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Perceptions of agroecological farmers on green manure use in Southeast Minas Gerais, Brazil

Productores agroecológicos y su percepción sobre el uso del abono verde en el Sudeste de Minas Gerais, Brasil

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ABSTRACT
The practice of green manuring is fundamental in agroecological agriculture systems for improved soil quality, nutrient cycling, organic matter input, and protection against soil erosion. The objective of the present study was to evaluate the perceptions of agroecological farmers in Southeastern Minas Gerais regarding the use of green manuring, to enable identification of the criteria guiding its selection, handling, and the limitations of its use. Fifteen agroecological farmers from the area were interviewed, in order to characterize farmers, farms, and green manure usage and management characteristics within their farms. The joint action of farmers and researchers/extensionists contribute to the introduction of green manuring practices in properties. Intercropping with the main crop system is the most common practice, along with weeding and cropping at flowering onset. Labor costs and difficulty in handling some species used in green manure were the main factors identified that limited the adoption and maintenance of this practice.

Key words: Biological fixation of N, Family farming, Organic fertilization, Fabaceae.

RESUMEN
El uso del abono verde es fundamental en sistemas agroecológicos para aumentar la materia orgánica, mejorar la estructura del suelo, una mayor disponibilidad de nutrientes y la protección contra la erosión del suelo. El objetivo de este estudio fue evaluar la percepción de productores agroecológicos del sureste de Minas Gerais sobre el uso del abono verde, para identificar los criterios que guían su selección, manejo y las limitaciones de su utilización. Se entrevistó a 15 agricultores que usan estas prácticas para caracterizarlos y describir el manejo que hacen del sistema. La acción conjunta de agricultores e investigadores/extensionistas contribuye a la introducción y manejo del abono verde en los sistemas productivos. Los cultivos intercalados con abono verde y su deshierbe al inicio de la floración son la práctica más común. El aumento del costo de mano de obra y la dificultad en el manejo de algunas especies utilizadas en el abono verde fueron los principales factores que limitaron la adopción de esta práctica.

Palabras clave: *Fijación biológica de N, Agricultura familiar, Fertilización orgánica, Fabaceae.*

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Introduction

The growing worldwide concern about the consequences of human activity on the planet's future has increased the prominence of agroecological practices. These practices have been predominantly followed by family-based farmers. In Brazil, family farms represent 84% of rural properties and are responsible for the majority of supply of basic foods (BRASIL, 2009).

In agroecological production systems, several alternative management practices are employed to minimize negative impacts on the environment and society. These practices focus on soil and water conservation, increasing biodiversity with crop and animal diversification, increasing nutrient cycling,

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and energy efficiency (Salmi *et al*., 2006). One of agroecology's basic principles is the use of inputs from natural biological processes (Finatto and Corrêa, 2010), including green manuring with legumes. This practice recycles nutrients and is able to contribute N to the soil via biological fixation (Fageria and Baligar, 2005).

Green manuring refers to the cultivation of plant species for biomass production. After harvesting, plant species are added to the soil to increase its organic matter content, promote soil protection, and recycle nutrients (Souza *et al*., 2012). This practice has the potential to increase soil fertility (Fageria and Baligar, 2005), decrease expenditure on fertilizers (Teixeira *et al*., 2006), control weeds (Recalde *et al*., 2015), and decrease erosion (Cardoso *et al*., 2012).

Despite a range of benefits, green manuring is still underused. Dourado *et al*. (2001) suggest that one of the reasons behind this is the lack of immediate economic return and the occupation of land space usually used for the main crop. A survey was conducted in 2007-2008 in Minas Gerais on the use of green fertilization, with 103 rural extensionists from Emater-MG (Technical Assistance and Rural Extension Company of the State of Minas Gerais). The survey was carried out during the agroecology courses promoted by Emater-MG and the green manure training courses for the Communal Seed Bank Program (Mantrangolo *et al*., 2008). The study showed that only 18.5% of the rural extensionists applied green manuring in their region, 23.3% reported non-intensive usage, and 58.2% reported that the practice was not applied in their region.

