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The models and the aspiring models: assessing the sustainable rural development philosophy and reality in India through multi-dimensional indices

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Introduction: The key to sustainable societies and food systems in developing countries like India is sustainable rural development because majority population reside in rural areas. In India, the Gandhian philosophy of rural self sustainability has been a major inspiration in shaping not only individual or philanthropic rural development efforts (philosophical and less planned), but also government rural development programmes (RDPs which are planned reality of the philosophy).

Methods: In this study, the authors assess the progressiveness of 'Aspiring' self-sustainable villages (planned reality) developed under a governmental rural self-sustainability programme named *Saansad Adarsh Gram Yojana* (SAGY) in comparison with the Model Villages of the Past (based on philosophy with no governmental intervention/philanthropic)as both categories of villages were developed on the basis of Gandhian philosophy of rural self-sustainability but there exists no comprehensive measure for comparing the progress of SAGY Villages (developed on realistic indicator based approach) with the Model Villages of the past (developed solely on philosophical approach) even after a decade of implementation of SAGY. Hence 7 multi-dimensional composite indices were developed in this study for comparative assessment after careful triangulation of indicators. Rural Health Status Index/RHSI (8 indicators), Rural Educational Status Index/RESI (6 indicators), Rural Farming Status Index/RFSI (8 indicators), Rural Infrastructure Index/RIF (40 indicators), Rural Livestock Status Index/RLSI (8 indicators), Rural Ecological Status Index/RECSI (7 indicators) and Status of Rural Women Index/SRWI (6 indicators) were developed using Categorical Principal Components Analysis method. Validation of the indices were done with 1200 respondents ($n = 1200$) of Model Villages and SAGY Villages of Maharashtra and Telangana states.

Results and discussion: The SAGY villages of Telangana were found to have progressed more than the Models of their state in terms of educational (RESI = 0.87), farming (RFSI = 1.06), livestock (RLSI = 1.31) and ecological status (RECSI = 0.56). The aspirant SAGY villages of Maharashtra were found to have excelled their Models in terms of health (RHSI = 1.62), farming (RFSI = 1.5) and

livestock status (RLSI = 1.29). Secondary database of District Census Handbook having household level quantitative data of sub-districts were found to be in corroboration with the index values (primary data analysis) obtained. The indices developed have scope of replication in similar rural systems of the world.

KEYWORDS

Gandhian philosophy, self-sustainable villages, Model villages, rural development in India, multidimensional composite indices, measurement of rural progressiveness, *Saansad Adarsh Gram Yojana* (SAGY)

1 Introduction

Approximately 65% of India's population lives in rural areas (Directorate of Census Operations, 2011; Pradhan, 2017; Gupta, 2004, 2005; Thapar, 2015; Singh, 1968; Raveesh, 2019), with their mainstay livelihood source as agriculture and allied activities (Ministry of Finance, 2023). The rural population for 2023 in the country was 909,121,500, a 0.03% increase from 2022, after the COVID-19 pandemic forced the rural migrants back to their native villages after losing their urban livelihoods. With increased urbanization (Dutt, 2009; Parry, 2003) and fast pace development taking the nation to a global pedestal of "Emerging Super Power of the East", it is extremely crucial to uplift the rural India (Strategic Investment Research Unit, 2022; Sahai, 2016), sheltering more than half of her population, too, at the same pace for achieving the target of a trillion dollar economy by 2047 (Virmani, 2024). Neglecting rural areas in any development initiative would mean incomplete intervention in a country such as India (Nwagboso and Duke, 2012). Hence, since the pre-independence era, the motto of rural development has been quite significant in India, so much so that Mahatma Gandhi had dreamt of Ideal villages/Model villages/*Adarsh Gram,* which can be self-sustainable units. In his words, *"You cannot build non-violence on a factory civilization, but it can be built on self-contained villages"* (Prabhu, 1968).

Based on this 'Gandhian Philosophy of Self Sustainable Model Villages', several philanthropists in the past had transformed their villages into Models. The approach often mitigated any one specific problem or a group of problems prevalent in the area. Such villages witnessed an overall positive transformation after redressal of their issues and were later declared as Successful Cases of Village Development, or in other words, Model villages by the Ministry of Panchayati Raj, Government of India (Ministry of Panchayati Raj, 2021).

Years later, in 2014, Government of India, taking cue from the Gandhian Philosophy, launched an ambitious rural development initiative named the *Saansad Adarsh Gram Yojana* (SAGY), where each Member of the Parliament is expected to adopt a village in their electoral constituency and strive to transform it into a Model village (Government of India, 2014). The SAGY is based on the 'Gandhian philosophy of *Adarsh Gram* or Ideal Village or Model Village' (Garg and Raut, 2015). The distinct features of SAGY are that it is (a) demand driven, (b) inspired by society, and (c) based on people's participation (Tiwari et al., 2019). It was launched to translate the comprehensive vision of Mahatma Gandhi about an ideal sustainable Indian village into a reality, keeping in view the present context. Under SAGY, interventions for social and infrastructure development are done to develop it into a Model village, so we can refer to SAGY villages as Aspiring Models.

A decade has passed since the implementation of SAGY, but except some post-project and third party evaluation efforts (Joshi et al., 2021) and occasional comparative studies with other RDPs (Mishra, 2016; Zafar, 2015; Venkatareddy, 2021; Baldaniya and Bhoye, 2019, 2021; Singh et al., 2023), there has not been any comparative assessment of SAGY villages (the "Reality" based on realistic approach) with the Model villages of the past philanthropists (the "Philosophy" based on philosophical approach).

2 Research gap and purpose of the study

The progress of SAGY has not yet been assessed against the very philosophy upon which it was formulated a decade back: the Gandhian philosophy of self-sustainability. To address this research gap, the authors conceptualized this study to comparatively assess the SAGY villages (intervention done under SAGY RDP inspired by Gandhian Philosophy) with the already existing Model villages of the past, which were developed not as part of any government RDP but individual philanthropic efforts purely based on Gandhian Philosophy. That is, the study is an effort to draw a comparison between RDPs, which have quantifiable objectives to achieve in contrast to philanthropic approaches of the past, the only similarity being both of them relying on "Gandhian Principles of Self Sustainability". However, assessing Rural Development Philosophy (Models/Model villages of the past) and Reality (Aspiring Models/SAGY) would require a comprehensive measurement tool or method, which was another research gap to be addressed. Hence, the objectives of this study were (i) to develop and validate multi-dimensional composite indices for the comprehensive assessment of rural progressiveness and (ii) to measure the progressiveness of SAGY and Model villages through their index values.

3 Review of literature

The concept of Model village (Bhattacharyya et al., 2021; Paterson, 2007; Gao et al., 2023; Muşat, 2015; Paliwal, 2005; Eraly, 2011) is popular throughout the world. It was basically

conceived from the idea of "shop floor based industry", where a machine or tool is at first designed, modeled for quality and perfection, and then mass produced (Ramesh and Sivaram, 2019). The same idea led governments and social reformers, sociologists, and philanthropists worldwide to develop Model villages, which are "near perfect in certain aspects" and then replicate the model in other parts of the country to bring an overall development of rural areas.

Model villages (Models) developed in the past by Indian philanthropists are already popular among the masses. The Hiware Bazar Model village in Maharashtra is known for water conservation in 40,000 contour trenches around hills (Menon, 2012); Ralegaon Siddhi Model village in Ahmednagar district of Maharashtra has transformed from a highly degraded village ecosystem in a semi-arid region of extreme poverty to one of the richest in the country by the watershed development efforts of social reformer, Shri Anna Hazare (Mehta and Satpathy, 2008); Punsari village in north Gujrat's Talodahas provided many facilities to its villagers such as a modern school, mineral water supply, local bus service, gutter project, primary healthcare center, eight kindergarten schools, banking facility, and toll free complaint receiving phone service (Ghatge and Chakrabarti, 2016); and Mann village in Maharashtra has fully computerized official records and Abhinav Farmers' Clubs of 305 members.

