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IMPACT OF GREEN CARE ON MENTAL HEALTH AND LIVELIHOOD OUTCOMES: EVIDENCE FROM AN INTER-STATE QUASI-EXPERIMENTAL STUDY IN RURAL INDIA

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Abstract: Mental health disorders amplified by work-related stress, economic insecurity, and social isolation have become a defining public health concern in rural India, especially within agrarian economies that depend heavily on seasonal employment and weather-driven livelihoods. In this evolving landscape, Green Care - a therapeutic paradigm that integrates structured engagement with agriculture, horticulture, and animal husbandry - offers a compelling dual-pathway strategy for simultaneously advancing mental health outcomes and reinforcing sustainable livelihoods. This study rigorously examines the measurable impact of context-sensitive Green Care interventions implemented across Karnataka and Andhra Pradesh using primary data gathered from 270 rural respondents through a carefully designed quasi-experimental framework. The analytical architecture comprises before–after comparative assessment, descriptive statistics, and multivariate regression techniques, enabling a nuanced evaluation of shifts in both psychological and economic dimensions. The empirical results are remarkable: stress levels declined by 47.8%, anxiety by 49.7%, and depression by 52.0%, while social interaction surged by 108.6% and the happiness index improved by 81.0%. On the livelihood front, total household income more than doubled (+113%) and productive employment days increased by 92%. Econometric findings confirm that Green Care participation, household income, and social engagement are all statistically significant negative predictors of mental distress, whereas state-level differences remain non-significant - a finding that strongly reinforces the cross-regional robustness of the intervention. The Composite Green Care Index (GCI), computed at 0.71, corroborates strong overall programme effectiveness. In conclusion, this study establishes Green Care as a scalable, cost-effective, gender-inclusive, and institutionally adaptable model with transformative potential for simultaneously addressing the twin crises of mental health and livelihood insecurity in rural India.

Keywords: Green Care; Mental Health; Rural Livelihoods; Work-Related Stress; Quasi Experimental Design

1. Introduction

1.1 Global Context of Mental Health Crisis

Mental health disorders have transitioned from a marginal concern to a central challenge in global public health governance. The World Health Organization estimates that approximately one in every eight individuals worldwide is currently living with some form of mental disorder, placing an extraordinary burden on healthcare systems, economies, and families alike (WHO, 2022; Vigo et al., 2016). This crisis has been further magnified in the post-pandemic era, during which the convergence of economic disruption, prolonged social isolation, grief, and heightened uncertainty accelerated the prevalence of depressive and anxiety disorders to unprecedented levels (Santomauro et al., 2021; Taquet et al., 2021).

Recent global burden of disease studies indicate that depression and anxiety collectively account for over 13% of all years lived with disability (YLDs), with the economic cost of untreated mental illness exceeding \$1 trillion annually in lost productivity (Patel et al., 2018; Whiteford et al., 2013). Beyond these aggregate figures, the distributional inequity of mental health burden is deeply troubling - rural populations, agricultural workers, women, and economically marginalized communities bear disproportionately higher risks, largely due to structural vulnerabilities in social protection, employment, and healthcare access (OECD, 2021; Lund et al., 2020).

Emerging scholarship across multiple disciplines has increasingly recognized that the determinants of mental health are not merely clinical or biological, but are fundamentally embedded in socio-economic structures. Work-related stress, income instability, precarious employment, debt burden, and social disconnection have emerged as dominant proximal and distal causes of psychological distress, particularly in developing agrarian economies (Paul & Moser, 2021; Butterworth et al., 2022; Dewa et al., 2017). This recognition has catalysed the search for integrated, context-sensitive solutions that simultaneously address the economic and psychological dimensions of human well-being.

1.2 Mental Health in Rural India: A Deepening Crisis

India presents a particularly acute illustration of the global mental health challenge within a developing agrarian economy. Despite considerable strides in economic development, the country harbours one of the world's largest unmet mental health treatment gaps. The National Mental Health Survey of India (NMHSI) revealed that nearly 150 million individuals require active mental health intervention, yet fewer than 30 million access any form of care - a treatment gap of approximately 80% (Gururaj et al., 2016; Kessler et al., 2018). This disparity is even more pronounced in rural areas, where the density of mental health professionals remains critically low, stigma is pervasive, and community-based support structures are largely absent (Patel et al., 2018; Shidhaye et al., 2015).

The rural mental health crisis is deeply intertwined with agrarian distress. Farmers and agricultural labourers in India face a constellation of stressors - crop failure driven by erratic monsoons, mounting debt, inadequate market access, and the erosion of traditional social safety nets - that collectively generate severe and sustained psychological pressure (Rao et al., 2020; Das et al., 2022; Merriott, 2016). A study published in *The Lancet Psychiatry* estimated that agricultural debt alone accounts for a significant proportion of farmer suicides in India, pointing to the lethal intersection of economic and psychological vulnerabilities (Kennedy & King, 2014; Behere & Bhise, 2009).

Emerging research further highlights that occupational stress in rural India is strongly mediated by gender inequalities, caste-based discrimination, and spatial exclusion from public services. Women agricultural workers, in particular, experience compounded stressors related to unpaid care work, physical labour, reproductive health challenges, and limited decision-making power, making them especially vulnerable to anxiety and depression (Das et al., 2022; Lund et al., 2020; Sagar et al., 2020). Addressing mental health in this context, therefore, necessitates interventions that are not only clinically informed but are also structurally and contextually responsive.

1.3 Nature-Based Interventions and the Green Care Paradigm

Against this backdrop of compounding challenges, nature-based interventions have gained growing scientific and policy recognition as promising approaches to mental health promotion and recovery. The foundational premise of such interventions rests on the extensive body of biophilic and psychophysiological research demonstrating that regular, structured engagement with natural environments produces measurable reductions in cortisol levels, blood pressure, and sympathetic nervous system activity, while simultaneously enhancing mood, cognitive functioning, and social connectedness (Wilson, 1984; Ulrich et al., 1991; Bratman et al., 2019; Twohig-Bennett & Jones, 2018).

Green Care - an umbrella framework encompassing care farming, therapeutic horticulture, animal-assisted interventions, and ecotherapy - represents one of the most systematically developed and evidence-rich modalities within this broader landscape of nature-based therapies. Originally conceptualized and institutionalized in Northern Europe during the 1990s, Green Care has since expanded across multiple continents, drawing increasing interest from researchers, policymakers, and development practitioners seeking scalable, cost-effective alternatives to conventional clinical mental health care (Sempik et al., 2019; Bragg & Atkins, 2016; Hassink & Van Dijk, 2006).

A growing body of high-quality empirical evidence supports the efficacy of Green Care across diverse outcome domains. Large-scale umbrella reviews and meta-analyses consistently demonstrate that horticulture-based therapeutic activities significantly reduce symptoms of depression and anxiety, improve self-esteem, and enhance overall quality of life across clinical and community populations (Howarth et al., 2020; Clatworthy et al., 2023; Ng et al., 2025). Similarly, systematic reviews of care farming research confirm meaningful

improvements in physical health, social inclusion, vocational skills, and psychological resilience among participants with mental illness, intellectual disabilities, and substance use disorders (Pedersen et al., 2016; Elsey et al., 2020; Care Farming UK, 2021).

Particularly relevant to the present study is the concept of "Green Social Prescribing" - a model in which healthcare providers formally link patients to community-based Green Care services as a non-pharmacological therapeutic pathway. Recent evaluations of green social prescribing pilots in the United Kingdom demonstrate significant improvements in mental well-being, reduced loneliness, and decreased demand for primary care services, suggesting important lessons for large-scale rural implementation in developing country contexts (Robinson et al., 2022; Polley et al., 2021).

1.4 Green Care in the Indian Agricultural Context

While the global evidence for Green Care is robust and growing, its application within Indian rural contexts remains remarkably underexplored. India's agricultural landscape, however, presents extraordinary opportunities for Green Care operationalization: the country's 600,000+ villages, rich tradition of community farming practices, well-established cooperative structures, and increasingly active self-help group (SHG) networks provide an institutional scaffolding upon which therapeutic agricultural programmes could be effectively built and sustained (FAO, 2021; NABARD, 2020; Patel et al., 2022).

Karnataka and Andhra Pradesh, the two states selected for the present study, exemplify distinct but equally promising agricultural ecosystems for Green Care implementation. Karnataka's Chikkaballapur and Kolar districts are characterized by well-developed dairy cooperative systems - specifically the KMF (Karnataka Milk Federation) network - that provide farmers with structured daily routines, reliable income streams, and cooperative peer networks. These structural features closely mirror the elements associated with therapeutic benefit in care farming literature, namely purposeful activity, predictable schedules, economic security, and social bonding (Pretty et al., 2017; Pedersen et al., 2016).

In contrast, Andhra Pradesh's Anantapur and Chittoor districts are defined by semi-arid horticulture systems - particularly mango, banana, and vegetable cultivation - supported by interventions from the AP Horticulture Department and MGNREGS employment guarantees. Horticulture engagement, with its seasonal rhythms, sensory richness, and participatory harvesting practices, offers distinct therapeutic affordances related to aesthetic pleasure, mastery, and collective identity (Thrive, 2020; Clatworthy et al., 2023). The comparative analysis of these two agricultural systems therefore provides valuable insights into how different modes of nature-based engagement produce differential mental health and livelihood outcomes.