Green manuring has been recommended and widely used by family farmers, particularly agroecological ones; however, studies on the farmers' perception of its use and management are lacking. Thus, knowing the limitations and potential of this practice is of great importance for maximizing the short-, medium- and long-term benefits that green fertilization can offer.

The objective of the present study was to evaluate green manuring perceptions of agroecological farmers in Southeastern Minas Gerais to enable identification of the choice criteria, handling, and limitations to its use.

Methodological Procedures

Contacts were established with representatives of social collectives to select agroecological farmers who worked with green manuring. Thus, the Center for Alternative Technologies of Zona da Mata (CTA-ZM) in Viçosa; the Agricultural Research Company of Minas Gerais (EPAMIG) - Viçosa regional branch; the Technical Assistance and Rural Extension Company of the State of Minas Gerais (EMATER-MG) - Viçosa regional branch; the Network of Alternative Technology Exchange (REDE), in Simonésia; and the faculty from the Federal University of Viçosa (UFV) were contacted. In collaboration with these partners, we sought to identify agroecological farmers who could be visited. In addition, the Farmers Week event at the Federal University of Viçosa also presented an opportunity to contact some farmers. Fifteen farmers were identified in the municipalities of Viçosa, Ponte Nova, Araponga, Senador Firmino, Simonésia, Caratinga, and Silveirânia, located in Southeastern Minas Gerais, Brazil (Figure 1).

The study area encompasses regions experiencing Tropical Aw and Tropical Altitude Cwa climates according to Köppen's climate classification. Regional characteristics include cold/mild and dry winters and warm and rainy summers. The average annual temperature varies between 18 and 26 °C and the average altitude of the studied sites varies from 500 m (Silveirânia) to 1,040 m (Araponga). The region also encompasses the so-called Mares de Morro domain of southeastern Brazil (AB'SABER, 1966), where deep, very weathered soils such as Red Yellow Latosols predominate. Land in the region is predominantly devoted to agricultural and livestock farming, with emphasis on grazing areas with extensive livestock farming, coffee, maize, and bean crops, mostly on small farms.

The farmers' social group chosen for the present study had some familiarity with the practice of green manuring. Interviews with farmers were the chosen method to systematize the acquisition of the desired information. To this end, a questionnaire for the characterization of the farmers, the properties, and the practice of the green manuring on the property was proposed (Figure 2). The first part of the questionnaire characterizes the families and farms: name, origin, relation to farm, crops, presence of animals, and labor. The second part dealt specifically with the green manuring-associated information. About 60–180 minutes were spent per interview, which varied according to the availability of the farmer and their relatives.

The questionnaire was applied within the context of participatory research, seeking to characterize the