Taking a cue from past philosophy, the RDP SAGY envisaged the integrated development of villages. The program was formulated with quantifiable goals and realistic steps to achieve them. A village development plan was prepared for every identified *Gram Panchayat* (village jurisdiction unit) with special focus on enabling every poor household to come out of poverty (Government of India, 2014). Before the formal plan formulation started, systematic environment creation and social mobilization was done, which was spearheaded by the MP himself/herself with involvement of stakeholders and beneficiary villagers. The Central and State Government schemes are leveraged for the development of the village, hence all concerned departments are intricately involved in this program. To date, a total of 3308 villages have been adopted under this program, 2833 villages have submitted their village development plans to implementation authorities, and developmental activities are in process. Out of 2,45,295 activities planned under village development plans, a total of 2,00,407 activities have been reported as completed and 8,860 are in progress (Ministry of Rural Development, 2023).

In a diverse and vast country like India, the language, food, culture, and practices change for every 100 km; in a nation of teeming millions and a bureaucratic setup, rural development efforts are often riddled with administrative roadblocks, corruption, poor targeting, and low awareness (Maurya and Kumar, 2023). Hence, assessment of RDPs is absolutely essential for ensuring the fulfillment of objectives and collecting critical feedback useful for future program formulation, and in this context, the usage of indicators and indices comes to the rescue. Every program has certain verifiable objectives to achieve which can be operationalized into indicators. Indicators provide a measurable term for variables or constructs that cannot be directly measured. Indicators are combinations of two or more statistical results to form a new derived measure (United Nations, 2007), which can be ranked like that done in World Competitiveness Rankings prepared by the International Institute for Management Development (IMD) (www.imd.org).[1] There are also synthetic indicators, which are composite measures of individual indicators designed to give an easy overview of a complex array of indicators or statistics. Different forms and techniques of "weighting" the individual series are used, such as in the Human Development Index (hdr.undp.org).[2] Indicators are statistical variables that help to transform data into relevant information and can be seen as the first attempt to structure complex interrelationships that may, in the end, help to formulate more sophisticated theories (OECD, 1996). It has been argued that indicator-based approaches offer a potentially useful way of monitoring the achievements of policies with respect to sustainability (Singh et al., 2009).

4 Conceptual framework

The research gap of identifying indicators and developing indices for the assessment of two categories of villages, as mentioned earlier, formed the basis of this study. The initial task was to arrive at a clear set of indicators. Hence, Method Triangulation, which involves the use of multiple methods of data collection about the same phenomenon (Carter, 2014), was adopted to triangulate the findings of the literature review, SAGY objectives, and pilot study in non-sample areas. A huge bank of literature in relation to rural development or rural quality of life indicators was studied (Cagliero et al., 2011; D'Agostini and Fantini, 2008; Igorevna, 2012; Viccaro et al., 2021; Bernard, 2018).

On the other hand, objectives of SAGY targeting multiple areas for rural development and sustainability promotion such as agriculture, health, education, sanitation, environment, and livelihoods under the eight broad heads of personal, social, human, economic, and environmental development coupled with basic amenities and services, social security, and good governance were thoroughly studied by the authors (Government of India, 2014).

Thereafter, a pilot study was done in villages surrounding Delhi NCR in India to get an idea of major rural development parameters that define the progressiveness and sustainability of a quality village life.

The triangulation led the authors to identify five broad domains of rural development: infrastructural, socio-economic, farming, socio-cultural, and ecological or environmental domains (Figure 1), which were common in both Models and Aspiring Models, and these formed the basis of the conceptual framework of the study.

1 https://www.imd.org/wcc/world-competitiveness-center/ (accessed July 07, 2024).

2 http://hdr.undp.org/en/humandev (accessed July 07, 2024). http://www.undp.org/content/dam/india/docs/DG/preparation-ofmanual-for-planning-integrated-village-development.pdf (accessed on 12 January, 2021).

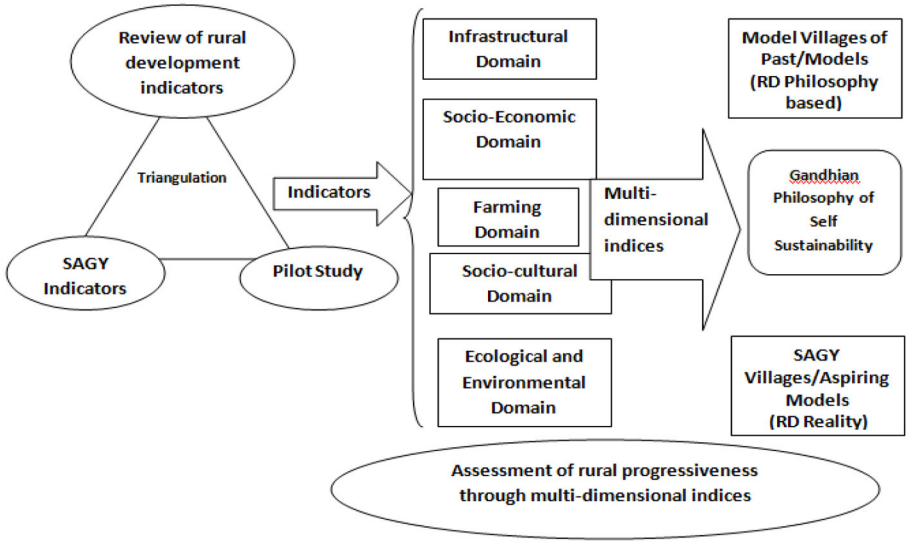


FIGURE 1
Conceptual framework of the study.

5 Material and methods

5.1 Identification of domains of rural progressiveness through triangulation

Through Method Triangulation, five major domains (Figure 1) and their indicators, which best define the domains, were identified and finalized for the study. The major domains were further broken down to finally develop seven composite indices, namely Rural Health Status Index (RHSI with eight indicators), Rural Educational Status Index (RESI with six indicators), Rural Farming Status Index (RFSI with eight indicators), Rural Infrastructure Index (RIF with 40 indicators), Rural Livestock Status Index (RLSI with eight indicators), Rural Ecological Status Index (RECSI with seven indicators), and Status of Rural Women Index (SRWI with six indicators). Out of these, only RIF was developed through the Equal Weightage Method, while others were developed through the NUEPA method.

5.2 NUEPA method of composite index development

The indicators finalized were first operationalized, codes allotted to each, and responses to the indicators collected. The NUEPA (National University of Educational Planning Administration, 2009) method had two basic steps: first, elimination of bias of scale in indicators; and second, determination of proper weights to be assigned to different indicators. Each indicator was normalized by subtracting the minimum value of the indicator from its actual value and then dividing it by the range, which is the difference between the maximum and minimum values of the selected indicator. Once the bias of scale was removed from the observations, the next difficult task was assigning appropriate weights to the selected indicators. Assignments of arbitrary weights based on independent judgment are exposed to subjectivity. Therefore, in this analysis, the weights of individual indicators were assigned based on principal component analysis (PCA). However, for this study, Categorical Principal Components Analysis (CATPCA) was used instead of traditional PCA because much of the data were at ordinal and nominal levels, and CATPCA lacks assumptions, which is a primary benefit (IBM, 2021). The analysis was done in Statistical Package for Social Sciences (SPSS version 16.0).

5.3 Equal weightage method of index development

The rural infrastructure indicators depicted the village-level data. Since there were in total eight villages under study (four Model and four SAGY villages), there were only eight data points/subjects for each village level indicator, while the total number of broad indicators (variables/items) identified was 40. So the subject-to-item ratio was abysmally small (0.2) against the usual guideline of 10:1 for exploratory factor analysis and PCA. Osborne et al. (2004) had reported that a large subject-to-item ratio and a large sample size had a greater probability of giving error-free results in PCA. Moreover, amongst the rural infrastructure indicators, nine of the items had zero variance. That is, all eight villages had the same scores. So, the PCA and NUEPA methods could not be used for developing a rural infrastructure index. Alternatively, all items were given equal weightage of 1 and simply added and divided by the maximum obtainable score to formulate the index, as shown below.

$$\textbf{Rural Infrastructure Index (RIF)} = (I_a + I_b + I_c \ldots .. + I_n)/MOS$$

Where I_a to I_n = Normalized value of each infrastructure indicator

MOS = Maximum Obtainable Score.