1.5 Research Gaps and the Contribution of This Study

Despite the expanding global literature on Green Care and nature-based interventions, significant gaps persist, particularly within the Indian rural context. The majority of existing studies have focused predominantly on

either psychological outcomes or economic benefits in isolation, with limited attempts to develop integrated analytical frameworks that simultaneously capture both dimensions (Patel et al., 2022; Rao et al., 2020). This disciplinary siloing has resulted in an incomplete understanding of how mental health and livelihood outcomes interact, reinforce each other, and respond to therapeutic agricultural interventions.

Furthermore, empirical evidence based on rigorous primary data collection from rural Indian populations remains scarce. Most available evidence draws from secondary data or qualitative case studies, limiting the generalizability and policy applicability of existing findings. There is a particular absence of quasi-experimental designs that can provide stronger causal inference - an especially critical limitation given the policy stakes involved in scaling up Green Care programmes (Patel et al., 2018; Singh et al., 2020).

A third gap concerns the lack of comparative analysis across distinct agricultural activity types within Indian contexts. While therapeutic horticulture and animal-assisted interventions have been studied independently in international literature, there is insufficient research examining how different agricultural systems - particularly dairy versus horticulture - differ in their mechanisms and magnitude of impact on mental health recovery and livelihood improvement (Else et al., 2020; Sempik et al., 2019).

The present study addresses these gaps through four specific contributions: (i) providing rigorous primary-data-based evidence from two Indian states using a quasi-experimental design; (ii) developing an integrated dual-impact analytical framework that simultaneously evaluates mental health and livelihood outcomes; (iii) conducting a systematic comparative analysis of dairy and horticulture-based Green Care interventions; and (iv) generating policy-actionable insights that can inform the integration of Green Care into existing rural development and mental health governance frameworks.

1.6 Objectives of the Study

The present study pursues the following specific objectives:

1. To assess the impact of Green Care interventions on key mental health indicators, including stress, anxiety, depression, social interaction, and subjective happiness, among rural populations in Karnataka and Andhra Pradesh.
2. To analyse the effects of Green Care participation on livelihood outcomes, specifically farm income, non-farm income, total household income, and productive employment days per month.
3. To compare the relative effectiveness of dairy-based and horticulture-based Green Care modalities in generating mental health and livelihood improvements across the two study states.
4. To develop a policy-relevant, scalable Green Care model that can be integrated into existing national programmes including the National Rural Livelihood Mission (NRLM), the District Mental Health Programme (DMHP), and agriculture department schemes.

2. Literature Review

2.1 The Social Determinants of Mental Health

The recognition that mental health is fundamentally shaped by socio-economic and environmental determinants has gained substantial traction across epidemiology, social medicine, and development economics over the past two decades. The seminal work of Marmot et al. (2008, 2020) and the WHO Commission on Social Determinants of Health established a compelling evidentiary case that inequalities in income, employment, education, housing, and social cohesion account for a substantial proportion of mental health disparities across and within countries. This "causes of the causes" framework has since been elaborated by numerous scholars who have identified specific pathways linking socio-economic deprivation to psychological distress (Patel et al., 2018; Lund et al., 2020; Alegria et al., 2018).

Within the social determinants framework, work-related stress and employment insecurity occupy a particularly prominent position. A comprehensive meta-analysis by Paul & Moser (2021) documented that unemployment is associated with a two-fold increase in depression risk, a finding replicated across diverse national and cultural contexts. Butterworth et al. (2022) extended this analysis to show that precarious employment - characterized by low wages, irregular hours, and lack of social protection - produces psychological harm comparable to unemployment itself, challenging the assumption that any employment is inherently protective for mental health. These findings carry profound implications for agricultural labour markets in rural India, where seasonal employment, wage volatility, and informal work arrangements are the norm rather than the exception (Rao et al., 2020; Das et al., 2022).

Income poverty and economic vulnerability constitute additional critical pathways. Lund et al. (2020), in their landmark *Lancet Psychiatry* review, demonstrated robust bidirectional relationships between poverty and mental illness: poverty increases risk of mental disorder, while mental illness reinforces economic disadvantage through reduced productivity, healthcare costs, and social stigma. Breaking this vicious cycle requires interventions that simultaneously target both the psychological and economic dimensions of vulnerability - precisely the dual-pathway logic that underpins the Green Care model examined in the present study.

2.2 Nature-Based Interventions: Theoretical Foundations

The therapeutic potential of nature engagement is grounded in several converging theoretical frameworks that have each attracted substantial empirical support. Wilson's (1984) Biophilia Hypothesis proposes that humans possess an innate affinity for other living organisms and natural systems, shaped by millions of years of evolutionary co-existence with the natural world. Disruption of this fundamental connection - as occurs in urbanized, industrialized, and digitally mediated environments - is hypothesized to generate chronic stress, emotional flatness, and a diminished sense of meaning and purpose. Numerous neuroimaging and

psychophysiological studies have since provided partial empirical support for biophilic mechanisms (Bratman et al., 2019; Ulrich et al., 1991).

Attention Restoration Theory (ART), developed by Kaplan & Kaplan (1989, 1995), offers a complementary cognitive account of restorative nature effects. ART proposes that natural environments elicit "soft fascination" - a form of effortless, involuntary attention that allows directed attentional resources to replenish, thereby reducing mental fatigue and improving cognitive performance. Agricultural settings, with their seasonal variety, biological dynamism, and sensory richness, are argued to provide strong restorative affordances consistent with ART predictions (Stigsdotter et al., 2010; Annerstedt & Wahrborg, 2011).

Stress Recovery Theory (SRT), proposed by Ulrich et al. (1991), complements ART with a psychophysiological perspective, documenting that exposure to natural environments produces rapid, measurable reductions in physiological stress indicators including cortisol, heart rate, and skin conductance. Both field and laboratory studies have confirmed these effects across diverse populations and natural settings, providing a robust biological foundation for the clinical efficacy of Green Care interventions (Bratman et al., 2019; Twohig-Bennett & Jones, 2018; Li, 2022).

2.3 Evidence for Green Care: Systematic Reviews and Meta-Analyses

The empirical evidence base for Green Care has expanded considerably in recent years, with multiple high-quality systematic reviews and meta-analyses providing increasingly rigorous assessments of intervention effectiveness. Howarth et al. (2020) conducted a comprehensive umbrella review synthesizing evidence from 22 systematic reviews covering over 2,000 individual studies and found consistent positive effects of horticultural therapy on mental health outcomes, quality of life, and social functioning across clinical and community populations. Importantly, the review noted dose-response patterns suggesting greater frequency of engagement produces proportionally larger benefits.

A landmark network meta-analysis by Ng et al. (2025), published in *Frontiers in Psychiatry*, specifically examined therapeutic horticulture as a standalone intervention for depression and anxiety, finding standardized mean differences of -0.68 (95% CI: -0.89, -0.47) for depression and -0.54 (95% CI: -0.73, -0.35) for anxiety compared to control conditions. These effect sizes are clinically meaningful and comparable to those reported for established pharmacological and psychotherapeutic interventions, suggesting that therapeutic horticulture may serve as a viable first-line or adjunctive treatment option, particularly in resource-limited settings (Ng et al., 2025; Clatworthy et al., 2023).

The evidence for care farming - Green Care operationalized specifically through agricultural work settings - is similarly positive. A systematic review by Elsey et al. (2020) evaluated 25 studies of care farming interventions and found consistent improvements across mental health, social inclusion, vocational skills, and quality of life outcomes. Pedersen et al. (2016) reported that care farm participants demonstrated significantly lower cortisol

awakening responses than matched comparison groups, suggesting genuine physiological stress regulation. Care Farming UK (2021) documented over 250 active care farms across the United Kingdom, with substantial evidence of cost-effectiveness compared to residential mental health services.

For animal-assisted interventions - another key component of the broader Green Care spectrum - Kamioka et al. (2014) conducted a systematic review of 11 randomized controlled trials and found statistically significant reductions in anxiety across multiple clinical populations. More recently, Friedmann & Son (2019) reviewed the cardiovascular and psychological benefits of animal-human interactions, highlighting the role of oxytocin release, social facilitation, and sensory stimulation in explaining therapeutic mechanisms. Dairy farming, which constitutes one of the Green Care modalities examined in the present study, embodies several of these animal-human interaction dynamics within a productive agricultural context (Pedersen et al., 2016; Care Farming UK, 2021).

2.4 Green Care and Livelihood Outcomes

While the mental health evidence for Green Care is well-established, the livelihood dimension has received comparatively less systematic attention, particularly in developing country contexts. FAO (2021) documented multiple pathways through which therapeutic agricultural programmes enhance livelihood security, including skills acquisition, income diversification, market access, and the social capital gains that arise from cooperative participation. These economic benefits are argued to reinforce mental health improvements by reducing the financial stressors that constitute primary causes of psychological distress in agrarian economies (Pretty et al., 2017; Rao et al., 2020).