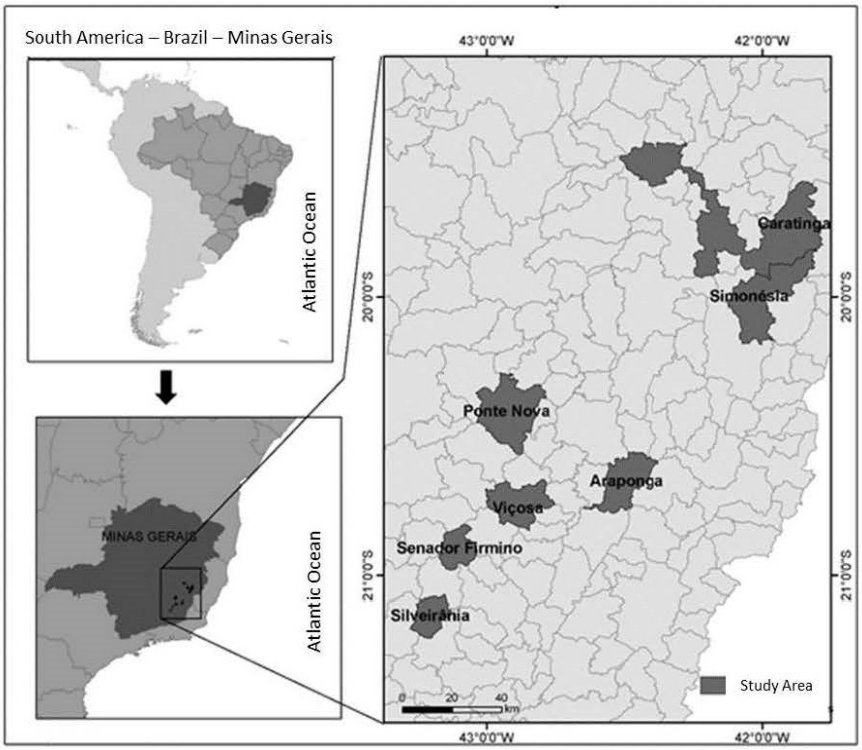

Figure 1. Map of South America, Minas Gerais, and Southeastern Minas Gerais highlighting the municipalities where the agroecological farmers interviewed on the use of green manuring are based.

Part 1 – characterization of families and properties

Name (optional): _____

Age: _____ City/State: _____

Married: ( ) No ( ) Yes - Children: ( ) No ( ) Yes - How many? _____

Farm: Location _____ Area: _____

Crops you work with: _____

Livestock farming: _____

Labor: Family _____ Employee _____ Partner _____ Other _____

Part 2 – characterization of green manuring

Do you know what green manuring is? ( ) No ( ) Yes

If "yes", do you use (or have you used) green manuring? ( ) No ( ) Yes

- If not, why?

( ) Unfamiliar with it ( ) Unfamiliar with its utilization ( ) Insufficient manpower

( ) Insufficient area ( ) Other: _____

Do you know of any green manure? ( ) No ( ) Yes - Which? _____

What crop is it applied to? _____

- If yes: Which green manure do you use (have you used)? _____

In what crops? _____

Where do you procure the seeds? _____

Type of handling of green manure:

Upon planting? _____ Manuring? ( ) No ( ) Yes - What with? _____

Do you weed? ( ) No ( ) Yes - At harvesting? _____

Do you incorporate? ( ) No ( ) Yes - Other handling options: _____

Main difficulties in using green manuring? _____

Improvements in crops? _____

Have you used (tested) species that you stopped using? ( ) No ( ) Yes - If yes, which one(s)? _____

If yes, why have you stopped using that (those) species? _____

Are you interested in testing other species not planted by you yet? _____

Would you be interested in taking part in a more complete survey on the use of green manuring? ( ) No ( ) Yes - Way of contact? _____

Figure 2. Questionnaire used to interviewing agroecological farmers in Southeastern Minas Gerais, Brazil.

group of farmers who empploy green manuring practices, encompassing the history and handling methods. The green manure usage options were also characterized to verify the management actions performed and the reasons for the abandonment or maintenance of this practice. Questions included management of species, planting times, plant harvesting, and advantages and difficulties encountered by farmers in using green manures.

As determined by Resolution Nº. 01/88, of the National Health Council, which deals with Health Research Norms, this research project was previously included in the Brazil Platform (CAAE 15028213.4.0000.5153) and approved by the Human Being Research Ethics Committee, according to report 364.278, of August 19th, 2013. Each interviewed farmer was given a Free and Informed Consent Form (FICF), which informed him or her of the characteristics and objectives of the project, as well as contact details for the project team. The FICF was signed by the project representative and the volunteer research subject.

Results and Discussion

Of the 15 farmers interviewed, 8 came from the municipality of Araponga, 2 from Caratinga, and 1 each from the Viçosa, Senador Firmino, Ponte Nova, Simonésia, and Silveirânia municipalities. It was not possible to interview a larger number of farmers, given the difficulty of finding farmers with prior green manuring experience. This situation has been reported in earlier studies (Storch *et al*., 2004; Monteiro *et al*., 2010), stemming from the small number of agroecological farmers who make use of this practice. Most farmers owned their land (n = 13), one was a tenant, and one other was in occupation pending resolution of an estate. Land ownership is relevant to ecological practices. As one of the Araponga farmers reported, he was able to start agroecological practices and green manuring upon becoming the farm's owner. The average age of these farmers was 49 years, ranging between 35 and 75 years, an age group suitable for fieldwork. This result does not support the view that countryside dwellers are mainly aging rural pensioners. Farmers' families lived onsite in 93% of the properties (n = 14), with an average number of 4.5 children (variation between zero and 19 children). Only one farmer was single and lived with his parents on the farm.