5.4 Performance of SAGY villages against Model villages

The index values of seven composite indices of SAGY and Models were compared. The scope for validating this primary data of n = 1,200 respondents with any quantitative secondary database was difficult because individual-level data are not available in the public domain, and that too of lower-level rural divisions. The District Census Handbook published by Government of India (Office of the Registrar General and Census Commissioner of India, 2014a,b,c,d) during every decadal census, presents household data of existence of some rural amenities and that too Block (sub-district) wise and not of individuals or village level. This data is also not available for most other collective rural parameters. Hence, the RHSI and RIF, whose indicators such as the availability of drinking water through tap source, usage of latrine depicted through presence of piped sewer system, closed drainage, and availability of basic infrastructure such as electricity in the household, were used to validate the primary data findings.

5.5 Study area

As the objective of the study was to compare the progressiveness of SAGY villages with Model villages, the states with the highest concentration of Model villages were purposively selected for the study. These states were Maharashtra and Telangana, which had two Model villages recognized by the Ministry of Panchayati Raj (Govt of India). For better comparative evaluation, from the districts where Model villages were located (Figure 2), SAGY villages were identified and finalized for the study. From Maharashtra, Hiware Bazar in Nagar block of Ahmednagar district and Mann village in Mulshi block of Pune district were selected as Model villages, whereas Malunja Budruk in Shrirampur block of Ahmednagar district and Tikekarwadi in Junnar block of Pune district were selected as SAGY villages. From Telangana, Gangadevipally in Geesugonda block of Warangal district and

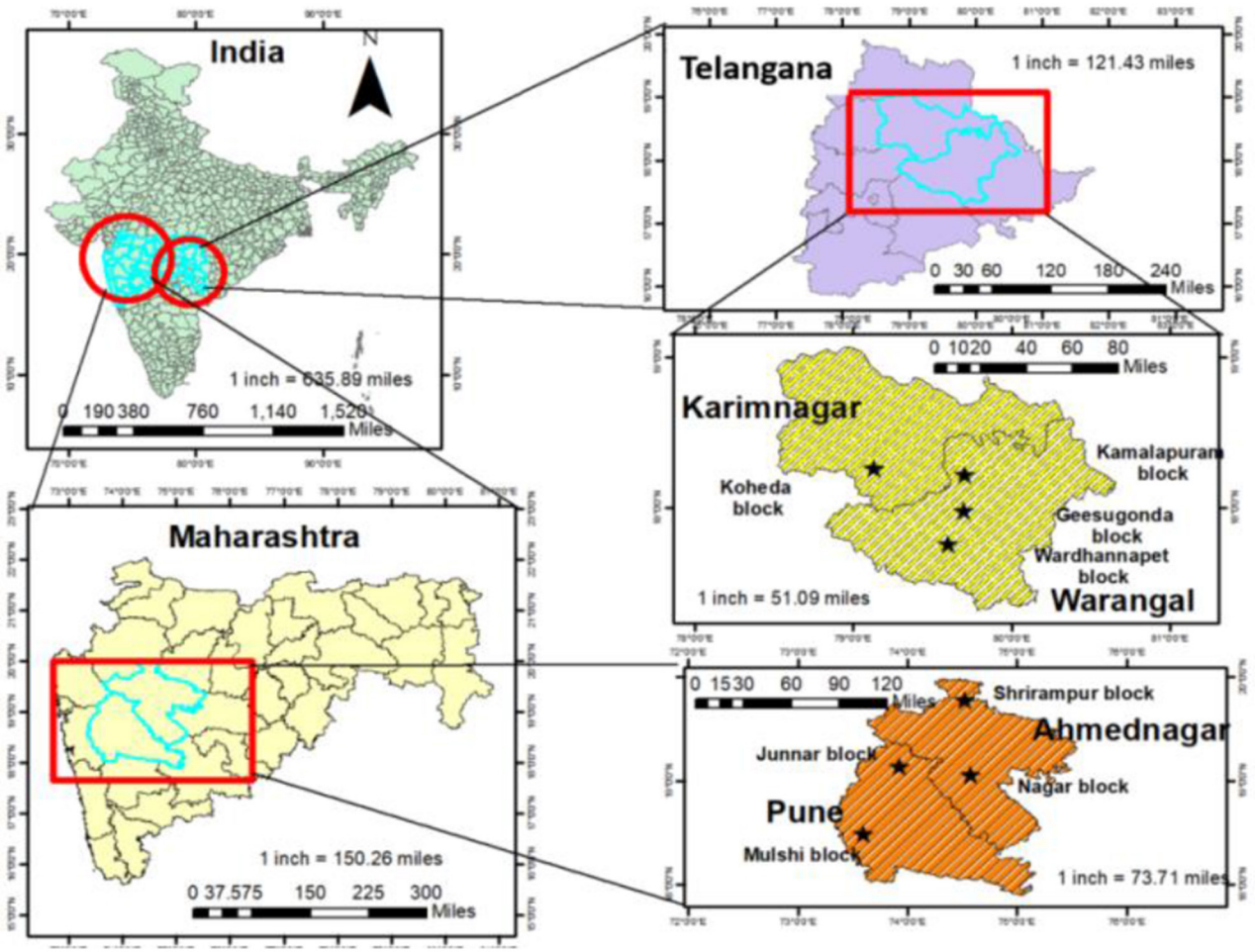


FIGURE 2
Map of study area.

Ramachandrapuram in Koheda block of Karimnagar district were selected as Model villages, whereas Inavolu in Wardhannapet block of Warangal district and Dandepally in Kamalapur block of Karimnagar district were selected as SAGY villages. Geographically, both states come under the Deccan Plateau of India.

5.6 Research design, sampling plan, and data collection

An exploratory research design, followed by an *ex-post facto* design, was adopted for the study. From each of the eight villages, 30 households were randomly selected for the study, thus making the sampling units 240 and the total sample size $n = 1{,}200$ (five members from each sampling unit).

TABLE 1 Interview schedule for data collection.

Part 1: Socio-economic profile	
1.	Name, age, address, and phone number
2.	Sex and marital status
3.	Educational qualification
4.	Family size
5.	Family type
6.	Farm size/size of land holding (in hectares)
7.	Farming experience (in years)
8.	No. of family members involved in agricultural activities
Part 2: Rural progressiveness parameters	
As in Table 2	

After identification of domains and indicators specific to the objective of the study, composite indices were developed, data were collected from respondents of the study area on indicators identified, index values were calculated, and progressiveness was assessed for both categories of villages. The data were collected through a personal interview method using a semi-structured interview schedule (Table 1) constructed in conformity with the objectives of the study.

6 Results

6.1 Socio-economic profile of respondents

In both Model (83.33%) and SAGY villages (85%), maximum respondents were middle aged (35–59 years) men (Figure 3). The predominant family structure was that of nuclear in the Models (77.5%) with average family size being less than five members (50.83%), while in SAGY or Aspiring Models, it was opposite. Joint family structures (63.33%) with 5–10 family members were prevalent in SAGY. In both categories of villages, the majority of respondents were graduates with more than 20 years of farming experience, with two to four family members involved in agriculture. The majority of respondents of Model villages were large farmers with an average land holding size of more than 6 hectares (46.67%), while that of SAGY was <4 hectares (48.33%).