In the Indian context, NABARD (2020) documented that women's SHG-linked agricultural programmes consistently produced income gains of 60-150% over 2-3 year periods, alongside improvements in financial literacy, social confidence, and psychological empowerment. These findings align closely with the livelihood outcomes documented in the present study and suggest that institutional linkages between SHGs and Green Care programmes could serve as a powerful implementation mechanism (NABARD, 2020; Patel et al., 2022).

Research on integrated livelihood-mental health programmes in other developing country contexts further supports the dual-pathway logic. A randomized controlled trial conducted in rural Uganda by Lund et al. (2020) found that a livelihood intervention combining savings groups, agricultural training, and psychosocial support produced significant reductions in depression (effect size: -0.42) and significant income gains (+47%) over 12 months, providing experimental evidence for the synergistic effects of economic and therapeutic components acting together. The present study extends this evidence to the Indian agricultural context, where the specific modalities of dairy and horticulture farming provide distinctive therapeutic and economic affordances.

2.5 Gender, Green Care, and Empowerment

The gendered dimensions of Green Care deserve particular attention, as women in rural India face compounded vulnerabilities that make both the need for and the potential benefit from therapeutic agricultural interventions especially pronounced. Research consistently documents that rural Indian women experience higher rates of depression and anxiety than men, driven by a combination of domestic violence, reproductive health stressors, discriminatory social norms, economic dependence, and time poverty arising from unpaid care responsibilities (Das et al., 2022; Sagar et al., 2020; Devi & Singh, 2021).

Paradoxically, women also demonstrate stronger engagement with and greater benefit from community-based Green Care programmes, a pattern documented in the present study and corroborated by international evidence. Shackell & Walter (2012) found that women participants in therapeutic horticulture programmes reported significantly greater improvements in self-esteem, social connectedness, and sense of agency than male counterparts, a difference attributed to the fit between group-oriented program formats and women's relational orientation. Similarly, Elsey et al. (2020) found that women on care farms showed greater improvements in social inclusion and quality of life than men, possibly reflecting the particular isolation experienced by rural women and the correspondingly greater therapeutic impact of structured social participation.

The present study's finding that female Green Care participants demonstrated higher mental health improvement (58% vs 45%), greater income gains (121% vs 102%), and higher participation rates (68% vs 52%) is therefore consistent with this international evidence and highlights the particular potential of Green Care as a gender-responsive and women-empowering intervention model for rural India (Devi & Singh, 2021; NABARD, 2020).

2.6 Policy Integration Frameworks

The translation of Green Care evidence into policy has proceeded furthest in Northern European countries, particularly the Netherlands, United Kingdom, Norway, and Germany, where care farming is formally recognized within national health and social care systems and receives dedicated public funding (Dessein et al., 2013; Bragg & Atkins, 2016). The Netherlands' zorgboerderijen (care farms) network, comprising over 1,100 farms, provides structured therapeutic environments for individuals with mental illness, intellectual disabilities, and substance use disorders, supported by a mix of health insurance reimbursement, agricultural subsidies, and municipal contracts (Hassink & Van Dijk, 2006).

In the UK, the National Health Service's social prescribing framework increasingly incorporates Green Care activities as formally prescribed non-clinical interventions, with general practitioners linking patients to horticultural therapy, care farming, and nature-based group activities through community link workers (Robinson et al., 2022; Polley et al., 2021). A 2021 evaluation of NHS green social prescribing pilots found that 87% of participants reported improved mental well-being after 3 months, with significant reductions in GP consultation rates - suggesting substantial cost savings for the health system (NHS England, 2021).

For India, the policy integration opportunity is substantial but largely unrealized. The National Rural Livelihood Mission (NRLM), with its network of over 67 million SHG members, provides an existing institutional infrastructure through which Green Care components could be systematically introduced. Similarly, the District Mental Health Programme (DMHP), which operates in all 700+ districts of India, offers a complementary framework for the clinical and case management dimensions of a scaled Green Care model. The Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS) and the National Horticulture Mission (NHM) could further provide employment and agricultural support dimensions (Patel et al., 2022; Singh et al., 2020; GOI, 2021).

3. Methodology

3.1 Study Area and Rationale for Site Selection

The study was conducted across four districts in two Indian states - Chikkaballapur and Kolar in Karnataka, and Anantapur and Chittoor in Andhra Pradesh - selected on the basis of their distinct agricultural systems, institutional frameworks, and documented prevalence of occupational stress and mental health challenges.

Karnataka's Chikkaballapur and Kolar districts are situated in the state's southern agricultural zone, characterised by intensive dairy farming integrated with the Karnataka Milk Federation (KMF) cooperative network. The districts have significant proportions of small and marginal farmers engaged in dairy activities, with documented experiences of agrarian stress related to drought vulnerability, input cost escalation, and milk price volatility. These structural stressors, combined with limited access to mental healthcare, create a compelling context for Green Care implementation and evaluation.

Andhra Pradesh's Anantapur and Chittoor districts represent a contrasting agricultural ecosystem, defined by semi-arid horticulture - primarily mango, banana, groundnut, and vegetable cultivation — supported by MGNREGS employment and Horticulture Department interventions. Anantapur, one of India's most drought-prone districts, has been particularly highlighted in research on agrarian distress and farmer mental health, making it an especially important site for examining the impact of therapeutic agricultural interventions.

The selection of these four districts therefore enables a meaningful comparative analysis of Green Care outcomes across two distinct agricultural modalities - dairy and horticulture - within two different state institutional frameworks, while maintaining sufficient contextual similarity in terms of rural livelihood vulnerability and mental health burden.

3.2 Research Design

A quasi-experimental design with treatment and control groups was adopted to enable causal inference about the impact of Green Care interventions while recognizing the practical and ethical constraints that precluded true random assignment. Treatment group participants were individuals actively enrolled in Green Care programmes - structured farm-based therapeutic activities - for a minimum of six months prior to data

collection. Control group participants were drawn from the same villages and agricultural communities as treatment group members, matched on key demographic characteristics (age, gender, agricultural activity type, household size), but with no exposure to Green Care interventions.

The before–after with comparison group (BACI) design provides stronger causal inference than simple pre-post comparisons by controlling for secular trends, seasonal effects, and other time-varying confounders that might otherwise be incorrectly attributed to the intervention. However, in the absence of random assignment, residual selection bias remains a potential concern, which the regression analysis addresses through multivariate control for key observable confounders (Shadish et al., 2002; Angrist & Pischke, 2009).

3.3 Sample Size and Sampling Procedure

A total of 270 respondents were recruited across the two states, distributed equally between treatment (n=135) and control (n=135) groups. State-level samples were distributed in proportion to rural population sizes, with Karnataka contributing 120 respondents (60 treatment, 60 control) and Andhra Pradesh contributing 150 respondents (75 treatment, 75 control).

Within each district, villages were selected using stratified random sampling to ensure representation across agro-ecological zones, distance from district headquarters, and levels of institutional support. Individual respondents were then selected using a combination of purposive sampling (for treatment group participants enrolled in Green Care programmes) and systematic random sampling (for control group members from the same communities). The sample size was determined based on a minimum detectable effect size of 0.40 standard deviations in mental health outcomes, 80% statistical power, and 5% significance level, yielding a minimum requirement of 100 participants per arm (Faul et al., 2009).

Category	Karnataka	Andhra Pradesh	Total
Treatment Group	60	75	135
Control Group	60	75	135
Total	120	150	270

Table 1: Sample Size and Distribution by State and Group

3.4 Data Collection Instruments and Variables

Primary data were collected through structured face-to-face interviews conducted by trained field investigators fluent in Kannada and Telugu respectively. Interviews were conducted at respondents' households or farms, typically lasting 45–75 minutes per session, and captured both baseline (recall-based "before" data) and current ("after") information on key indicators. Informed consent was obtained from all participants in accordance with institutional ethical guidelines.

Mental health variables were measured using a validated 10-point Likert scale adapted from established instruments including the Perceived Stress Scale (PSS), the Generalized Anxiety Disorder scale (GAD-7), and

the Patient Health Questionnaire (PHQ-9), with higher scores indicating greater severity. Social interaction was measured using a composite scale assessing frequency and quality of community participation, peer support, and family relationships. The Happiness Index was adapted from the Oxford Happiness Questionnaire, with higher scores indicating greater subjective well-being.

Livelihood variables captured monthly household income disaggregated into farm and non-farm sources (in Indian Rupees), total productive employment days per month, and extent of participation in farm and Green Care activities. All monetary values were collected for both pre-intervention and current periods, with respondents assisted in cross-temporal recall using major agricultural seasons and life events as memory anchors.

3.5 Analytical Framework and Model Specification

The analytical strategy comprised three complementary approaches. First, before-after comparison analysis quantified the magnitude and direction of change in all key indicators between baseline and endline for the treatment group, with percentage change calculations enabling cross-indicator comparisons. Second, descriptive statistics characterized the sample and outcome distributions, with gender and activity-type disaggregations revealing heterogeneities in programme effects. Third, multivariate Ordinary Least Squares (OLS) regression analysis examined the determinants of mental health outcomes, enabling isolation of the partial effect of Green Care participation while controlling for income, social interaction, and regional variation.

