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Constraints faced by farmers in the adoption of green manure crops and their suggestions for promoting sustainable agriculture

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Abstract

Green manuring is a traditional soil fertility management practice that enhances soil organic matter, biological nitrogen fixation, and overall soil health, thereby contributing to sustainable agriculture. Despite its recognized agronomic and environmental benefits, the adoption of green manure crops has declined due to several practical and socio-economic challenges. The present study was undertaken to identify the major constraints in adoption and to document farmers' suggestions for improving the practice. The study was conducted in Navsari district of South Gujarat. Two talukas, Jalalpore and Gandevi, having a higher number of green manuring growers were selected purposively. Five villages from each taluka and twelve growers from each village were selected randomly, constituting a total sample of 120 respondents. Data were collected using a pre-tested interview schedule and analysed through frequency, percentage, mean, and ranking techniques. The major constraints identified were unavailability of labour (86.67%), lack of a positive mindset toward green manuring (70.83%), unavailability of seed at the proper time (53.33%), and shortage of irrigation facilities (44.17%). Key suggestions included promotion of farm mechanization (70.83%), timely training (67.50%), and timely seed supply at reasonable prices (55.00%). Based on farmers' responses and expert consultation, appropriate extension strategies were formulated to promote sustainable adoption of green manuring practices.

Keywords: Green manuring, adoption constraints, farmers' suggestions, sustainable agriculture, extension strategy

Introduction

Green manuring is one of the oldest soil fertility management practices and has historically been associated with fallow-based crop rotations. Ancient records indicate its early use in China around the 12th century B.C., and later in Greece and Southern Europe where crops such as lupines and fiber beans were utilized to improve soil fertility. Green manuring refers to the practice of incorporating green plant biomass into the soil while the crop is still succulent, primarily to enrich the soil with organic matter and nutrients. The value of green manuring lies in the incorporation of organic matter into the soil, which is fundamental to maintaining true soil fertility (Valizadeh *et al.*, 2023) ^[13]. In recent years, organic nutrient sources such as green manure crops have gained renewed attention due to increasing environmental concerns and the need to reduce input costs associated with synthetic fertilizers (Pappa *et al.*, 2006) ^[7].

Green manure crops, particularly legumes, play a significant role in enhancing soil fertility through biological nitrogen fixation. It has been estimated that a 40–5 day-old green manure crop can contribute approximately 80–100 kg N ha⁻¹ and even if only half of this nitrogen becomes available to the succeeding crop, it can effectively replace 50–60 kg fertilizer N ha⁻¹ (Sharma *et al.*, 2013) ^[10]. Crops such as Dhaincha, sunhemp, mungbean and guar grown during the kharif season have been reported to produce 8–21 tonnes of green biomass and contribute 42–95 kg N ha⁻¹, while Khesari, cowpea and berseem cultivated during the Rabi season can supply 12–29 tonnes of green matter and 67–68 kg N ha⁻¹ (Mishra & Nayak, 2004) ^[6]. Green manuring improves soil physical, chemical and microbial properties, enhances biodiversity, and increases crop yield potential (Singh *et al.*, 2022) ^[12]. Furthermore, legume green manure crops release organic acids, amino acids, carbohydrates, vitamins and mucilage during growth and

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decomposition, which substantially influence soil health and are considered essential components of sustainable agriculture (Irin & Biswas, 2022; Shukla *et al.*, 2011; Laishram *et al.*, 2020) ^[3, 11, 5]. The incorporation of green manure crops is also recognized as an important strategy for soil remediation and sustainable land use, particularly in salt-affected soils (Wong *et al.*, 2019) ^[14]. Despite these documented benefits, the adoption of green manuring has declined in many regions due to increasing pressure for food production, competition from more profitable crops, and the widespread availability of chemical fertilizers. Continuous cropping and intensive agricultural practices have contributed to the depletion of soil organic matter and declining soil productivity (Salahin *et al.*, 2013; Reddy *et al.*, 2022) ^[9, 8]. The reduction in soil organic matter adversely affects soil structure, water-holding capacity and cation exchange capacity, thereby limiting nutrient availability and mineralization (Abdulraheem *et al.*, 2012; Bonini and Alves, 2010) ^[1, 2]. However, renewed concern over soil fertility degradation and energy conservation has led to a resurgence of interest in green manures among both organic and low-input farming systems (Kumar *et al.*, 2014) ^[4]. Green manuring has been shown to improve soil physical and biochemical properties, reduce nutrient losses through leaching, and enhance water-holding capacity (Pandey *et al.*, 2008). Although green manuring offers considerable agronomic and environmental benefits, its adoption is not universal. Practical challenges such as limited awareness, seed availability, management constraints, and competition with main crops may hinder its widespread use. Given its recognized contribution to sustainable agriculture, it is essential to understand the constraints faced by farmers in cultivating green manure crops and to document their suggestions for improving adoption. Therefore, the present study entitled “Constraints Faced by Farmers in the Adoption of Green Manure Crops and Their Suggestions for Promoting Sustainable Agriculture” was undertaken to systematically analyse the barriers affecting adoption and to generate farmer-driven recommendations for strengthening sustainable soil fertility management practices.

