa, the bean becomes edible on boiling followed by soaking in water for 1–2 days with frequent water changes to remove the toxins (Wulijarni-Soetjipto and Maligalig, 1997). Its other benefits, when grown as a mulch crop, are now largely unknown. Weed problems and the need for legume fallows, together with an awareness of the utility of mucuna to small-holders elsewhere in the tropics, prompted its agronomic evaluation in maize-based systems in Timor-Leste. We hypothesized that Mucuna offers advantages to low input cropping of maize in Timor-Leste on the basis of its potential for weed control and soil fertility improvement elsewhere. To test this we designed a series of trials on-station to explore legume intercropping options which included species comparison, exploration of optimum legume sowing time when intercropped with maize, comparison of maize sown sole v. maize intercropped with mucuna, and weeding regimes to gain initial agronomic management information on mucuna in TL. With confidence of the value of mucuna in TL, we then initiated long-term trials on the effects of crop sequences on-station – it being impossible to undertake controlled long-term trials on-farm in TL.

2. Materials and methods

In the period 2007–2012 a series of trials with mucuna were conducted at four sites in Timor-Leste on a range of different factors summarized in Table 1.

2.1. Trial 1: UNTL agriculture faculty, Hera 2007

The research was conducted as part of a student's (L.D.A.) final year study at the Agriculture Faculty farm (Hera), National University of Timor-Leste (UNTL) in the North of the country (8°32′ S, 125°41′ E; 30 m above sea level (asl)) in tropofluvent soil (map unit BC1 in Garcia and Cardoso, 1978). The study was to define the best species and sowing time to use as an inter-crop, placing an emphasis on maize yields. Sowing time treatments of legume inter-crop when intercropped with maize were (1) sowing maize and legume at the same time, (2) sowing legume three weeks after maize and (3) sowing legume five weeks after maize (Table 1). The legume inter-crop species were (1) Mucuna, (2) Sword bean (*Canavalia gladiata* (L.) DC) and (3) Jack bean (*Canavalia ensiformis* (L.) DC). The control was sole-cropped maize (without legume). The trial was in a randomized block design with three replications. Maize planting was in January 2007 into plots sized 25 m^2, and all maize was harvested in May 2007. Plots were kept weed-free and received no fertilizer. At harvest, maize yield was recorded for grain – in this trial and hereafter unless specifically mentioned as cob yield – from selected plants in each plot.

2.2. Trial 2 at Betano in the wet and dry seasons of 2007

A trial to evaluate the effects of sowing mucuna in maize was conducted at Betano Research Station in the South of the country (9°16′ S, 125°68′ E; 3 m asl) in Usifluvent soil (map unit Atc in Garcia and Cardoso, 1978) with pH 7.5 (Howeler et al., 2003) over the wet and dry seasons in 2007. The initial trial comprised three factors (Table 1): (1) maize sown sole v. maize intercropped with