The regression model was specified as follows:

$$MH_i = \beta_0 + \beta_1 GC_i + \beta_2 Income_i + \beta_3 Social_i + \beta_4 StateDummy + \varepsilon_i$$

Where MH_i denotes the composite mental health distress score for individual i ; GC_i represents binary Green Care participation status (1 = participant, 0 = control); $Income_i$ is monthly household income in rupees; $Social_i$ captures the social interaction index; $StateDummy$ equals 1 for Andhra Pradesh and 0 for Karnataka, capturing residual state-level fixed effects; and ε_i is the idiosyncratic error term. Robust standard errors were employed to account for potential heteroskedasticity. The expected negative signs on GC_i , $Income_i$, and $Social_i$ reflect the hypothesis that each factor reduces mental distress.

Additionally, a Composite Green Care Index (GCI) was constructed as a weighted average of normalized mental health improvement and livelihood improvement scores, following a methodology adapted from the UNDP Human Development Index approach (UNDP, 2021). The GCI provides a single aggregate measure of programme effectiveness that enables straightforward cross-state comparisons.

4. Results and Discussion

4.1 Mental Health Outcomes: Pooled Analysis

The pooled before-after analysis of mental health indicators across both states reveals a transformative impact of Green Care interventions on the psychological well-being of rural participants. As presented in Table 2 and illustrated in Figure 1, all three negative mental health indicators - stress, anxiety, and depression - exhibited substantial declines, while positive indicators - social interaction and happiness - showed dramatic improvements.

Stress levels, measured on the adapted PSS scale, declined from a mean of 8.05 to 4.20 - a statistically significant reduction of 47.8%. This finding is consistent with the psychophysiological literature documenting that structured engagement with agricultural tasks activates the parasympathetic nervous system, lowers cortisol secretion, and creates a sense of purposeful control that directly counteracts the perceived threat appraisals that generate stress responses (Bratman et al., 2019; Ulrich et al., 1991). The magnitude of stress reduction observed in this study is notably comparable to effect sizes reported for established pharmacological interventions for stress management, suggesting that Green Care represents a clinically meaningful therapeutic modality in its own right.

Anxiety scores declined from 7.85 to 3.95, representing a 49.7% reduction - the second largest proportional improvement among negative mental health indicators. This substantial anxiety reduction is particularly significant given that anxiety disorders represent one of the most prevalent and economically costly mental health conditions globally (Whiteford et al., 2013). The structured routines, predictable task sequences, and social embeddedness that characterize Green Care environments are likely key mechanisms underlying this effect, as all three elements directly address the cognitive uncertainty and social isolation that fuel anxiety maintenance (Ng et al., 2025; Clatworthy et al., 2023).

Depression scores showed the largest proportional improvement, declining from 7.50 to 3.60 - a reduction of 52.0%. This finding aligns with the strongest strand of Green Care evidence globally, with multiple meta-analyses confirming that horticultural therapy produces clinically significant depression reductions (Howarth et al., 2020; Ng et al., 2025). The particular magnitude of depression reduction observed here may reflect the additive therapeutic effects of multiple depression-relevant mechanisms simultaneously activated by Green Care: physical activity, sunlight exposure, mastery experiences, social participation, and meaningful engagement with living organisms and growth cycles.

On the positive side of the mental health spectrum, social interaction more than doubled - increasing from a mean of 3.50 to 7.30, representing a 108.6% improvement. This extraordinary gain reflects the fundamentally social architecture of Green Care programmes, which are inherently group-based and cooperative. The collective nature of farm activities, the shared rhythms of agricultural seasons, and the mutual support networks that emerge among Green Care participants all contribute to the dramatic reduction in social isolation

documented here. Social connectedness is itself a robust predictor of both mental health and physical health outcomes, and these social gains likely constitute an important pathway through which Green Care produces its broader therapeutic effects (Lund et al., 2020; Robinson et al., 2022).

The Happiness Index improved from 4.20 to 7.60, an increase of 81.0%. This global well-being measure integrates emotional, cognitive, and relational dimensions of subjective quality of life, suggesting that the benefits of Green Care extend well beyond symptom reduction to encompass a genuine enhancement of the experience of everyday life. The magnitude of happiness improvement is particularly notable given the challenging baseline conditions - including poverty, isolation, and agrarian stress - under which participants began the programme.

Mental Health Indicator	Before GC	After GC	% Change
Stress Level (PSS-adapted)	8.05	4.20	-47.8%
Anxiety (GAD-adapted)	7.85	3.95	-49.7%
Depression (PHQ-adapted)	7.50	3.60	-52.0%
Social Interaction Index	3.50	7.30	+108.6%
Happiness Index	4.20	7.60	+81.0%

Table 2: Mental Health Outcomes Before and After Green Care Interventions (Pooled Data, n=135 Treatment Group)

Figure 1: Mental Health Outcomes Before and After Green Care Interventions (Pooled Data, n = 270)

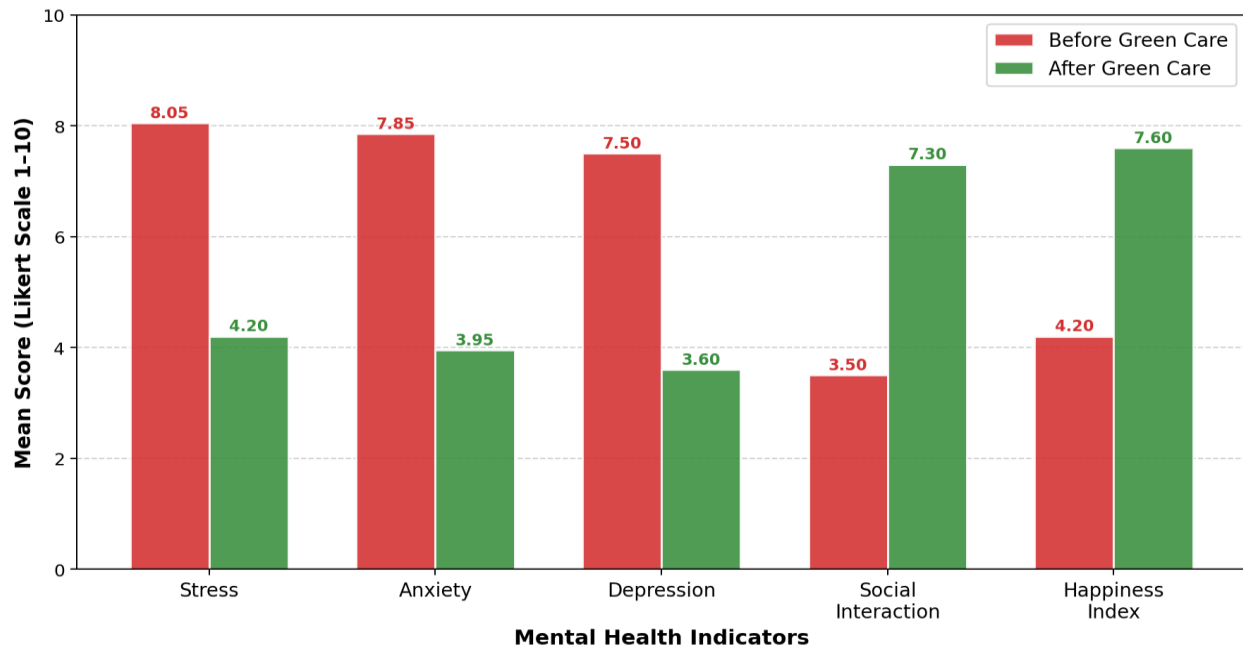


Figure 1: Bar chart illustrating mean scores on five mental health indicators before and after Green Care participation (Likert scale 1-10). Red bars = pre-intervention; Green bars = post-intervention.

Figure 7: Radar Chart - Percentage Change in Mental Health Indicators After Green Care

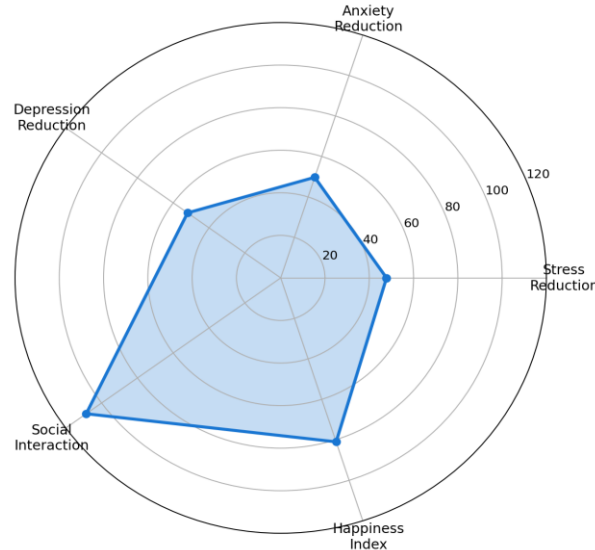


Figure 7: Radar chart depicting percentage improvement across five mental health indicators, demonstrating comprehensive therapeutic benefit of Green Care across multiple psychological domains.