6.2 Multi-dimensional composite index development

Availability and access to the health infrastructure of the village and practice of healthy habits among villagers constituted the

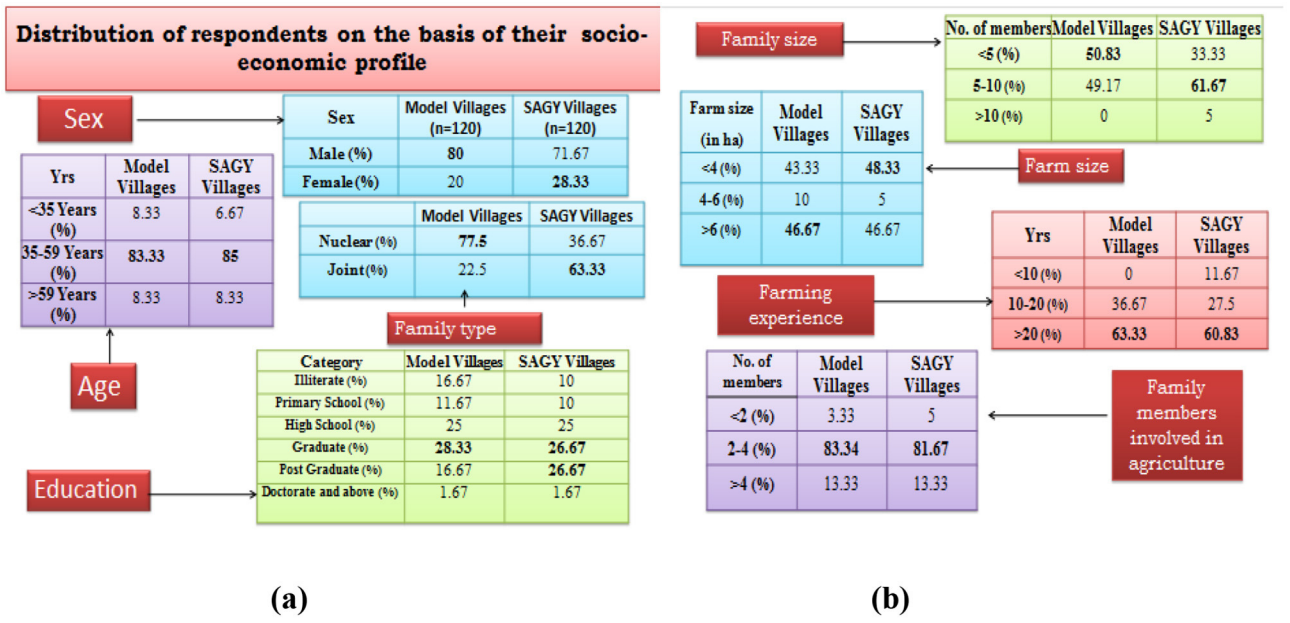


FIGURE 3
(a, b) Socio-economic Profile of Models and Aspiring Model (SAGY) villages.

majority of rural health indicators identified for the purpose of Rural Health Status Index (RHSI) development (Table 2). Eight rural health indicators were identified from method triangulation. Practice of hygiene such as the usage of toilets and practice of healthy habits such as exercising, abstinence from alcohol, and smoking were taken into account. Quality of drinking water and history of waterborne diseases in the family were also included in the list of rural health indicators. The healthcare facilities in the village and the satisfaction of villagers with the healthcare services were also taken into account. The Cronbach's alpha was satisfactory (82.4%). The total variance explained was 54.862% in the optimally scaled matrix of eight items. The component loadings plot depicted the spread of component loadings in two dimensions. The component loadings obtained from CATPCA were used to obtain weightages of each indicator (Table 3). The total of eight rural health indicators had a grand total weight of 4.73, and the formula for RHSI was derived (Table 3).

Educational status of respondents and their family members, including children, women, and adult members of the household, was taken into account (Table 2). The educational infrastructure present in the village was assessed in the rural infrastructure index development section. Hence, the rural educational status index pertained to only the individual and family educational status of selected villages. The internal consistency coefficient (Cronbach's Alpha) was satisfactory (87.6%), with the total variance explained being 61.756% in the optimally scaled matrix of six items. The total of six rural educational indicators had a grand total weight of 8.08 and the formula for RESI was derived (Table 3).

In the Rural Farming Status Index (RFSI), all sorts of common indicators that could determine the status of farming of a rural household were identified. The size of land holding, area under micro irrigation, and number of basic farm implements possessed by the respondent were taken into account. Indicators pertaining to basic scientific farming were also included, such as area of land put under the practice of crop rotation, intercropping, Integrated Pest Management (IPM), and green manure cultivation. An indicator pertaining to the interest of rural youth of study area was included too.

The Cronbach's alpha was satisfactory (91.7%), with the total variance explained being 63.37% in the optimally scaled matrix of eight items. The total of eight rural farming indicators had a grand total weight of 15.38 (Table 3).

Livestock status indicators were identified to develop the rural livestock status index (RLSI). Indicators related to scientific practices, such as deworming, vaccination, balanced feed, and timely check-up of livestock, were included in the list of indicators. Respondents were also asked about their fodder cultivation practice, if any. The sale of livestock produce and income from it were also taken into account (Table 2). The Cronbach's alpha was satisfactory (89.2%), with the total variance explained being 56.93% in the optimally scaled matrix of eight items. The total of eight rural livestock indicators had a grand total weight of 15.82 (Table 3).

The rural ecological index (RECSI) found a place in this study to determine the level of progressiveness and sustainability of selected villages. Indicators pertaining to disposal methods of wet and dry waste, use of cloth bags instead of plastic, usage of organic inputs in farming, and participation in village cleanliness drives formed part of the personal eco-friendly habit list. Respondents were also asked about their perception of the level of cleanliness of their village. The presence of a watershed in the neighborhood and its effect on agriculture and related profit was included in the list (Table 2). The Cronbach's alpha was satisfactory (81.3%), with the total variance explained being 51.08% in the optimally scaled matrix of seven items. The total of seven rural ecological indicators had a grand total weight of 7.82 (Table 3).

An index to measure the status of rural women was developed to determine the level of progressiveness of the selected villages (SRWI). Accordingly, the indicators were identified. Marriageable age of women in the household and the number of women family members involved in formal or informal jobs, business, and agriculture were taken into account. The decision-making power of women in the household was also taken care of in the list of indicators (Table 2). The Cronbach's alpha was satisfactory (72.5%), with the total variance explained being 52.09% in the optimally scaled matrix of six items. The six indicators had a grand total weight of 7.82 (Table 3).

A total of 40 indicators were identified, each having equal weightage of 1, making the maximum obtainable score as 90 (Table 3) for the Rural Infrastructure Index (RIF).

6.3 Assessing the performance of SAGY villages against Model villages

The index values of the selected villages were calculated as per the formula derived in Table 3.

The aspirants of SAGY villages of Maharashtra were found to have excelled (Table 4) the Model villages of their state in terms of health, farming, and livestock status with combined scores of RHSI = 1.62, RFSI = 1.5, RLSI = 1.29, while Models were far more progressive than the aspirants in terms of educational, infrastructural, ecological status, and status of women with combined scores of RESI = 1.22, RIF = 1.56, RECSI = 1.19, and SRWI = 0.72. Tikekarwadi (RHSI = 0.99) had the highest RHSI amongst all eight villages (Table 4) owing to advanced and hygienic drinking water facilities present in the form of water ATM in the village. The second-highest RHSI value obtained by Model village Hiware Bazar (0.76) was owing to the impressive open gym and park facilities and the presence of highly health-conscious adults in the village.

In Telangana, Model villages were found to be more progressive than the SAGY aspirants in terms of health (RHSI = 1.03), owing to the residents of Gangadevipally Model village collectively running some health clubs wherein they practiced exercise, yoga, etc., daily in the morning. In terms of infrastructural status (RIF = 1.29) and status of women (SRWI = 0.61), the Models had outperformed the SAGY aspirants. The SAGY villages, on the other hand, were found to have progressed more in terms of educational status (RESI = 0.87), farming (RFSI = 1.06), livestock (RLSI = 1.31), and ecological status (RECSI = 0.56).

In Maharashtra, RESI value was highest in Model village Maan (0.65) owing to the improved educational facilities available in

TABLE 2 Indices developed through the NUEPA method.