Characterization of properties

Most of the workforce on the farms consisted of the owner's family, which applied in 73.3% (n = 11) of cases. Only one farmer had an employee, and three others worked alone, without the help of family members, but in partnership with neighbors. The average farm size was 11 ha, with a range between 1.5 and 37 ha, a size typical of small rural properties in the region, which do not exceed the four fiscal modules (112 ha). This size is consistent with most of the properties devoted to agroecological principles. Studies conducted in Southern Brazil by Storch *et al*. (2004) and Teixeira *et al*. (2009), with 14 and 23 family farmers, respectively, found that 79% and 70% of properties were smaller than 20 ha.

The main crops produced by the farmers were vegetables (with great diversity due to the continuous rotation of crops), fruit (not specified because of the high variety in all properties, referred to as "orchard"), coffee, maize, and beans. In all, 16 different species were cited for commercial purposes and/or own consumption (Table 1). Vegetable and fruit crops were recorded in all properties, followed by beans (14 properties), maize (13), and coffee (11). Cassava, peanut, sugarcane, soybean, pasture, arrowroot (*Maranta arundinacea*), rice, Juçara palm (*Euterpe edulis*), sesame, and roots in general were also mentioned. The average number of crops grown per family of farmers was 7.4, ranging between 2 and 13.

We observed that the number of crops grown per family was not correlated whit the size of the property (Figure 3). The diversity of crops found on properties was consistent with agroecological practice. The three most extensive properties (1, 2, and 3) contained some unique features, including areas with steep slopes and/or with larger permanent preservation areas.

Livestock farming was reported in all properties. Nine species of animals – cattle, swine, poultry, bees, horses, ducks, fish, rabbits, and birds – were identified for commercial purposes, own consumption, and use on the property (Figure 4). Poultry was found in 80% (n = 12) of farms, followed by cattle in 66.7% (n = 10), and swine in 40% (n = 6). The number of animal species per property ranged from 1 to 7, with an average of 2.5. The diversification of animals and plants in properties is fundamental in agroecological production, as it favors nutrient cycling, biological balance between pathogens and "natural enemies", improved pollination, and diversification of farmers'

Table 1. Crops grown on the properties of agroecological farmers in Southeastern Minas Gerais, Brazil.

Crops	Interviewees who mentioned the species (no.)
Vegetable	15
Fruit	15
Beans	14
Maize	13
Coffee	11
Cassava	10
Sugarcane	8
Roots and tubers	7
Peanut	6
Pasture	5
Açaí (jussara)	2
Rice	1
Soybean	1
Sesame	1
Arrowroot	1

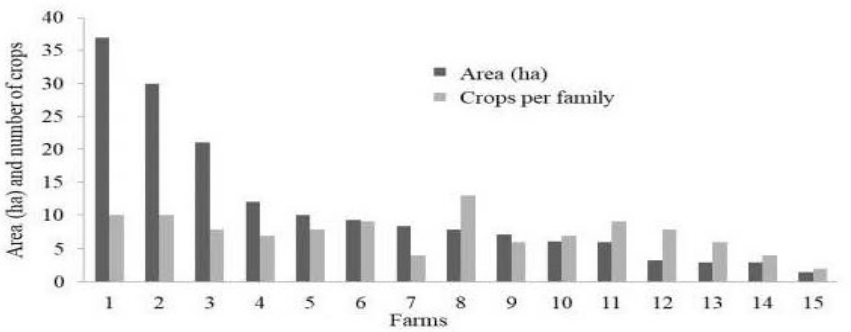

Figure 3. Area of rural properties and number of crops cultivated by agroecological farmers in Southeastern Minas Gerais, Brazil.