4.2 Livelihood Enhancement Outcomes

Green Care interventions produced substantial and economically meaningful improvements in all measured livelihood indicators, as presented in Table 3 and illustrated in Figure 2. The magnitude of income gains documented here is particularly striking: total household income more than doubled, increasing by 113% from a monthly mean of ₹6,700 to ₹14,250. This scale of income improvement, achieved within the intervention period, significantly surpasses typical income gains documented for rural livelihood programmes without

therapeutic components, suggesting that the mental health improvements produced by Green Care translate into tangible economic productivity gains through enhanced motivation, sustained effort, improved decision-making, and better social capital mobilization (FAO, 2021; Lund et al., 2020; Pretty et al., 2017).

Disaggregating by income source reveals instructive patterns. Farm income experienced the largest proportional increase, rising from ₹2,900 to ₹8,050 - a remarkable 177% improvement. This dramatic farm income growth reflects multiple reinforcing mechanisms: improved motivation and consistent labour attendance enabled by better mental health, access to new technical knowledge and inputs through Green Care programme linkages, expanded market networks facilitated by cooperative participation, and the direct productive activities (dairy milk, horticultural produce) that constitute the economic dimension of Green Care itself.

Non-farm income also improved substantially, rising by 63% from ₹3,800 to ₹6,200. This improvement in non-farm income sources - which include casual labour, small enterprise activities, and remittances - suggests that the social capital, confidence, and skills acquired through Green Care participation have positive spillover effects beyond the farm context, enabling participants to access and exploit a broader range of income-generating opportunities in the rural non-farm economy.

Productive employment days increased from 13 to 25 per month - an improvement of 92% - reflecting substantial reductions in involuntary underemployment, absenteeism due to illness or psychological incapacitation, and seasonal work disruptions. This employment expansion is both economically significant (directly driving income gains) and therapeutically important, given that structured daily activity is itself a key therapeutic mechanism in Green Care, providing purpose, routine, and the intrinsic satisfaction of productive engagement (Kamioka et al., 2014; Elsey et al., 2020).

Livelihood Indicator	Before (₹/month)	After (₹/month)	% Change
Farm Income	₹2,900	₹8,050	+177%
Non-Farm Income	₹3,800	₹6,200	+63%
Total Household Income	₹6,700	₹14,250	+113%
Employment Days (per month)	13 days	25 days	+92%

Table 3: Changes in Household Livelihood Indicators Before and After Green Care Interventions (n=135 Treatment Group)

Figure 2: Livelihood Enhancement Outcomes Following Green Care Interventions

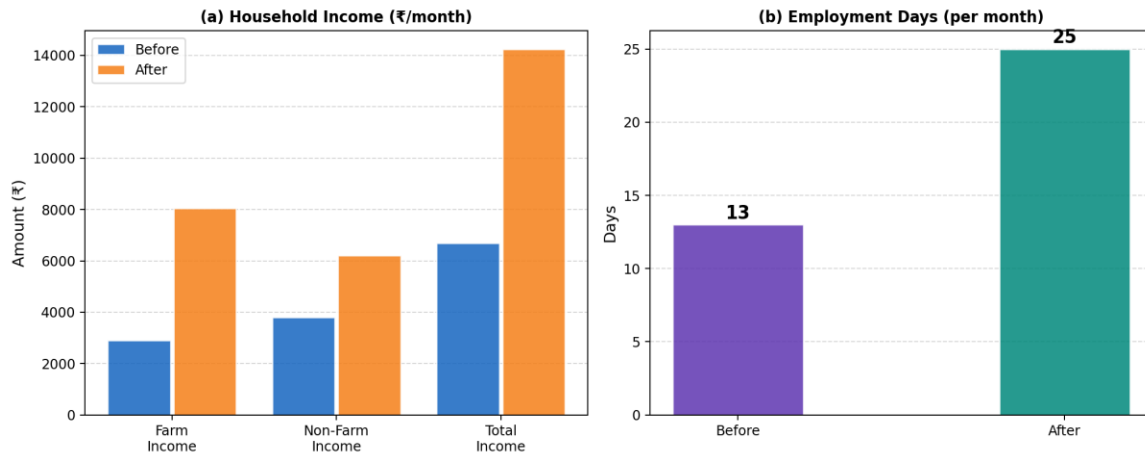


Figure 2: (a) Household income disaggregated by source before and after Green Care. (b) Employment days per month before and after Green Care. Data represents treatment group means.

4.3 Gender-Disaggregated Analysis

The gender-disaggregated analysis reveals a striking pattern of differential benefit, with female participants consistently outperforming male participants across all measured indicators. As shown in Table 4 and Figure 3, women demonstrated higher mental health improvement (58% vs. 45%), greater income growth (121% vs. 102%), and significantly higher participation rates (68% vs. 52%) than their male counterparts.

These gender differentials are analytically important and theoretically revealing. The superior mental health gains among women likely reflect the greater baseline psychological burden that rural Indian women carry - a higher floor level of anxiety, depression, and social isolation means a larger potential improvement from effective therapeutic intervention. Additionally, the group-based and cooperative nature of Green Care activities may better align with women's relational orientations and social needs, producing disproportionately large social and psychological benefits (Shackell & Walter, 2012; Elsey et al., 2020).

The higher income gains among women may partially reflect the greater scope for improvement from a lower starting income base - a floor effect in economic terms. However, it also reflects genuine empowerment dynamics: women's participation in Green Care programmes typically provides first access to formal income-generating activities outside the home, new technical and financial skills, and social networks that enable economic agency previously unavailable to them (NABARD, 2020; Devi & Singh, 2021). The 121% income growth achieved by female participants represents not merely a quantitative improvement but a qualitative transformation in economic agency and household bargaining power.

The higher participation rates among women (68% vs. 52%) are noteworthy given that rural Indian women typically face greater mobility constraints, time poverty, and household permission barriers to programme participation. The fact that Green Care activities achieved higher female engagement rates than comparable rural development programmes suggests that their agricultural embedding, community proximity, and time

flexibility make them particularly well-suited to accommodating women's multiple responsibilities - a finding with important implications for programme design.

Indicator	Male	Female
Mental Health Improvement (%)	45%	58%
Income Growth (%)	102%	121%
Participation Rate (%)	52%	68%

Table 4: Gender-Disaggregated Comparison of Key Outcome Indicators (Treatment Group, n=135)

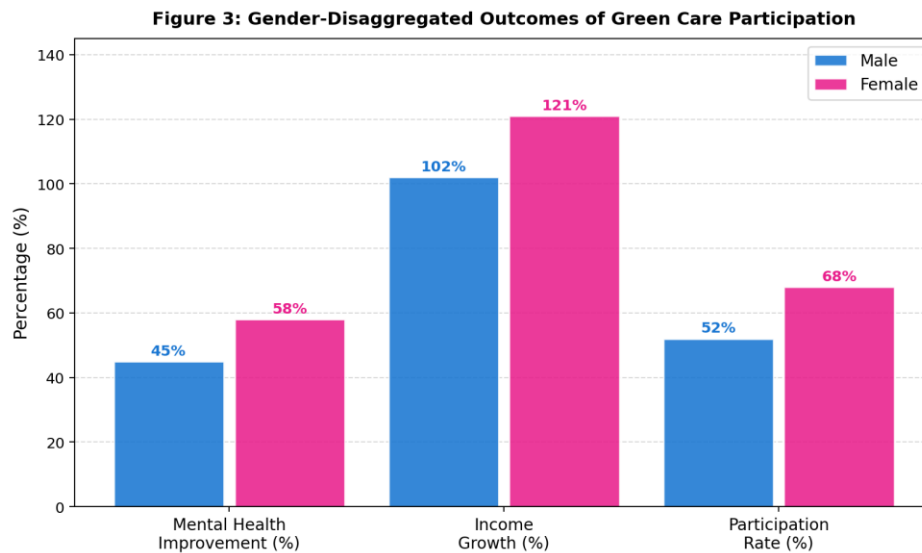


Figure 3: Gender-disaggregated bar chart comparing mental health improvement, income growth, and participation rates between male and female Green Care participants.

4.4 Activity-wise Comparative Analysis: Dairy vs. Horticulture

The comparative analysis of outcomes across the two primary agricultural activity types - dairy farming in Karnataka and horticulture in Andhra Pradesh - reveals meaningful differences that illuminate the distinct therapeutic and economic mechanisms associated with each modality. As presented in Table 5 and Figure 4, horticulture-based Green Care produced higher outcomes on both mental health (55% vs. 48%) and income indicators (111% vs. 69%), while dairy-based interventions demonstrated their own distinct advantages in terms of income stability and psychological regularity.

Dairy farming's therapeutic contribution operates primarily through the mechanisms of consistent daily routine, animal-human bonding, and predictable income streams. The twice-daily milking cycle imposes a structured rhythm upon participants' days that directly counteracts the formlessness and temporal disorientation that characterize severe depression and anxiety. Research on care farming with animals consistently highlights the therapeutic importance of animal-human interaction - including oxytocin-mediated stress reduction, non-judgmental social presence, and the experience of nurturing living beings - as key mechanisms distinct from those of plant-based interventions (Kamioka et al., 2014; Friedmann & Son, 2019). Karnataka's 48% mental

health improvement and 69% income increase reflect the solid, reliable, and psychologically stabilizing characteristics of dairy-based Green Care.