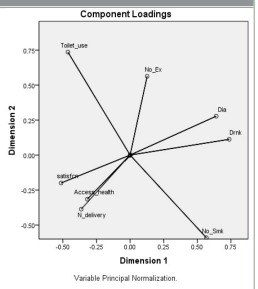
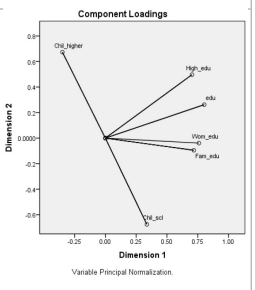
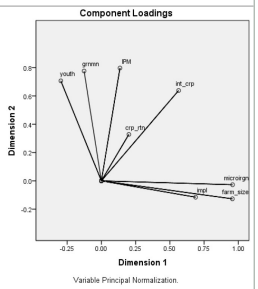
Sl. no.	Index	Indicators with codes	Measurement	Cronbach alpha (%)	Total variance explained (%)	Component loadings plot
1.	Rural Health Status Index (RHSI)	(i) No. of family members using toilets (Toilet_use). (ii) (a) No. of family members practicing physical exercise/yoga/sports/jogging/walking (No_ex). (b)Frequency of practice (iii) (a) No. of family members smoking/drinking/addicted to drugs. (b) Frequency of the habit (No_smk). iv) Satisfaction with the quality of services rendered in Village Health Center (Satisfcn). (v) Number of family members accessing government health services (Access_health). (vi) Quality of drinking water in the household (Drnk). vii) Last occurrence of diarrhea in the family (Dia) viii) Place of last birth in the family (delivery).	(i) None (0), Some (1), All (2). (ii) (a) None (0), Some (1), All (2). (b) Regularly (2) Sometimes/irregularly (1), Never (0). (iii) (a) None (3), Some (2), All (1). (b) Regularly (1), Sometimes/irregularly (2), Never (3). (iv) Very much (2), To some extent (1), Not at all (0). (v) All (4), Only adults (3), Only children (2), Only pregnant women (1), None (0). (vi) Poor (1), Good (2), Very good (3). (vii) Before 3 months (1), Before 6 months (2), None in this year (3). (viii) PHC or nearest hospital (2), At home through mid-wife (1).	82.4	54.86	
2.	Rural Educational Status Index (RESI)	(i) Respondent's Educational Status (Edu). (ii) School enrolment of children of the family (Chil_scl). (iii) Enrolment of children in Higher education institutes (colleges/univs) outside the village (Chil_higher). (iv) Basic educational status of family (Fam_edu). (v) Educational qualification (Most qualified adult person in the household is to be considered) (High_edu). (vi) Educational qualification of female member of family (Most qualified adult female member in the household) (Wom_edu).	(i) Illiterate (0), Primary School Pass (1), High School Pass (2), Higher Secondary Pass (3), Graduate and above (4). (ii, iii) Yes (1), No (0). (iv) No one in the family has attended school (0), Less than 50 % of the family members have attended school (1), More than 50% of the family members have attended school. (2). (v, vi) Illiterate (0), Passed primary school (1), Passed secondary school (2), Higher secondary or equivalent degree holder (3), Graduate (4).	87.6	61.75	
3.	Rural Farming Status Index (RFSI)	(i) Size of your landholding (farm_size) (ii) Land area under micro irrigation (microirgn) (iii) No. of basic agricultural implements you possess (impl) (iv) Land area under crop rotation (crp_rtn) (v) Land area under intercropping(int_crp) (vi) Land area under IPM in crops(IPM) (vii) Land area under green manuring (grnmn) (viii) Wish to let your children continue farming or quit and migrate to urban areas for non-farm employment opportunities (youth)	(iv–vii) On all of the owned land (4), On half of the owned land (3), On one third of the owned land (2), On less than one third of the owned land (1), Do not practice (0) (vii)Yes, they should quit farming and migrate to urban areas (1), No, they should stay in the village but engage in non-farm activities (2), No, they should continue farming as I do (3), No, they should practice scientific farming (4)	91.7	63.37	

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TABLE 2 (Continued)

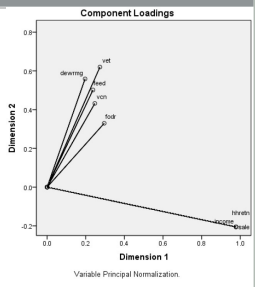
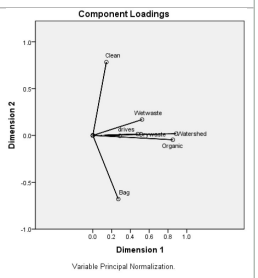
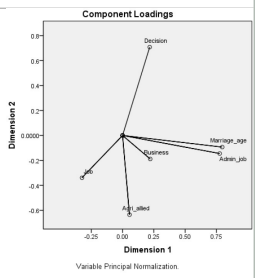
Sl. no.	Index	Indicators with codes	Measurement	Cronbach alpha (%)	Total variance explained (%)	Component loadings plot
4.	Rural Livestock Status Index (RLSI)	(i) Following the timely deworming schedule of your animals (dewrmg). (ii) Following the timely vaccination schedule of your animals (vcn). (iii) Frequency of taking animals to the veterinarian for check-up (vet). (iv) Giving balanced feed to your animals (feed). (v) Cultivation of fodder crops (fodr). (vi) Sale of your livestock produce (sale). (vii) Contribution of animal husbandry to annual household income (income). (viii) Portion of livestock produce retained for household consumption (hhretn).	(i, ii, iv, v, vi) (ii and iii) Yes (1), No (0). (iii) Never (0), When the animal is sick (1), Every year for annual check-up (2). (vii) >50% of annual HH income (2), <50% of annual HH income (1), No income (0). (viii) >50% of total produce retained (1), <50% of total produce retained (2), No produce from animals at present (0).	89.2	56.93	
5.	Rural Ecological Status Index (RECSI)	(i) Method of disposal of the wet/organic/kitchen waste of your house (Wetwaste). (ii) Method of disposal of the dry waste of your house (Drywaste). (iii) Practice of taking your own cloth bag to the market to avoid bringing plastic bags home (Bag). (iv) Change in profit in agriculture after the construction of the watershed (Watershed). (v) Land area under organic fertilizers/bio fertilizers/eco-friendly insecticides or pesticides (Organic). (vi) Perception of your village being clean and green enough (Clean). (vii) Participation in cleanliness drive campaigns (Swaacch Bharat) or community cleanliness initiatives when organized in the village (Drives).	(i) Just throw it away in the open (1), Feed it to animals (2), Turn it into compost (3). (ii) Just throw it away in the open (1), Incinerate it (2), Landfill (3) (iii) Yes (1), No (0). (iv) Enhanced profit (3), No change (2), Loss (1), No watershed constructed (0). (v) On all of the owned land (3), On more than half of the owned land (2), On less than half of the owned land (1), Use chemicals wholly (0). (vi) Yes a lot (2), To some extent (1), Not at all (0) vii) Yes (1), No (0).	81.3	51.08	
6.	Status of Rural Women Index (SRWI)	(i) Average age at which females of your household get married (Marriage_age). (ii) Any woman of your household holding any administrative position (Gram panchayats etc.) (Admin_job). (iii) Any women of your household involved in running their own enterprises (Business) (iv) Any woman of your household employed in any job (formal/informal) (Job). (v) Any woman of your household involved in	(i) <20 (1), 20–25 (2). More than 25 (3). (ii–v) Yes (1), No (0) (vi) Yes in all major decisions (2), In some decisions (1), Never involved (0)	72.5	52.09	

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TABLE 2 (Continued)

Sl. no.	Index	Indicators with codes	Measurement	Cronbach alpha (%)	Total variance explained (%)	Component loadings plot
		agriculture and allied activities (Agri_allied). (vi) Women of the household having a say in all major decisions of your family (Decision)				
7.	RIF	Presence of basic infrastructures in village such as roads, drainage system, schools, health centers, veterinary clinics, markets for sale of village produce, banks, post office, ATMs, local governance facilities, digitization of records, computer cafes, kiosks etc, street lights, seed banks, manure banks, dairy cooperatives, etc.				

the village, and also the presence of parents aspiring to provide quality education to their children due to the proximity of the village to Pune city's IT hub. The SAGY villages had achieved more progress than the Model villages in Telangana with respect to rural education.

Furthermore, in Maharashtra, the RFSI value (Table 4) was highest in SAGY village Malunja Budruk (0.80) owing to a large number of farmers practicing scientific farming and having multiple farm enterprises. The SAGY villages had achieved more progress than the Model villages in Telangana with respect to farming.

