Herbaceous forage legume adoption trajectories in Eastern Indonesia

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Abstract

Herbaceous forage legumes and the associated nitrogen (N) fixation can provide multiple benefits to smallholder farmers, including increased soil fertility and provision of high quality livestock fodder. Previous research demonstrates that, in Eastern Indonesia, forage legumes can increase both crop and livestock production, however their role in smallholder farming systems and the process of adoption remains unclear. This research assessed the adoption and adaptation of forage legumes from 2013 to 2016 in East Nusa Tenggara province, Indonesia. Using farmer focus groups and on-farm research we assessed forage legume adoption and adaptation, preferences for forage legume use as well as the benefits across a range of farming systems. Farm record keeping, regular visits and group discussion as well as participatory research and assessments with various stakeholders have shown promising technology uptake and indicates there is significant scope for further adoption of forage legumes in the region, with large potential benefits to both livestock and whole farm production.

Keywords

Fodder, soil fertility, legume ley, smallholder, participatory, East Nusa Tenggara.

Introduction

Legumes are commonly used in smallholder dryland farming systems in relay or in rotation with cereal crops. Traditionally, this includes grain or dual purpose legumes such as peanut (*Arachishipogea*), mung bean (*Phaseolusradiatus*), pigeon pea (*Cajanuscajan*), cowpea (*Vignaunguiculata*) as well as local mucuna species or soybean (*Glycine max*).As these legumes are mainly used as food crops and often have low levels of biomass production, they provide limited fodder inputs for livestock production. In comparison, herbaceous forage legumes can provide high quality feed for ruminants and improve soil fertility, benefits which are increasingly important given increasing pressure for land and nutrients and estimates that global meat and milk demand will double by 2050 (Herrero et al. 2009). In the Eastern Indonesian province, East Nusa Tenggara, forage legumes provide an opportunity for smallholder farmers to take advantage of increasing beef demand from Java and address declining soil fertility. Despite the potential production benefits identified by Nulik et al. (2013), the adoption drivers and processes for forage legume adoption by smallholder farmers on the Eastern Indonesian islands West Timor and Sumba are not yet understood.

Methods

This research investigated the drivers and processes of forage legume adoption at four villages in Eastern Indonesia. Previous research shows that intensively feeding cattle leucaena (*Leucaenaleucocephala*) can improve liveweight gain for local Ongole bulls (Kana Hau and Nulik 2015). However, in general this tree legume fodder is not yet readily eaten by the cattle, especially under grazing conditions. Rather, cattle prefer forage legumes, such as butterfly pea (*Clitoria ternatea*), indicating that there is considerable potential to further develop forage legume production in Eastern Indonesian islands. Selected villages had already planted and started adapting forage legumes, especially butterfly pea, to their farming system as part of an international agricultural research project which introduced forage legumes.

Two case study villages were selected in West Timor that covered both lowland and upland farming systems. The lowland case study was at Uelvillage, (10˚02’57”S, 123˚50’42”E; 17 m above sea level (ASL)) and has Vertosol soils. Rice is planted during the wet season and irrigated maize in the dry season; only a small number of farmer group members own cattle. Farmers in the local farmer group have been growing forage legumes for three years. The highland village, Oenai, (9˚50’58”S, 124˚31’12”E; 732 m ASL) and has bobonaro clay type soils. The staple food is maize, and cattle farming is an important source of income as well as saving for the family. Farmers have been growing forage legumes for two years.

Two case study villages were also selected in Sumba. Melolo is a coastal village (9º52'41"S, 120º31'31.4"E; 40 m ASL) of East Sumba District. At Melolo, farmers were introduced to forage legumes through involvement in a feeding trial where (Kana Hau et al. 2015) five Ongole cows were supplemented with forage legume butterfly pea hay at night after free grazing during the day. The legume hay fed to the cattle was grown at the site, harvested and baled for hay. Farmers in Melolo have been growing forage legumes for two years. The other case study, Praipuluhamu, was an inland village (10º2'42"S, 120º37'51"E; 263 m ASL) where farmers were introduced to butterfly pea when 4 ha was (Kana Hau et al. 2016) planted in the village. The butterfly pea biomass was harvested, dried and fed to 15 cattle during the dry season at night time. Farmers in Praipuluhamu have been growing forage legumes for one year.

Villages were visited at least once a month by researchers or technical staff to assess forage legume adoption and provide technical support to farmers. At each visit, informal farmer group meetings and semi-structured interviews were used to assess current adoption levels, key benefits and uses as well as forage legume management, including whether it was planted as a monoculture, with food crops or with other forage species, such as leucaena cv. Tarramba. Farmer on-farm record keeping was used to record information and data such as size of planting area, planting date, harvest date, and hay weight obtained for the feeding trials. The information and data collected were then used for the qualitative analysis presented below.