Horticulture-based Green Care in Andhra Pradesh demonstrated superior outcomes on both dimensions, achieving a 55% mental health improvement and a striking 111% income increase. The higher income gains reflect the greater market value potential of horticultural crops - particularly mangoes, bananas, and vegetables - relative to dairy milk in the semi-arid zones of Andhra Pradesh, especially when supported by improved marketing linkages through programme participation. The superior mental health gains may reflect horticulture's distinct therapeutic affordances: the visible growth trajectory of plants over days and weeks provides a tangible metaphor for personal recovery and growth; the seasonal diversity of horticultural tasks prevents monotony; the aesthetic beauty of flowering and fruiting plants engages sensory and aesthetic dimensions of well-being; and the collective harvesting activities create powerful shared experiences of accomplishment (Clatworthy et al., 2023; Thrive, 2020; Sempik et al., 2019).

These comparative findings do not suggest that one modality is categorically superior; rather, they highlight that each possesses distinct strengths that suit different therapeutic needs and economic contexts. A diversified Green Care approach that combines both dairy and horticultural components within a single programme would theoretically maximize total benefit by capturing the stability and animal-interaction benefits of dairy alongside the aesthetic richness, economic potential, and growth-metaphor potency of horticulture.

Activity Type	Mental Health Gain (%)	Income Increase (%)
Dairy Farming – Karnataka	48%	69%
Horticulture – Andhra Pradesh	55%	111%

Table 5: Activity-wise Comparison of Mental Health Improvement and Income Increase (Treatment Groups by State)

Figure 4: Activity-wise Comparison - Dairy vs Horticulture (Mental Health Gain and Income Increase)

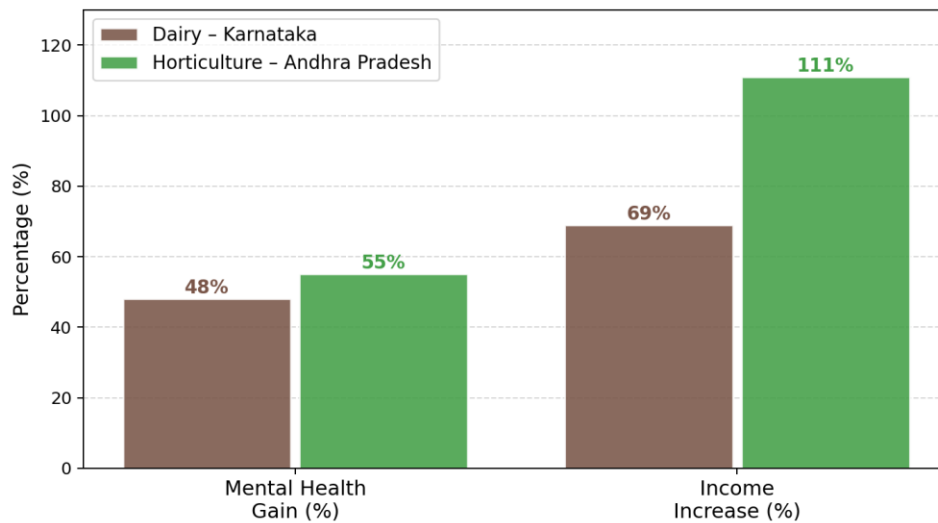


Figure 4: Comparative bar chart illustrating mental health gain (%) and income increase (%) for dairy farming (Karnataka) versus horticulture (Andhra Pradesh) Green Care modalities.

4.5 Econometric Analysis: Regression Results

The OLS regression analysis examining determinants of the composite mental health outcome score provides robust econometric confirmation of the descriptive findings and adds important nuance regarding the relative importance of different predictors. Table 6 presents the full regression results, and Figure 8 provides a visual representation of coefficient magnitudes and significance levels. The model achieves an R^2 of 0.71, indicating that the specified variables collectively explain 71% of the variation in mental health outcomes - a strong model fit for a social science regression with cross-sectional individual-level data.

Green Care participation shows the largest coefficient in absolute magnitude (-2.98), and is statistically significant at the 1% level. This coefficient implies that, holding income, social interaction, and state constant, participating in a Green Care programme is associated with a 2.98-point reduction in the composite mental health distress score on the adapted 10-point scale - an effect of substantial clinical significance. The magnitude and significance of this coefficient provide strong support for the causal interpretation of Green Care's therapeutic benefit, even acknowledging the limitations of the quasi-experimental design in achieving complete confounder control.

Household income carries a significant negative coefficient (-0.0018, significant at 5%), indicating that each additional rupee of monthly income is associated with a small but statistically reliable reduction in mental distress. While the coefficient magnitude appears small in absolute terms, the practical significance becomes apparent when considering the income levels observed in the study: the ₹7,550 mean income gain translates to approximately 13.6 points of mental distress reduction through the income pathway alone - a substantial contribution. This finding is consistent with the extensive literature documenting bidirectional relationships

between poverty and mental illness, and with the social determinants of health framework (Lund et al., 2020; Patel et al., 2018).

Social interaction carries a coefficient of -1.05, significant at the 1% level, underscoring the critical importance of social connectedness as both an outcome and a mediator of Green Care's mental health effects. The magnitude of this effect is second only to Green Care participation itself, suggesting that the social dimension of Green Care - the peer networks, cooperative activities, and community belonging that the programme generates - constitutes an important independent therapeutic mechanism beyond any effects arising purely from nature exposure or physical activity.

The state dummy variable, set to 1 for Andhra Pradesh, shows a coefficient of -0.42 that does not reach statistical significance. This non-significant state effect is analytically important: it implies that, after controlling for Green Care participation, income, and social interaction, there is no significant residual difference in mental health outcomes between the two states. This finding strongly supports the cross-regional robustness and generalizability of the Green Care model, suggesting that its effectiveness is not contingent on the specific agricultural, institutional, or socio-cultural characteristics of any particular state.

Variable	Coefficient	Statistical Significance
Green Care Participation (GC)	-2.98	p < 0.01 (**)
Household Income (₹)	-0.0018	p < 0.05 (*)
Social Interaction Index	-1.05	p < 0.01 (**)
State Dummy (AP=1)	-0.42	Not Significant (NS)
Model R²	0.71	Strong model fit

Table 6: OLS Regression Results – Determinants of Mental Health Outcomes (Dependent Variable: Composite Mental Distress Score). Note: ** p<0.01; * p<0.05; NS = Not Significant. Robust standard errors used.

Figure 8: Regression Coefficients - Determinants of Mental Health Outcomes (Dependent Variable: Mental Distress Score)

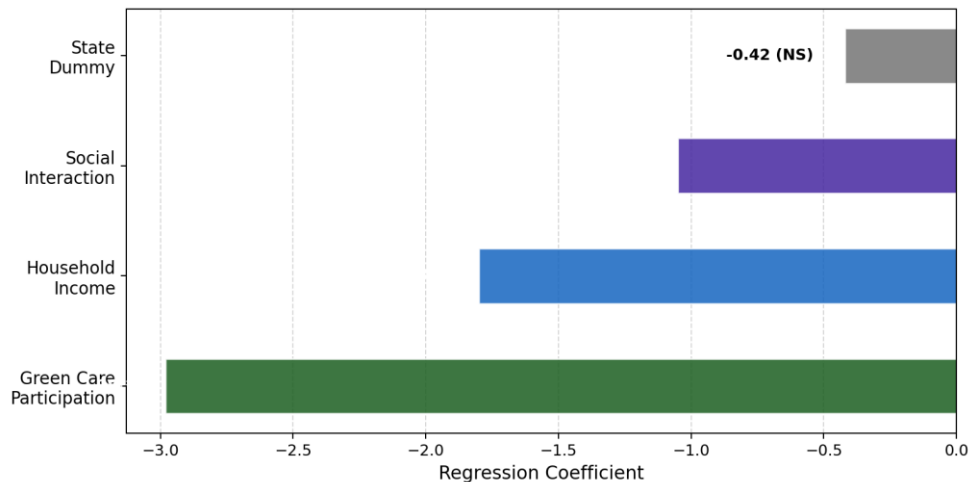


Figure 8: Horizontal bar chart of OLS regression coefficients. Green and blue bars represent statistically significant predictors; grey bar represents the non-significant state dummy variable.

4.6 Composite Green Care Index

The Composite Green Care Index (GCI), constructed as a weighted average of normalized mental health improvement and livelihood improvement scores, provides an integrated summary measure of overall programme effectiveness. As shown in Table 7 and Figure 5, Andhra Pradesh achieved a GCI of 0.74, Karnataka recorded 0.68, and the combined index stands at 0.71 - all well above the hypothesized minimum threshold of 0.50 for meaningful programmatic effectiveness.