As evident from Table 4, in Maharashtra, the RIF value was highest in Model village Maan (0.83) owing to the proximity of the village to Pune city's IT hub. The SAGY village Malunja Budruk had the lowest RIF score (0.48) owing to the deplorable conditions of the village road, which was the major problem reported by the villagers, especially in rainy seasons when the villagers struggle to reach the nearest town. In Telangana, Model village Gangadevipally (0.77) had the highest RIF owing to the excellent infrastructural facilities of the village including roads, *Panchayat* offices, etc.

RLSI value was highest in Model village Hiware Bazar (0.70), followed by SAGY village Malunja Budruk (0.68). As already mentioned, farmers of Malunja had multiple farm enterprises in which livestock rearing was found to be very common. In Telangana, SAGY villages fared well in RLSI values than Model villages. Dandepally (0.77) was way ahead owing to its excellent veterinary healthcare facilities present in the village.

RECSI value was highest in Model village Hiware Bazar (0.84) owing to the ecologically advanced initiative of developing a watershed area in the region. In Telangana, SAGY villages had achieved more progress than Model villages in Telangana with respect to rural ecology.

In both states, the SRWI values were in close range with none exceeding 0.5 out of 1, which proved that no matter how much a community progresses physically, economically, socially, and scientifically, the aspect of progress of women in a community is totally a different ball game and needs customized targeted gender-based interventions.

6.4 Validation with secondary databases

The primary data were studied and validated against the secondary database of District Census Handbooks of Pune and Ahmednagar districts of Maharashtra (Office of the Registrar General and Census Commissioner of India, 2014a,b). The percentage of households having a piped sewer system, tap water facilities, closed drainage systems, and electricity in sub-districts of Nagar and Mulshi, i.e., those having Model villages under them of Hiware Bazar and Maan respectively, was comparatively lesser than those having these basic amenities in sub-districts of Shrirampur and Junnar, having Malunja and Tikekarwadi SAGY villages in their divisions. Among them, Junnar sub-district had higher percentages of households having these basic facilities (Figure 4). These findings are in corroboration of the index values of RHSI and RIF obtained from the four rural units of Maharashtra.

The primary data from Models and Aspiring Models of Telangana were validated against the secondary database of District Census Handbooks of Warangal and Karimnagar districts of Telangana (Office of the Registrar General and Census Commissioner of India, 2014c,d). The percentage of households having piped sewer systems, tap water facilities, closed drainage systems, and electricity in sub-districts of Geesugonda and Koheda, i.e., those having Model villages under them of Gangadevipally and Ramachandrapuram, respectively, was comparatively more than those having these basic amenities in sub-districts of Wardhannapet and Kamalapur, having Inavolu and Dandepally SAGY villages in their divisions (Figure 5). These findings are in corroboration of the index values of RHSI and RIF obtained for the four rural units of Telangana.

TABLE 3 Weights of indicators and index formula derivation.

Index	Indicators	Component loadings from CATPCA		Component weights (Component loadings * Eigen value)		Total weight (w_i)	Index formula
RHSI	Toilet_use	−0.46	0.93	−0.92	1.48	0.55	$\{H_1^*0.55 + H_2^*1.50 + H_3^*1.07 + \ldots\ldots + H_8^*(-1.34)\}/W$
	No_Ex	0.22	0.66	0.45	1.05	1.50	Where H_1 to H_8 = Normalized value of each
	No_Smk	0.76	−0.29	1.53	−0.46	1.07	health indicator
	Satisfcn	−0.21	−0.20	−0.42	−0.31	−0.74	W = 4.73 (Grand Total Weight)
	Access_health	−0.31	−0.31	−0.63	−0.49	−1.13	
	Drnk	0.93	0.41	1.87	0.65	2.53	
	Dia	0.84	0.37	1.68	0.59	2.28	
	N_delivery	−0.36	−0.38	−0.72	−0.61	−1.34	
						Grand total weight = 4.73	
RESI	Edu	0.803	0.262	1.975676	0.322458	2.29	$\{E_1^*2.29 + E_2^*(-0.002) + \ldots.. + E_6^*1.82)\}/W$
	Chil_scl	0.33	−0.67	0.82	−0.83	−0.00	Where E_1 to E_6 = Normalized value of each
	Chil_higher	−0.34	0.67	−0.85	0.82	−0.02	education indicator
	Fam_edu	0.71	−0.09	1.76	−0.11	1.65	W = 8.08 (Grand Total Weight)
	High_edu	0.70	0.49	1.73	0.61	2.34	
	Wom_edu	0.76	−0.03	1.86	−0.04	1.82	
						Grand total weight = 8.08	
RFSI	farm_size	0.95	−0.12	2.66	−0.29	2.37	$(F_1^*2.37 + F_2^*2.60 + F_3^*1.65 + \ldots\ldots\ldots + F_8^*1.42)/W$
	Microirgn	0.95	−0.02	2.66	−0.06	2.60	Where F_1 to F_8 = Normalized value of each
	Impl	0.68	−0.11	1.91	−0.26	1.65	farming indicator
	crp_rtn	0.20	0.32	0.55	0.74	1.30	W = 15.38 (Grand Total Weight)
	Youth	−0.26	0.70	−0.82	1.61	0.78	
	int_crp	0.56	0.63	1.57	1.45	3.02	
	IPM	0.13	0.79	0.37	1.82	2.19	
	Grnmn	−0.12	0.77	−0.35	1.77	1.42	
						Grand total weight = 15.38	
RLSI	Dewrmg	0.19	0.55	0.62	0.76	1.39	$(L_1^*1.39 + L_2^*1.37 + L_3^*1.71 + \ldots. + L_8^*2.83)/W$
	Vcn	0.24	0.43	0.78	0.59	1.37	Where L_1 to L_8 = Normalized value of each
	Vet	0.27	0.62	0.87	0.84	1.71	livestock indicator
	Feed	0.23	0.50	0.75	0.68	1.44	W = 15.82 (Grand Total Weight)
	Fodr	0.29	0.33	0.94	0.45	1.39	
	Sale	0.97	−0.20	3.11	−0.28	2.83	
	Income	0.97	−0.20	3.11	−0.28	2.83	
	Hhretn	0.97	−0.20	3.11	−0.28	2.83	
						Grand total weight = 15.82	
RECSI	Wetwaste	0.52	0.17	1.14	0.18	1.33	$(E_1^*1.33 + E_2^*1.06 + \ldots. + L_7^*0.62)/W$
	Drywaste	0.47	0.01	1.04	0.01	1.06	Where E_1 to E_8 = Normalized value of each
	Bag	0.27	−0.68	0.59	−0.74	−0.15	ecological indicator
	Watershed	0.88	0.01	1.94	0.02	1.96	W = 7.82 (Grand Total Weight)

(Continued)

TABLE 3 (Continued)

Index	Indicators	Component loadings from CATPCA		Component weights (Component loadings * Eigen value)		Total weight (w_i)	Index formula
	Organic	0.85	−0.04	1.86	−0.05	1.81	
	Clean	0.14	0.78	0.31	0.86	1.17	
	Drives	0.28	−0.00	0.62	−0.00	0.62	
						Grand total weight = 7.82	
SRWI	Marriage_age	0.79	−0.09	1.14	−0.10	1.04	$(W_1^*1.04 + W_2^*0.96 + \ldots + W_6^*1.07)/W$
	Admin_job	0.77	−0.14	1.11	−0.15	0.96	Where W_1 to W_6 = Normalized value of each status of
	Business	0.22	−0.18	0.31	−0.20	0.11	rural women indicator
	Job	−0.32	−0.33	−0.46	−0.36	−0.83	W = 1.75 (Grand Total Weight)
	Agri_allied	0.05	−0.63	0.07	−0.68	−0.60	
	Decision	0.21	0.70	0.31	0.76	1.07	
						Grand total weight = 1.75	
RIF						Maximum obtainable score = 90	**Rural Infrastructure Index (RIF)** $= (I_1 + I_2 + I_3 \ldots . + I_{40})/MOS$ Where I_1 to I_{40} = Normalized value of each infrastructure indicator MOS = 90 (Maximum Obtainable Score)

7 Discussion

Rural development is a complex phenomenon, more so in today's era where modernization and urbanization have become new parameters of development. The boundaries of rurality, in the true sense, have been diluted as of now because of urbanization. In India, the concept of rural development is not urbanization in a direct sense but a self-sufficient and sustainable rural society with modern amenities, a culture of its own, and technology-driven agriculture to boast off. And this is in line to the emerging trend of "Rurality as a Choice" of Sub-Saharan Africa (SSA) where the motto is to develop rural areas not in an urban way but by heritagization of rural areas, introduction of rurality-focused vision in planning, and organization of campaigns for the protection of rural heritages, among others (Chigbu, 2013).