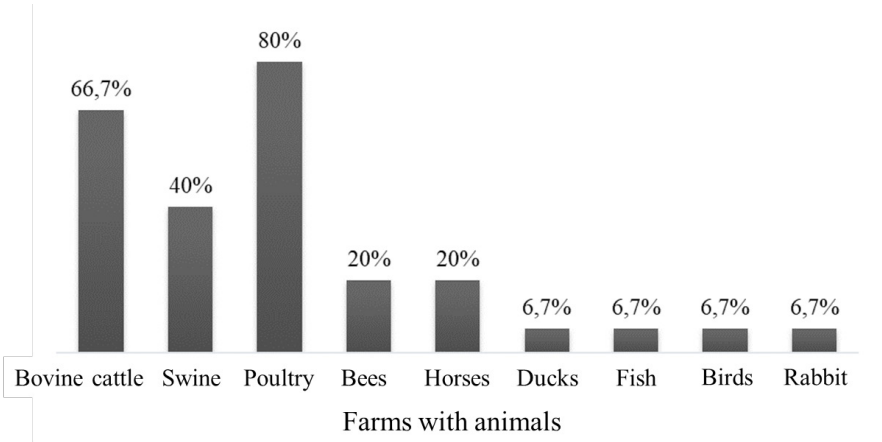

Figure 4. Percentage and diversity of animals on the properties of agroecological farmers in Southeastern Minas Gerais, Brazil.

revenues (Brussaard *et al*., 2007; Smukler *et al*., 2010; Tosetto *et al*., 2013).

Characterization of green manuring

The length of time farmers had been using green manuring ranged between 1 and 28 years, with an average of 13.5 years (Figure 5). Senador Firmino's farmers began experimenting with this practice in the mid-1980s. The second longest usage time – 25 years – corresponded to an Araponga farmer. In 1989, a green manuring experiment coordinated by CTA-ZM and involving farmers in the Zona da Mata region was initiated (Souza, 2006), which sought to increase organic matter in soil, something considered to be in decline by farmers and responsible for soil degradation. That experiment was mentioned by five Araponga farmers as the reason why they had tried green manuring practices.

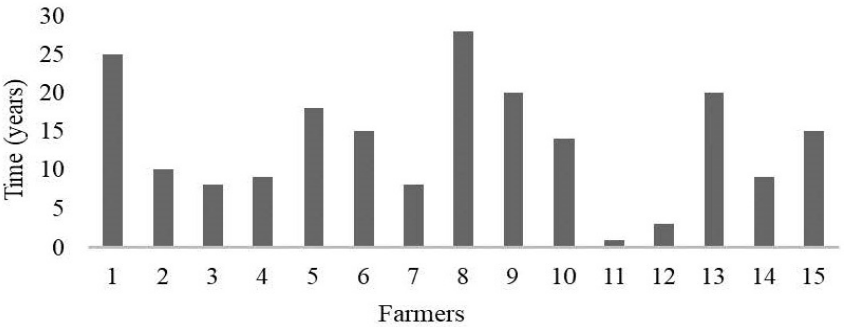

Figure 5. Time of use of the green manuring by each agroecological farmer in Southeastern Minas Gerais, Brazil.

The number of plant species used as green manure by farmers was impressive, with 32 different types (other than *scrub*, see below), encompassing 13 plant families (Table 2). *Scrub* is the term used by farmers to refer to spontaneous vegetation species. The average number of used species per farmer was 6.1, ranging between 1 and 12. Species from the Fabaceae family were the most reported by the farmers. This family is associated with biological N fixation in the soil, which allows the farmer to avoid nitrogenated fertilizers, among other benefits (Teixeira *et al*., 2006).

Some of the species mentioned by farmers, such as pineapple, araticum, avocado and cecropia, though uncommon, were considered green manures since farmers considered the crop remnants used applied to the soil surface and/or incorporated into the soil as such. Pineapple's use as a green manure is uncommon, as it is a fibrous, hard to decompose material (Marques *et al*., 2013); araticum also fails to meet the main green manuring objectives, as it grows slowly, yields low biomass quantities, and decomposes slowly (Braga Filho *et al*., 2014). It is important to highlight that each species used as green manure, especially legumes, has specific requirements regarding soil and climate characteristics, which makes a correct choice important for the success of this practice (Espindola *et al*., 2005).