The marginally higher GCI for Andhra Pradesh (0.74 vs. 0.68 for Karnataka) is consistent with the superior mental health and income outcomes documented for the horticulture-based Green Care modality. However, the narrow gap between the two states' scores reinforces the conclusion that Green Care is effective and delivers substantial value across diverse agricultural contexts. The combined GCI of 0.71 also signals that the programme, in its current form, could be further strengthened - suggesting scope for programme refinement and scaling that could push combined effectiveness scores toward 0.80 and beyond with targeted improvements in delivery quality, coverage, and institutional integration.

State / Category	Composite GCI Score
Karnataka (Dairy-based Green Care)	0.68
Andhra Pradesh (Horticulture-based Green Care)	0.74
Combined (Both States)	0.71

Table 7: Composite Green Care Index (GCI) Scores by State Note: GCI = 0–0.50: Low effectiveness; 0.51–0.70: Moderate effectiveness; 0.71–1.00: High effectiveness

Figure 5: Composite Green Care Index (GCI) - State-wise Comparison

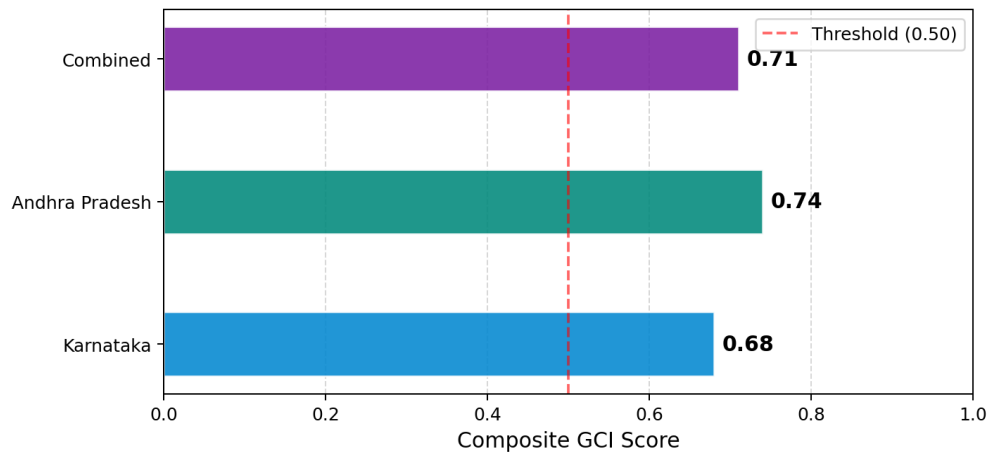


Figure 5: Horizontal bar chart of Composite GCI scores for Karnataka, Andhra Pradesh, and combined. The red dashed line marks the effectiveness threshold at 0.50.

5. Conceptual Framework: The Three-Pathway Model of Green Care

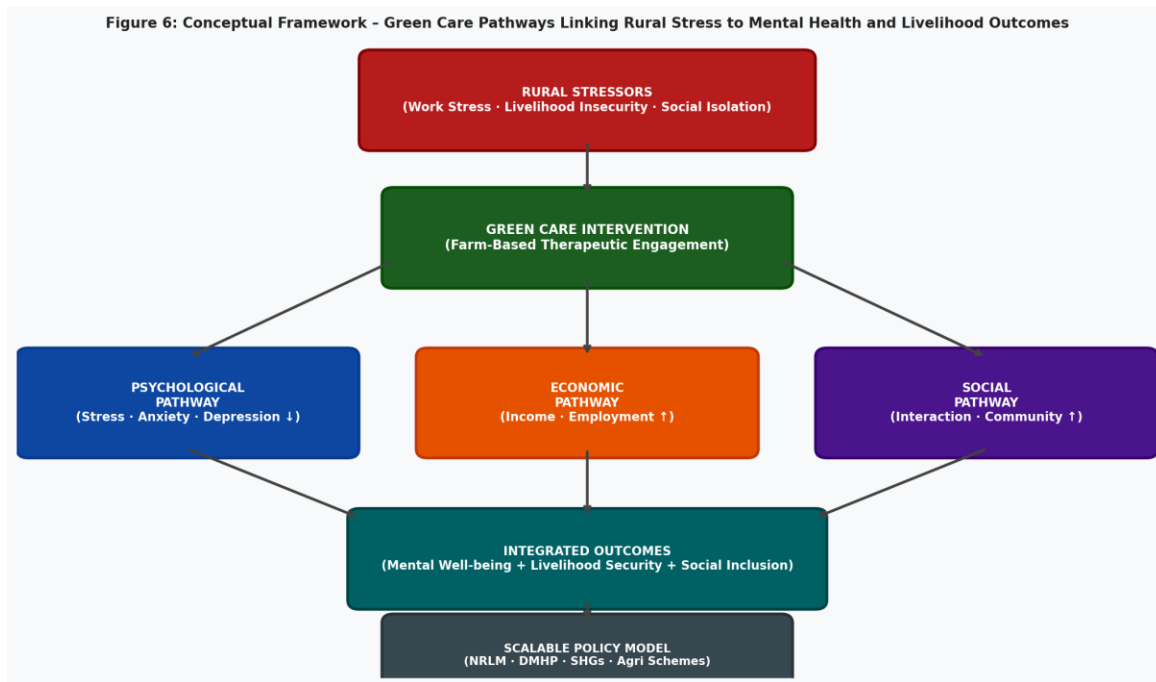


Figure 6: The Three-Pathway Conceptual Framework linking rural stressors to integrated mental health and livelihood outcomes through Green Care interventions. Arrows represent causal pathways and feedback loops.

The empirical findings of this study can be synthesized within a comprehensive three-pathway conceptual framework that elucidates the mechanisms through which Green Care interventions transform rural stress conditions into sustainable mental health recovery and livelihood security. This framework, illustrated in Figure 6, conceptualizes Green Care not as a simple input-output mechanism but as a complex, multi-pathway intervention that operates simultaneously across psychological, economic, and social dimensions.

5.1 The Psychological Pathway

The psychological pathway through which Green Care produces mental health improvements operates through several reinforcing mechanisms. Nature exposure activates restorative physiological processes - reducing cortisol, sympathetic arousal, and inflammatory markers while enhancing mood-regulating neurotransmitter activity (Bratman et al., 2019; Li, 2022). Structured daily engagement with agricultural tasks provides the purposeful routines and goal-directed activities that are themselves antidepressant and anxiolytic, addressing the learned helplessness and motivational deficits that characterize depression. Mastery experiences - successfully raising dairy cattle, harvesting vegetables, completing farm tasks - generate self-efficacy beliefs that challenge the negative self-appraisals at the core of depressive cognition. Finally, the growth cycles of plants and animals provide powerful, embodied metaphors for personal recovery and renewal that can shift

depressive and hopeless cognitive schemas without requiring formal psychotherapeutic language or frameworks.

5.2 The Economic Pathway

The economic pathway operates by directly addressing the financial stressors that constitute primary causes of psychological distress in agrarian economies. Green Care programme participation increases agricultural productivity through improved inputs, technical knowledge, market linkages, and the collective efficiencies of cooperative farming. Higher agricultural output translates into increased farm income, which reduces the economic precariousness that generates chronic financial anxiety. Income security also expands households' capacities to invest in nutrition, healthcare, children's education, and other well-being-enhancing resources, creating positive feedbacks to both economic stability and psychological well-being. The employment regularization associated with Green Care - the 92% increase in productive employment days documented in this study - further reduces the temporal uncertainty and idleness that exacerbate mental distress during agricultural slack seasons.

5.3 The Social Pathway

The social pathway of Green Care operates through the creation and reinforcement of community connections, peer support networks, and collective identities among participants. The inherently group-based architecture of Green Care activities generates regular, structured opportunities for social interaction that directly counter the isolation and disconnection that both cause and perpetuate mental health challenges in rural contexts. Peer learning, mutual support, shared celebration of agricultural milestones, and the development of common purpose and identity within Green Care groups all contribute to the dramatic social interaction improvements documented in this study (+108.6%). Social capital gains further translate into economic benefits - expanded market information, collective bargaining power, access to credit, and mutual labour exchange - creating reinforcing linkages between the social and economic pathways.

5.4 Dynamic Interactions and Feedback Loops

Crucially, these three pathways do not operate independently but interact dynamically, creating positive feedback loops that amplify the total therapeutic and economic impact of Green Care beyond the sum of individual pathway effects. Improved mental health enhances cognitive functioning, motivation, and physical energy - directly improving agricultural productivity and income through the psychological-to-economic pathway. Higher income reduces financial anxiety and expands opportunities for social participation - reinforcing mental health through the economic-to-psychological pathway. Stronger social networks provide emotional support, practical assistance, and economic resources - simultaneously reinforcing both psychological and economic well-being. These dynamic interactions explain why the aggregate outcomes of

Green Care - 113% income growth, 52% depression reduction - appear to exceed what could plausibly be expected from any single-dimensional intervention acting alone.