Again, it is a proven fact that rural areas, when they are in proximity to urban regions, outperform other remote villages in certain parameters, thus implying that urbanization has both positive and negative effects. Similar to this study, the Model village Maan, which was located in a peri-urban area, had a lower livestock status (0.36) than all SAGY villages but the third highest farming status (0.60) amongst all selected villages (Table 4). It was reported that for a few years, residents of Maan started practicing hi-tech horticulture, i.e., cultivation of high-value exotic vegetables and herbs in greenhouses with automatic irrigation facilities. The reason was due to high demand for such exotic fresh food in nearby restaurants and eateries, which started mushrooming after the establishment of the IT hub in the near proximity to Maan. The IT hub resulted in a drastic reduction of pasture areas. Residents, as a result, abandoned animal husbandry and shifted to horticulture in small poly-houses after observing the demand for exotic vegetables in nearby markets, thus animal husbandry took a back foot. The environmental status has also degraded in the area over time (RECSI = 0.35) due to industrialization. Similar degradations have been reported in villages of Turkey and China (Kurucu and Chiristina, 2008; Lora-Wainwright et al., 2012). On one hand, as a boon, the educational status improved in the village due to the establishment of advanced schools in the neighborhood. On the other hand, the Model village Ramachandrapuram of Telangana was a comparatively remote one, which, due to the overall negligence of the authorities of the village, failed to maintain the Model village status. The village, which was progressive at one point in time due to philanthropic efforts, was now suffering from underdevelopment. In most parameters, the village scored even lower than the SAGY villages of the state. This brings us to a future research prospect of evaluating the viability of Models or the Philosophical Units of Rural Development. Similar findings of indirect effects of urbanization in rural development of Sub Saharan Africa (SSA) was reported (Sakketa, 2023) and was said to occur through seven pathways: (i) production and consumption linkages; (ii) employment linkages; (iii) financial linkages; (iv) land market linkages; (v) information and knowledge linkages; (vi) social interactions linkages; and (vii) environmental externalities linkages. Recognizing the importance of such linkages and incorporating them into the local and national economic policies was crucial for sustainable development. The impact of urbanization on rural development in SSA was reported to be conditional and heterogeneous.

The construction of multi-dimensional indices in the context of rural development has been adopted in several studies.

TABLE 4 Performance of SAGY villages against Model villages.

Multi-dimensional composite indices	Model villages						SAGY Villages					
	Maharashtra			Telangana			Maharashtra			Telangana		
	Hiware bazar	Maan	Combined scores	Gangadevipally	Ramachandrapuram	Combined scores	Malunja Budruk	Tikekarwadi	Combined scores	Inavolu	Dandepally	Combined scores
RHSI	0.76	0.58	1.34	0.71	0.32	1.03	0.62	0.99	1.61	0.14	0.27	0.41
RESI	0.57	0.65	1.22	0.31	0.23	0.54	0.57	0.46	1.03	0.43	0.44	0.87
RFSI	0.77	0.60	1.37	0.28	0.38	0.66	0.80	0.70	1.5	0.52	0.54	1.06
RIF	0.73	0.83	1.56	0.77	0.52	1.29	0.48	0.61	1.09	0.67	0.61	1.28
RLSI	0.70	0.36	1.06	0.53	0.32	0.85	0.68	0.61	1.29	0.54	0.77	1.31
RECSI	0.84	0.35	1.19	0.27	0.22	0.49	0.28	0.29	0.57	0.27	0.29	0.56
SRWI	0.38	0.34	0.72	0.35	0.26	0.61	0.31	0.32	0.63	0.20	0.19	0.39

Composite indices have been used by Paul et al. (2020) and Paul et al. (2021) in the context of rural sustainability as well. Abreu and Mesias (2020) from Spain developed a set of 25 indicators pertaining to four dimensions viz., population, social welfare, economy, and environment; Li et al. (2015) examined the relationship between rurality index and major socio-economic and geographical indicators; Slee and Feliciano (2015) suggested improved impact indicators based on the relationship between rural land use and greenhouse gas (GHG) emissions; Common Monitoring and Evaluation Framework (CMEF) was developed by the European Commission in 2007–2013 policy period to assess rural development policy achievements (Directorate General for Agriculture Rural Development, 2006) with seven common impact indicators (European Commission, 2007).

The domains and indicators finalized after triangulation in the study were of major significance as well and have often been considered as basic standards of rural progressiveness. Educational status (Pal, 2010), agricultural status (Li et al., 2019; FAO, 2017; Rani and Roy, 2017; Kumar et al., 2015), livestock status (FAO, 2020), ecological status (Mahlabani et al., 2016), status of women (Aregu et al., 2018), and rural infrastructure have been adjudged as indicators of rural progressiveness in different regions of the world.

From the combined scores of indices, it became evident that aspirant Models (SAGY) of Telangana had excelled over Models of that state in four parameters, while aspirants of Maharashtra had excelled in only three parameters out of seven (Table 4). In both states, the farming and livestock sector witnessed significant improvement in performance after the introduction of SAGY than the Model villages. Meanwhile, the Model villages of both states had better infrastructure and the status of rural women. Thus, it can be concluded that the basis of Gandhian philosophy had successfully triggered infrastructural development and improvement in the status of women in rural societies of the Deccan plateaus of India. On the other hand, government RDPs with measured outcomes have mostly targeted improvement in the economic prosperity of residents through scientific farming techniques in those regions.

However, individual assessment shows advancement in various parameters. There was an excellent performance reported from Tikekarwadi Aspirant village in health status (RHSI = 0.99) due to the establishment of drinking water ATMs in the village under the SAGY initiative, which provided safe, germ-free water. The rural transformation brought about by Water ATMs has been reported in other countries too, such as Kenya, Uganda, Nepal, Egypt, and Tanzania (Guma and Wiig, 2022; Bouman et al., 2022; Otter et al., 2020).

The aspirants in Telangana were more progressive than Models of their state in terms of not only farming status (such as Maharashtra) but also livestock and education. SAGY RDP was successful in transforming the agricultural, livestock, and educational scenario of the villages. Establishment of schools, livestock health centers, recruiting veterinary doctors in livestock health centers, etc., were some of the interventions that resulted in this transformation.

During interaction with the beneficiary or SAGY villages, it was found that SAGY had a major lacuna in its formulation, due to which the ambitious target of Gandhian Self-Sustainability was becoming difficult to achieve. It did not have a separate

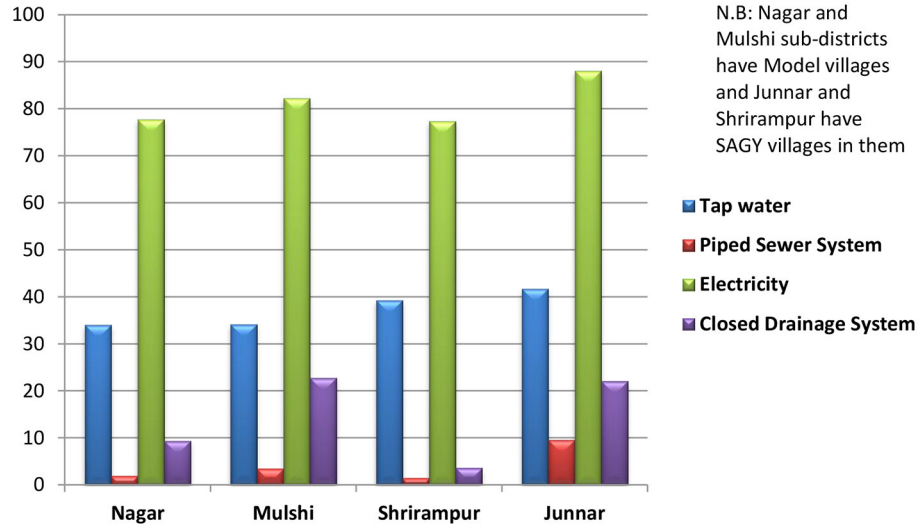

FIGURE 4
Percentage of households of sub-districts of Maharashtra having different amenities as per District Census Handbook, 2014. Compiled from District Census Handbook Pune and Ahmednagar, 2014; (Office of the Registrar General and Census Commissioner of India, 2014a,b,c,d).