Results

Research in West Timor demonstrated that, at Uel, forage legume adoption began before the research project was commenced in the village. This was driven by one farmer who, having observed forage legumes on a local researcher's farm, was interested in the high value of butterfly pea seed and asked the researcher for a small amount of seed. This farmer then started to sell butterfly pea seed to the provincial agricultural department and gave interested neighbours seed to plant on their own farms. Based on the success of this individual farmer and his neighbours in growing and selling forage legume seed, these farmers (n = 10) formed a farmer group to grow both forage legumes as well as psyllid tolerant leucaena (cv. Tarramba). At first, famers focused on seed production as most of them did not have ruminant animals to feed however, with the income from seed sales and government support some farmers purchased animals and started using forage legumes for fodder. Seeing the performance of cattle supplemented with forage legumes, other farmers in the group started feeding forage legumes to either to their own cattle or cattle obtained through a share profit scheme with the government livestock department or individual investors. A range of forage legume management strategies were used at Uel, depending farmers' production objectives and resource endowments. Where farmers didn't have livestock they commonly used them to increase soil fertility and produce seed, planting them in relay with maize or rotation with rice. Other farmers, who were more focused on livestock feeding and seed production, often planted forage legumes as a single stand around their house.

In comparison, at Oenai farmers initially started planting forage legumes after they were introduced by the research project. Farmers identified fodder and soil fertility as the key benefits of forage legumes. Fodder was a key benefit as a large proportion of farmers owned cattle or contract fattened cattle, the majority of whom faced sever fodder shortages in the late dry season. Farmers indicated that forage legumes could increase fodder quality and quantity in the dry season, although after two years growing legumes the areas planted were too small to sustain higher grown rates over an extended period. Soil fertility was also important as no synthetic fertilisers were used in crop production and steep slopes and low levels of soil organic matter meant inherent soil fertility was low. There were also a range of management options employed with some farmers preferring to establish land allocated solely to forages while others favoured relay cropping so they could achieve dual soil fertility and fodder benefits.

In Sumba, farmers at Melolo village were initially interested in forage legumes as an option for improving liveweight gain and condition score of cattle. Importantly, after the research experiment at the village was finished, local farmers to continued growing forage legumes to provide additional quality feed for the animals, especially during the dry season when all the native grasses have hayed off and feed is scarce. Notably, farmers favoured planting forage legumes as a monoculture as they considered fodder production a more important benefit than increasing soil fertility and subsequent crop production. Farmers at Praipuluhamu were also most interested in the fodder benefits, and were expanding the area planted to forage legumes so they could continue to fatten their bulls with fresh legume biomass.

Discussion

This research demonstrated that preferences for forage legume management differ with farming systems, farmers' production objectives and agro-climatic conditions. To demonstrate, at Oenai soil fertility was an important production constraint because of low fertility soils and low use of inorganic fertiliser. Consequently, improvements in soil fertility was considered a key benefit of forage legume production. In comparison, soil fertility was less important at Uel as local Vertosol soils have relatively high inherent soil fertility. Thus, farmers at Uel preferred to use forage legumes for seed or biomass production. However, these preferences were also driven by their farming system and production objectives. Where farmers owned livestock, fodder production was commonly considered the key benefit of forage legume production. However, where farmers were not fattening cattle then seed production was seen as an immediate source of income for households. Consequently, forage legumes provided a range of importance benefits however, the importance of these benefits differ with production objectives, farm type and agro-climatic conditions.

Farmers commonly adapt forage legume management to optimise the most important benefits of forage legumes. For farmers which favoured increasing soil fertility and grain yield, forage legumes was commonly integrated into crop production, planting forage legumes as a maize-forage legume relay or in rotation with rice. In comparison, farmers who wanted to produce high quality fodder planted forage legumes as a permanent stand as biomass production and the subsequent increases in livestock production were larger. Thus, farmers will adapt forage legume management to suit their production objectives. Researchers and extension officers should cater for these differing objectives by providing farmers with a suite of management options which they can adapt to fit their farming system and production objectives.

Importantly, farmers' preferences for forage legume use can change within short periods of time. For example, at Uel, some farmers changed from seed production to biomass production for fattening livestock after they either purchased cattle or were contracted to fatten cattle. In comparison, other farmers diversified into selling seed and fodder while other farmers started rotating butterfly pea with maize and rice in the wet season. Thus, while forage legumes were first introduced into Uel after one farmer became interested in seed production, over three years a diverse range of management options had been developed and adopted by farmers. As forage legumes are a new, knowledge intensive, technology this means that future extension programs should provide sufficient training for farmers to not only adopt forage legumes, but also to adapt forage legume management to fit their continually evolving farming systems.

Research indicates that forage legumes can provide multiple benefits to smallholder farmers including increased soil fertility, income from seed sales and increased livestock production. This indicates that forage legumes can provide benefits to a range of different farm types. For example, subsistence focused farmers can increase soil fertility and crop production while also collecting seed to replant or sell. In comparison, farmers with cattle can increase liveweight gain and the sale price of their livestock. Forage legumes may also be an important fodder in regions, such as Sumba, where leuceana is not readily accepted by cattle as a fodder supplement. Notably, the broad preference to use forage legumes as a fodder over increasing soil fertility or producing seed indicates that farmers with livestock may be the most likely long term adopters and beneficiaries of forage legume production.

Conclusion

Though the development and adoption of herbaceous forage legumes started after the development and use of leucaena in East Nusa Tenggara, research demonstrates that forage legumes can play an important role in smallholder farming systems. This is particularly important were leucaena is not readily consumed by livestock or in annual crop production systems, such as rain-fed rice, where perennial fodders can compete with food crop production. However, achieving the potential benefits of forage legumes requires effective seed production systems, distribution of seed and an effective and sustainable seed market.

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