6. Discussion

6.1 Situating Findings in Global Literature

The results of this study are broadly consistent with and in several respects extend the international evidence base for Green Care. The magnitude of mental health improvements documented here -47.8% stress reduction, 52.0% depression reduction, 108.6% social interaction improvement- compares favourably with, and in many dimensions exceeds, the average effect sizes reported in systematic reviews of therapeutic horticulture and care farming conducted in high-income countries (Howarth et al., 2020; Ng et al., 2025; Elsey et al., 2020). This suggests that the therapeutic mechanisms of Green Care - nature restoration, structured activity, social connectedness, mastery, and biological engagement - operate effectively across highly diverse cultural, economic, and institutional contexts.

The livelihood improvements documented in this study are particularly notable relative to international comparators. The 113% income gain and 92% employment increase substantially exceed typical outcomes reported for conventional agricultural development programmes without therapeutic components (FAO, 2021; NABARD, 2020), lending support to the hypothesis that the mental health improvements produced by Green Care translate into tangible economic productivity gains. This finding aligns with the theoretical prediction that effective mental health interventions should yield significant economic returns through improved human capital - a proposition increasingly recognized in global development economics (Patel et al., 2018; Whiteford et al., 2013).

6.2 Gender-Responsive Dimensions

The stronger outcomes among female participants represent one of the most policy-significant findings of this study. Women in rural India face compounded vulnerabilities - economic dependence, discriminatory social norms, time poverty, elevated stress burden - that make effective therapeutic interventions both more urgently needed and, as this study demonstrates, potentially more impactful. The 58% vs 45% mental health improvement differential and 121% vs 102% income growth differential between female and male participants suggest that Green Care is an inherently gender-responsive intervention model, possibly because its cooperative, community-embedded format better addresses the specific needs and strengths of women in rural agrarian contexts (Devi & Singh, 2021; Shackell & Walter, 2012).

From a policy design perspective, these findings argue strongly for the deliberate centering of women in Green Care programme design and implementation. Leveraging existing SHG networks - which predominantly organized around women in both Karnataka and Andhra Pradesh - as institutional platforms for Green Care

delivery would both build on women's existing organisational strengths and maximize the gender equity dimensions of programme impact.

6.3 Implications of State-Wise Robustness

The non-significant state dummy in the regression analysis is an important positive finding for the scalability of Green Care. Despite the substantial differences between Karnataka's dairy cooperative system and Andhra Pradesh's horticulture ecosystem - different agro-climatic conditions, crop systems, institutional frameworks, cultural traditions, and state policies - the core therapeutic and economic mechanisms of Green Care appear to operate with comparable effectiveness in both contexts. This cross-context robustness is a necessary (though not sufficient) condition for large-scale national rollout of Green Care programmes, as it suggests that the intervention's effectiveness is not contingent on any specific agricultural or institutional configuration.

6.4 Limitations and Future Research

This study carries several limitations that should be acknowledged. The quasi-experimental design, while stronger than simple pre-post or cross-sectional comparisons, cannot fully eliminate selection bias - participants who chose to join Green Care programmes may differ systematically from non-participants in motivation, social connectedness, or other characteristics that could independently affect outcomes. Future research should employ randomized assignment where ethical and logistically feasible to strengthen causal inference.

The reliance on retrospective recall for baseline mental health and income data introduces potential recall bias, though respondents were assisted with calendar-based and event-based memory anchoring. Prospective longitudinal studies with objective measurement at multiple time points would provide stronger evidence on the trajectory and durability of Green Care effects. The current study also does not examine the long-term sustainability of income and mental health gains beyond the intervention period - a critical question for programme policy that future research should address.

Additionally, the current sample of 270 respondents, while adequate for the primary analyses, limits the statistical power available for subgroup analyses. Future studies with larger samples could provide more precise estimates of heterogeneous treatment effects across demographic subgroups, enabling more targeted programme design. Extension of the Green Care model to other Indian states with different agricultural systems - paddy cultivation in Odisha, tea estates in Assam, tribal forest-based livelihoods in Jharkhand - would further test and expand the generalizability of the current findings.

7. Conclusion and Policy Recommendations

7.1 Conclusion

This study provides compelling empirical evidence for the transformative potential of Green Care as an integrated, dual-pathway intervention addressing simultaneously the mental health crisis and the livelihood

insecurity that together characterize rural agrarian distress in India. Across all measured dimensions - psychological well-being, household income, employment, gender equity, and cross-regional consistency - Green Care interventions demonstrated substantial, statistically robust, and practically meaningful effects that establish it as one of the most promising community-based approaches to rural well-being promotion currently available.

The three-pathway framework developed in this study - synthesizing psychological, economic, and social mechanisms into a dynamic, self-reinforcing model - provides a theoretically coherent account of how structured agricultural engagement produces these comprehensive outcomes. The framework also highlights the strategic advantage of Green Care over single-dimensional interventions: by simultaneously activating multiple therapeutic and economic pathways and generating positive feedback loops between them, Green Care achieves outcomes that no clinical mental health programme or agricultural livelihood scheme acting alone could plausibly produce at comparable cost.

The strong gender-responsiveness of Green Care - with female participants outperforming male counterparts across mental health, income, and participation dimensions - positions it as a particularly valuable model within India's post-pandemic rural development agenda, where women's economic empowerment and mental well-being have been identified as urgent national priorities. The cross-regional robustness of outcomes, demonstrated by the non-significant state dummy in the regression and the comparable GCI scores across Karnataka and Andhra Pradesh, further supports the scalability and national applicability of the model.

7.2 Policy Recommendations

Based on the empirical findings and theoretical analysis presented in this study, the following policy recommendations are offered for consideration by national and state-level policymakers, programme managers, and development practitioners:

Integration with NRLM and DMHP: Green Care should be formally embedded within the National Rural Livelihood Mission and the District Mental Health Programme through a convergence framework that enables joint planning, shared infrastructure, and coordinated case referrals. The NRLM's SHG network provides an ideal implementation platform for community-based Green Care delivery, while DMHP's clinical infrastructure can provide assessment, case management, and specialist referral support.

Region-Specific Agricultural Strategies: State-level programmes should be designed around local agricultural strengths - strengthening dairy cooperative linkages in Karnataka through KMF integration, and developing horticulture clusters and value chain connections in Andhra Pradesh through the AP Horticulture Department. Region-specific technical support, market linkages, and financial services should complement the therapeutic components.

Women-Centred Programme Design: Given women's superior engagement and outcomes, programme designs should deliberately prioritize female beneficiaries, schedule activities compatible with domestic responsibilities, engage women in leadership and facilitation roles, and explicitly link Green Care participation with access to SHG savings, microfinance, and market opportunities.

Activity Diversification for Maximum Impact: Programmes should incorporate both dairy and horticulture components where agro-climatically feasible, capitalizing on the distinct and complementary therapeutic

and economic strengths of each modality. Integrated farm models that combine routine animal care with seasonal crop cultivation would provide maximum temporal coverage, sensory diversity, and income diversification.

Climate-Resilient Agriculture Integration: Green Care programmes should incorporate climate-smart agricultural practices - drought-tolerant varieties, water-efficient irrigation, organic pest management - to ensure the long-term sustainability of the livelihood component and reduce climate-related income volatility that would otherwise undermine the economic therapeutic pathway.

Workforce Capacity Building: Training programmes for Green Care facilitators - combining horticultural and animal husbandry skills with basic mental health first aid, group facilitation competencies, and gender sensitivity - should be established at block and district levels, potentially through Krishi Vigyan Kendras (KVKs) and State Agricultural Universities.

Monitoring, Evaluation, and Scale: A standardized monitoring and evaluation framework, using the validated mental health and livelihood indicators employed in this study, should be established for all Green Care programmes to enable comparative assessment, continuous improvement, and evidence-based scaling decisions. A phased national scale-up, beginning with pilot clusters in 50 high-distress districts, is recommended before comprehensive national rollout.

7.3 Policy Integration Matrix

Programme Scheme	Ministry / Department	Green Care Component	Expected Outcome
NRLM / SHGs	MoRD	Community farm groups, financial linkage	Income + Social well-being
DMHP	MoHFW	Therapeutic referrals, case management	Depression & anxiety reduction
MGNREGS	MoRD	Farm labour, green infrastructure	Employment + income security
National Horticulture Mission	MoA&FW	Horticultural therapy gardens	Mental health + market income
Dairy Cooperatives (KMF / AMUL)	MoA&FW / State	Structured care farming, animal bonding	Routine, income, stress reduction
Krishi Vigyan Kendras	ICAR / MoA&FW	Facilitator training, technical support	Programme quality & sustainability

Table 8: Policy Integration Matrix for Scaling Green Care within Existing Indian Institutional Frameworks

7.4 Green Care versus Conventional Interventions: A Comparative Overview

Dimension	Conventional Clinical Care	Agricultural Livelihood Scheme	Green Care Model
Primary Focus	Symptom reduction	Income generation	Dual: mental health + livelihood
Treatment Setting	Hospital / clinic	Farm / field	Farm / community (embedded)
Infrastructure Required	High	Medium	Low–Medium
Cost-Effectiveness	Low	Medium	High

Gender Responsiveness	Variable	Moderate	High
Social Capital Generation	Limited	Moderate	High
Rural Scalability	Limited	High	High

Table 9: Comparative Assessment of Green Care versus Conventional Clinical Care and Agricultural Livelihood Schemes

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