Methodology

The present study was conducted in Navsari district of South Gujarat. Navsari district was randomly selected for the study. The district comprises six talukas, out of which two talukas, namely Jalalpore and Gandevi, having a higher number of green manuring growers, were selected purposively to ensure adequate representation of respondents practicing green manuring. From each selected taluka, five villages were selected randomly. From each selected village, twelve green manuring growers were selected randomly. Thus, a total of 120 green manuring growers constituted the sample for the present investigation. Thirteen independent variables and one dependent variable were selected for the study in accordance with the objectives. An interview schedule was developed based on the study objectives and

relevant literature. The schedule was pre-tested in a non-sample area, and necessary modifications were made to ensure clarity and content validity. Data were collected through personal interviews conducted at the respondents' farms.

Measurement of Constraints

The constraints faced by farmers in the adoption of green manuring were measured using a structured list of identified constraints. Respondents were asked to indicate whether they experienced each constraint. The responses were recorded in dichotomous form (Yes/No). Frequency and percentage were calculated for each constraint, and the constraints were ranked in descending order based on percentage values.

Measurement of Suggestions

Farmers were also requested to offer suggestions to overcome the constraints faced in the adoption of green manuring. The suggestions were compiled, categorized, and analysed using frequency and percentage. Ranking was done based on the percentage of respondents suggesting each measure.

Development of Extension Strategy

The extension strategy to overcome constraints was developed through triangulation of (i) constraints reported by farmers (ii) suggestions given by farmers (iii) consultation with subject matter experts and extension personnel. Based on this triangulated approach, strategic measures and responsible executing agencies were identified.

Statistical Analysis

The collected data were coded, tabulated, and analysed using appropriate statistical tools such as frequency, percentage, mean and ranking techniques in accordance with the objectives of the study.

Results and Discussion

Constraints Faced by Green Manuring Growers

The respondents were requested to indicate the constraints faced by them in the adoption of green manuring practices for sustainable agriculture. Frequency and percentage were calculated for each identified constraint, and the constraints were ranked based on the descending order of percentage. The results are presented in Table 1.

The data presented in Table 1 reveal that the major constraints faced by farmers in the adoption of green manuring were: unavailability of labour (Rank I), lack of a positive mindset toward green manuring practices (Rank II), unavailability of seed at the proper time (Rank III), shortage of irrigation facilities (Rank IV), higher cost of cultivation of green manuring as compared to the use of FYM or other manures (Rank V), lack of systematic training on green manuring (Rank VI), and pressure to follow only traditional farming practices from elder family members (Rank VII).

Table 1: Constraints faced by farmers in the adoption of green manuring (n = 120)

Sr.	Constraints	Frequency	Percent	Rank
1	Unavailability of labours.	104	86.67	I
2	Lack of positive mind set regarding green manuring practices.	85	70.83	II
3	Unavailability of seed at proper time.	64	53.33	III
4	Shortage of irrigation facility.	53	44.17	IV
5	Higher cost of cultivation for green manuring as compare to use of FYM or other manure	49	40.83	V
6	Lack of systematic training about green manuring.	45	37.50	VI
7	Force to practices only traditional farming from elder of the family.	44	36.67	VII

Seek their suggestions for developing the extension strategy for enhancing the knowledge level of green manuring growers

An attempt was made to elicit suggestions from farmers to overcome the constraints faced in the adoption of green manuring. The respondents were requested to provide their suggestions to address the difficulties encountered in practicing green manuring. The data collected were compiled, analysed using frequency and percentage, and the results are presented in Table 2.