Crops grown with green fertilizers and handling

Coffee and maize were the most important crops in the region, with 66% (n = 10) of farmers growing these crops (Table 3). According to previous studies, the use of green manure in vegetable culture, reported by 53% (n = 8) of farmers, is uncommon. In vegetable crops, green manuring is carried out after the construction of the beds, or by using the material as mulch before planting. Most farmers intercropped green manures with major crops. Only one farmer had dedicated an exclusive area to the cultivation of several legume species to fertilize the major crops on the property.

The way in which green manuring is used is organized within the production system of the farm. Most producers (60%) planted the green manure species at the beginning of the rainy season, intercropped with the main crops (Table 4). This is an option that can limit green manure efficiency, since there could be competition for space, light, and nutrients in the soil, depending on the way it is managed. There is also competition for labor in

Table 2. Plant species used as green manure by agroecological farmers in Southeastern Minas Gerais, Brazil.

Popular name	Scientific name	Family	Nº.	Municipality
Avocado	*Persea Americana*	Lauraceae	1	Araponga
Pineapple	*Ananas sp.*	Bromeliacea	1	Araponga
Peanuts	*Arachis hypogaea L.*	Fabaceae	1	Araponga
Pinto peanut	*Arachis pintoi*	Fabaceae	5	Araponga, Caratinga, Silveirânia
Araticum	*Annona coriácea*	Annonaceae	1	Araponga
Rice (straw)	*Oryza sativa*	Poaceae	1	Silveirânia
Black oat	*Avena strigosa*	Poaceae	1	Silveirânia
Banana tree	*Musa sp.*	Musaceae	1	Araponga
Signal grass	*Brachiaria decumbens*	Poaceae	1	Viçosa
Calopo	*Calopogonium muconoide*	Fabaceae	5	Araponga, Caratinga
Solanum	*Solanum granuloso*	Solaneceae	1	Araponga
Crotalaria	*Crotalaria spectabilis*	Fabaceae	2	Araponga, Simonésia
Crotalaria juncea	*Crotalaria juncea*	Fabaceae	7	Viçosa, Araponga, Caratinga, Simonésia
Desmodium	*Desmodium gangeticum*	Fabaceae	1	Simonésia
Cecropia	*Cecropia sp.*	Urticaceae	1	Araponga
Septicweed	*Senna occidentalis*	Fabaceae	2	Araponga
Beans (straw)	*Phaseolus vulgaris*	Fabaceae	2	Senador Firmino, Araponga
Pigeon bean	*Cajanus cajan*	Fabaceae	8	Araponga, Caratinga
Jack Bean	*Canavalia ensiformis*	Fabaceae	8	Araponga, Viçosa, Caratinga
Sunflower	*Helianthus annuus*	Asteraceae	1	Caratinga
Inga	*Inga sp.*	Fabaceae	2	Araponga, Silveirânia
Lablab bean	*Dolichos lablab*	Fabaceae	8	Araponga, Caratinga.
River Tamarind	*Leucaena leucocephala*	Fabaceae	3	Araponga, Caratinga
Prickly Ash	*Zanthoxylum rhoifolium*	Rutaceae	1	Araponga
Castor bean	*Ricinus communis L.*	Euphorbiaceae	2	Araponga, Caratinga
Scrub (spontaneous vegetation species)			7	All municipalities
Maize (straw)	*Zea mays*	Poaceae	2	Senador Firmino, Silveirânia
Velvet bean	*Mucuna deeringiana*	Fabaceae	2	Araponga
Gray velvet bean	*Mucuna cinereum*	Fabaceae	4	Araponga, Caratinga
Black Velvet bean	*Mucuna Pruriens*	Fabaceae	8	Araponga, Caratinga
Radish	*Raphanus sativus L.*	Brassicaceae	2	Araponga, Silveirânia
Silk floss tree	*Ceiba speciosa*	Bombacaceae	1	Araponga
Lupine	*Lupinus albus*	Fabaceae	1	Silveirânia

Nº.: number of properties in which the species were mentioned.

Table 3. Crops fertilized by green manures by agroecological farmers in Southeastern Minas Gerais, Brazil.

Main Crops	Number of green manure references
Coffee	10
Maize	10
Beans	4
Vegetables	8
Fruits	5
Area set aside	1

Table 4. Green manure management by agroecological farmers in Southeastern Minas Gerais, Brazil.