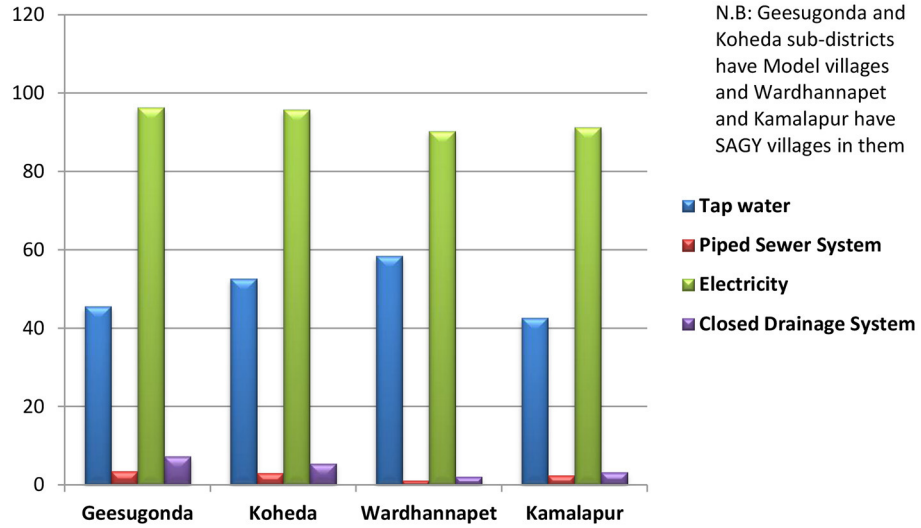

FIGURE 5
Percentage of households of sub-districts of Telangana having different amenities as per District Census Handbook, 2014. Compiled from District Census Handbook Warangal and Karimnagar, 2014 (Office of the Registrar General and Census Commissioner of India, 2014a,b,c,d).

budget but sought convergence of existing government schemes for implementation (Tiwari et al., 2019). Moreover, public investment, being a crucial factor in deciding the success of an RDP, has also been reported in RDPs of Southeast Asia (Balisacan et al., 2005), Germany (Țenea, 2021), and Ukraine (Tomashuk, 2017).

Another inhibiting factor to SAGY was Members of Parliament (MPs) being worried that adopting one village in their electoral constituency as SAGY village would trigger hostility among other villages and cost them politically. The other basic flaw in the scheme was that MPs were being asked to focus on micro-level monitoring work in *gram panchayats*, which is the domain of Member of Legislative Assemblies (MLAs), thereby triggering a conflict between central and state legislators (Bhattacharyya et al., 2021).

Some suggestions for effective implementation of SAGY can be ensuring convergence and dovetailing of schemes and its proper implementation on priority basis, namely leveraging on facilitating factors such as community participation and social mobilization of the village community, instilling a spirit of brotherhood and cultural bonding to speed up different developmental activities of the program; correction of faulty adoption policy of the program; and involvement of NGOs, community bodies, and line department officials, and less political involvement to contain political hostility and resentment.

The present study had a time limitation; therefore, a very deep and in-depth study was not possible, but future research can be designed for a more in-depth study. Comparative studies among groups of SAGY villages of a state or at the pan-India level can be done in future. Studies on the convergence of departments for funding, SAGY implementation, and training needs assessment for officials of those departments can also be designed.

8 Conclusion

The dynamic concept of development, the relative aspect of Model villages, and the urge and need to quantify progress to evaluate the success of rural development programs have become a matter of concern for social science researchers, government bodies, and policymakers for uplifting the rural section of the society. In this context, the selection of a framework for measuring rural progressiveness and then the development of a holistic indexing approach was the motive behind this study, which has larger implications and scopes of replication, with or without modifications, throughout the globe. Given the context of climate change, the RFSI indicators can be modified to include climate-smart agriculture (CSA) approaches to promote coordinated actions by farmers, researchers, private sector, civil society, and policymakers toward climate-resilient pathways, such as (1) building evidence; (2) increasing local institutional effectiveness; (3) fostering coherence between climate and agricultural policies; and (4) linking climate and agricultural financing (Lipper et al., 2014).

The rural development indices developed in this study not only serve as a direct feedback of SAGY RDP but also have long-term implications with respect to sustainable agri-food systems, food security, crop sustainability, crop-based rural livelihood, and climate resilience at policy-making level. Given the fact that climate change is an inevitable, unavoidable, yet manageable phenomenon harshly impacting the global agri-food system which employ an estimated 1.23 billion people globally (FAO, 2024), its direct sufferers are the regions and people with considerable development constraints such as poverty, governance challenges, limited access to basic services and resources, and violent conflict and high levels of climate-sensitive livelihoods like smallholder farmers, pastoralists, and fishing communities (IPCC, 2023). Hence, the RECSI, RFSI, and RLSI indices developed in this study have a crucial role toward the completion of a rural sustainability framework in not only the Indian context but also in other developing economies of the world. The indices can be further enhanced through the integration of climate-smart agriculture (CSA) indicators, which is the only answer to tackling climate adaptation. As rural livelihoods intricately depend on agriculture, especially in developing countries, CSA is of utmost importance to mitigate the effects of climate change and build resilience. CSA is an approach to developing the technical, policy, and investment conditions to achieve sustainable agricultural development for food security under climate change. The CSA approach is designed to identify and operationalize sustainable agricultural development within the explicit parameters of climate change (FAO, 2013). It has been well proven that the average income of a farm household in the climate-smart villages is 40% more than in a conventional village, as during a drought situation, the farmers of climate-smart villages were better off by 19.5% (Samuel et al., 2024). In Ethiopian highlands too, CSA approaches have improved climate resilience of smallholder farmers (Teklu et al., 2023). Adopting CSA practices improved crop yields and productivity, income and profitability, and technical and resource use efficiency as per studies in China (Zheng et al., 2023). The developed indices of this study can be further enhanced using socio-ecological dimensions of livelihood resilience, namely, buffer capacity, self-organization, and learning capacity, which have been proven to be sustainability parameters too (Speranza et al., 2014). From an ecological and farming perspective, the indices of RECSI and RFSI can be modified to include indicators of land degradation as parameters of agricultural sustainability (Valjarević et al., 2025).

As the Indian approach of rural development draws inspiration heavily from the Gandhian Philosophy of Self-Sustainability, it becomes essential to evaluate RDPs against the philosophy itself. The indices developed for evaluation can act as standards to assess not only the rural ecosystem of SAGY and Model villages but also assess similar rural development programs and ecosystems worldwide. The novel approaches used in this study for index development ensure statistical rigor through the NUEPA and CATPCA methods. In future, the indices can be used by government and non-government development agencies, policymakers, and programers to evaluate and rank villages after a program has been implemented. The indices can serve as a guideline for designing development programs for villages, for regional, and state-level planning.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Author contributions

SB: Formal analysis, Investigation, Validation, Writing – original draft, Writing – review & editing. RB: Conceptualization, Visualization, Writing – review & editing. RP: Formal analysis, Methodology, Writing – review & editing. SP: Data curation, Software, Writing – review & editing. PV: Writing – review & editing, Methodology. AD: Software, Writing – review & editing. PR: Investigation, Writing – review & editing. SD: Resources, Writing – original draft. SS: Resources, Writing – original draft. SK: Resources, Writing – original draft.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declare that no Gen AI was used in the creation of this manuscript.

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