The findings presented in Table 2 indicate that the major

suggestions provided by farmers to overcome constraints in green manuring adoption were: adoption of farm mechanization (Rank I), timely and adequate training on green manuring practices (Rank II), timely supply of green manure seeds at reasonable prices (Rank III), provision of irrigation facilities at subsidized rates (Rank IV), reduction in the cost of cultivation compared to FYM and other manures (Rank V), provision of technical know-how regarding green manuring and efficient use of farm resources (Rank VI), and modification of traditional farming practices to incorporate improved techniques (Rank VII).

Table 2: Suggestions provided by farmers to overcome constraints in green manuring adoption (n = 120)

Sr.	Suggestions	Frequency	Percent	Rank
1	Farm mechanization should be followed	85	70.83	I
2	Adequate training regarding green manuring should be imparted in time	81	67.5	II
3	Timely supply of seed for green Manuring with reasonable prices	66	55	III
4	Irrigation facilities at subsidies rate should be provided	53	44.17	IV
5	Cost of cultivation should be decreased as compare to FYM and other manure	44	36.67	V
6	Technical know-how regarding use of green manuring and farm resources should be provided	35	29.17	VI
7	Farming practices must be changed to use the new farming techniques	30	25.00	VII

Extension Strategy to Overcome Constraints in Green Manuring Adoption

Based on the constraints identified by farmers, expert suggestions, and triangulation of responses, an appropriate extension strategy was formulated to address the major barriers in green manuring adoption.

The problem of unavailability of labour can be addressed through the promotion of farm mechanization. Farmers should be provided with proper guidance on the effective utilization of available resources and labour-saving technologies during periods of labour scarcity. This strategy may be implemented by the concerned government departments. To overcome the lack of a positive mindset toward green manuring practices, timely and adequate training programs should be organized. Capacity-building initiatives conducted by institutions such as Krishi Vigyan Kendras (KVKs), State Agricultural Universities (SAUs), and Agricultural Technology Information Centres (ATICs) can help improve awareness and attitude toward green manuring.

The issue of unavailability of seed at the proper time may be addressed through the timely supply of quality green manure seeds at reasonable prices. Seed distribution should be ensured by government agencies, institutions, and non-governmental organizations (NGOs) to facilitate accessibility. Shortage of irrigation facilities can be mitigated by promoting efficient irrigation methods and providing irrigation facilities at subsidized rates. Farmers may be supported through appropriate schemes and assistance from higher authorities to improve irrigation infrastructure. The higher cost of cultivation associated with green manuring, as compared to FYM or other manures, may be reduced through the provision of subsidies and financial support for green manure cultivation. Government intervention and policy support are essential in this regard. The lack of systematic training on green manuring can be addressed by providing technical know-how and practical training on the effective use of green manure crops and farm resources. Agricultural Officers (AOs), Extension Officers (EOs), and related institutions should take responsibility for organizing such training programs. Finally, resistance to change due to adherence to traditional farming practices influenced by elder family members can be reduced through continuous extension education and awareness campaigns. Extension personnel, along

with institutions such as KVKs, ATMA, and ATICs, should encourage farmers to adopt improved and innovative farming practices.

Conclusion

The findings of the present study clearly indicate that although green manuring is a valuable practice for improving soil fertility and promoting sustainable agriculture, its adoption among farmers is constrained by several practical and socio-economic factors. The major constraints identified were unavailability of labour, lack of a positive mindset toward green manuring practices, unavailability of seed at the proper time, shortage of irrigation facilities, higher cost of cultivation compared to FYM and other manures, lack of systematic training, and resistance to change due to adherence to traditional farming practices. These constraints highlight that both resource-related and behavioural factors significantly influence adoption. Farmers also provided practical suggestions to overcome these barriers. Promotion of farm mechanization, timely and adequate training, provision of quality seeds at reasonable prices, subsidized irrigation facilities, reduction in cost of cultivation, technical guidance, and encouragement to adopt improved practices were identified as important measures. The triangulated extension strategy developed from farmers' responses and expert consultation emphasizes institutional support, capacity building, input accessibility, and policy interventions.

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Disclaimer (Artificial intelligence)

The author(s) hereby declare that generative AI technologies, such as OpenAI ChatGPT version 4, have been used during the writing or editing of manuscripts for language improvement.

Author Conflict

Authors have declared that no competing interests exist.

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