Farmers	Municipality	Planting season	Cutting season	Manure application	Weeding	Incorporation
1	Araponga	Start of rainy season	At flowering	Yes	Yes	No
2	Araponga	If necessary	If necessary	No	Yes	No
3	Viçosa	If necessary	If necessary	Yes	Yes	Yes
4	Araponga	Start of rainy season	At flowering	No	No	No
5	Araponga	Start of rainy season	At flowering	Yes	Yes	Yes
6	Araponga	Start of rainy season	At flowering	No	Yes	No
7	Araponga	If necessary	If necessary	No	Yes	Yes
8	Sen. Firmino	If necessary	If necessary	Yes	Yes	Yes
9	Araponga	Start of rainy season	At flowering	No	Yes	Yes
10	Araponga	Start of rainy season	At flowering	No	Yes	No
11	Silveirânia	None	-	No	No	No
12	Ponte Nova	None	-	No	No	No
13	Caratinga	Start of rainy season	At flowering	No	Yes	Yes
14	Caratinga	Start of rainy season	At flowering	No	Yes	Yes
15	Simonésia	Start of rainy season	At flowering	No	No	Yes

handling green manures. Farmers hold the view that planting green manure and main crops simultaneously pay dividends. However, not everyone is aware of potential competition problems.

Twenty-seven percent of farmers did not routinely apply green manure practices – i.e., they plant and manage green manures according to needs and feasibility. Only one farmer used spontaneous vegetation as green manure. The cultivation of species used for green manuring required organic fertilization for 27% of the interviewees; one other reported using mineral fertilization (NPK) and liming. Green manure species weeding was a common practice, performed by 73% of the interviewees. Many reports that at least one weeding event is important to prevent spontaneous plants from affecting the production of green manure species, especially in the first few weeks post-planting.

Green manure species were cut at flowering by 60% of farmers, a time regarded as ideal for biomass nutrient use. Cutting without a prior definition of the period was performed by 27% of the farmers. The one farmer using spontaneous vegetation performs regular cuts, spreading the green manure throughout the crop area. After cutting, 53% of the farmers use the green manure by manual incorporation into the soil. Other forms of management were also mentioned: about 46% of farmers reported that they use biomass as mulch, with the goal of also providing physical protection to the soil, in addition to nutrient cycling.

One green manure use deserves to be highlighted: its use as a component of agroforestry systems in ciliary forest regeneration, which is carried out in Silveirânia, where the farmer considered the insertion of legumes contributed nutrients and biomass to the soil. In Araponga, one farmer used the green manure in crop rows in contour lines, with the objective of better conservation of soil and water with the formation of contour barriers.

Benefits and difficulties of green manuring

There were several benefits associated with green manuring mentioned by farmers. The soil was the most cited natural resource, with 80% of the interviewees considering it the most benefited

element, specifically: increased fertility, improved color, maintenance of moisture, reduced nutrient loss, increased organic matter content, and improved soil structure. The perception and use of technical terms by some of these farmers is a reflection of the fact that entities such as CTA, EPAMIG, and EMATER work with this collective. Most of the producers had access to the soil analysis parameters of their properties, which made them better grounded in their arguments. In one of the interviews, a farmer removed a part of the root of a legume to show the nodules; moreover, he was able to explain a part of the biological fixation phenomenon.

Two farmers highlighted positive effects on the water in their properties: both cited the smaller risk of water contamination by decreasing mineral fertilizer usage. One reported that a large variety of species cultivated in a very steep region enabled the retention of water on the property. One other interviewee mentioned the increase in the amount of water produced on the farm after the adoption of green manuring, in conjunction with other agroecological practices. Regarding the benefits associated with the main crops on each farm, farmers commented that the use of green manures facilitates the control of spontaneous plants and reduces the labor expended on weeding (Souza *et al*., 2001).

Three farmers reported that when using green manure in vegetable crops, both the vegetables and their leaves exhibited brighter colors, sharper flavors, and a longer post-harvest shelf life. This is compared to vegetables grown either by themselves or others in the conventional way, with the use of chemical fertilizers and agrochemicals. Two farmers report that, in coffee crops, the production becomes more uniform, the quality of the final product improves, the grains are bigger and fuller, and the number of bad grains is reduced. One farmer reported that there was an increase in maize and bean crop yields after application of green manure in consecutive years.

According to farmers' perceptions, the use of green manure improves land and crop health, allowing the farmer to avoid using fertilizers and agrochemicals. Moreover, some farmers highlighted the increase in biodiversity in their properties stemming from the use of green manures. Great importance was ascribed to this factor, as it is an indicator of environmental quality preservation, with direct and indirect effects on human and animal health.

Among the difficulties associated with the practice of green manuring most mentioned by the farmers, the requirement of labor was prominent (46% of respondents) as a complicating factor, which also affects the expansion of the practice. The same difficulty was also reported by 58% of farmers in Pelotas, Rio Grande do Sul-Brazil (Storch *et al*., 2004). Two farmers reported difficulty in obtaining information on green manuring techniques.

According to Altieri (2010), agroecological principles can modernize small farms, as they are capable of improving soils and habitats. These practices can promote healthy plant growth and balance the entire system, using beneficial organisms, labor, and local resources effectively. In this context, some agroecological practices may become location-specific, since the use of available resources is valuable.

Some green manure species were characterized as difficult to manage by farmers. Pinto peanuts were aggressive when intercropped with beans, while solanum was considered difficult to control after seed production. The black velvet bean, one of the most used, was also mentioned for its difficulty to control. One report described that, 20 years after allowing the production of velvet bean pods, the plants still sprouted together with the crop of commercial interest. According to Monteiro *et al.* (2010), the black velvet bean is an aggressive climbing plant.

The purpose and management of green manuring may change over time. An Araponga farmer of 18 years standing using green manuring of his coffee crop reported that his focus at the outset was to ensure soil protection and nutrient supply. For this, species of small size were used. Subsequently, the farmer chose shrub or tree species, as he believed that their farm had reached a suitable amount of organic matter in the soil. Thus, the green fertilization of coffee plants started employing large trees, which provide shade and contribute biomass and nutrients. For management, the farmer uses only a machete for pruning, leaving the cut materials on the ground.

In 80% of the properties, green fertilization practices were initiated after encouragement by some research, teaching, and/or extension institution operating in the region. The remaining 20% began with family tradition and personal access to information on this practice. Obtaining the seeds through multiplication by the farmers themselves was reported by 40% of the interviewees, an important factor for the success and expansion of green manuring in the region. Approximately 20% of the farmers reported acquiring the seeds from trades with neighbors, while

40% reported obtaining seeds from the UFV, CTA-ZM, EPAMIG, IFSEMG-RP, REDE, and FUNBIO Projects.

The cost of seeds is a point to consider in the dissemination of green manuring. It must be planned so that after acquiring the first seeds, the farmers can later produce them themselves, making them independent in terms of seed acquisition. The seed cost and the lack of availability in agricultural stores were the main limiting factors for farmers interviewed during a maize productivity event promoted by Emater-MG and Embrapa Milho and Sorgo in 2007 (Mantrangolo *et al*., 2008).

Another concern expressed by some farmers was the occupation of the area with a crop that does not provide immediate economic return. However, the medium- and long-term benefits to soil and commercial crops should be considered. According to Queiroz *et al*. (2007), green manuring in rotation, succession, or intercropping systems are alternatives that allow the best use of the area and cost reduction. The intercropping system was reported by most of the respondents in the present study, which is an alternative when space limitation is a factor. However, planting time and adequate spacing should be considered in order to avoid competition for water, light, and nutrients.

Conclusions

The joint action of farmers and researchers/extensionists contributes to the introduction of green manuring practices in properties.

Fabaceae family species are the most widely used by farmers, particularly the jack bean, pigeon bean, black velvet bean, lablab bean, and crotalaria juncea. An intercropping system with the main crop is predominant, in conjunction with weeding and cutting at flowering onset.

Labor costs and the difficulty in managing some species used in green manure are the main limiting factors for the adoption and maintenance of this practice.

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