A concept of knowledge and technology enabled empowerment of rural Indian villages

Anil Kakodkar[1,3], Babruvahan Ronge[2], Ajit Patankar[1], Smita Mule[3] and Prashant Pawar[2,*]

[1]Rajiv Gandhi Science and Technology Commission, Mumbai 400 032, India
[2]Shri Vithal Education and Research Institute, Pandharpur 413 304, India
[3]Bhabha Atomic Research Centre, Mumbai 400 085, India

The objective of rapid development of rural population in a sustainable manner with a view to bridging the urban–rural divide would require leveraging knowledge and technology in an environment conducive for innovation. The concept of a CILLAGE that incorporates the best of a city in a village is developed with this objective in mind. A CILLAGE is a knowledge-based ecosystem for integrated education, research, technology development and deployment as well as capacity building in rural areas. The focus of research work at a CILLAGE is on regional problems. CILLAGE activities also include a comprehensive engagement with people in the neighbourhood for demonstration and deployment of relevant technologies through a number of Advanced Knowledge-based Rural Technology Initiative (AKRUTI) centres located in the neighbourhood. CILLAGE should thus become a centre of innovation in rural areas to solve the problems of the region and disseminate the developed technologies in the region through AKRUTI centres. This article discusses the philosophy of the CILLAGE concept and describes its implementation through an example.

Keywords: Digitally connected villages, knowledge and technology, livelihood generation, rural empowerment.

ACCORDING to the 2011 Census of India, around 70% of our population lives in rural areas. India development story is thus largely dependent on the development of people in rural areas. Rapid development and empowering of rural population, in a manner that significantly raises not just their individual income but also the level of self-empowerment, particularly at the base of the economic pyramid, should therefore be a matter of high priority.

Economic activities are increasingly becoming knowledge-based and are getting globalized at a fast pace. Thus there is a great need to prepare rural youth to adopt to advanced knowledge-based technologies and be an effective player in the emerging economic paradigm. Rural areas require much greater attention and speedier actions in this regard to ensure that most of the population is on the right side of the digital and hence the technological divide. There is thus a need to evolve an ecosystem in rural areas in which there are opportunities for everyone to be well-educated and get trained in new technologies (both modern and traditional) that open up new opportunities as well as inculcate relevant skills. For this purpose, quality teaching/learning and first-hand participation in related real-life development activities that lead to better human empowerment and livelihood, need to be pursued synergistically.

The average per capita rural income in India is less than half of the average per capita urban income[1]. Access to better technology, inculcation of requisite skills and nurturing innovation in the context of local resources and opportunities in rural areas are the keys to bridging this gap. If capacity building of people and nurturing the ecosystem in which they would need to operate is done properly, the livelihood can go up by multiples rather than by percentage points. Enhancing agricultural output and maximum possible value-addition to agricultural output along with other allied earning opportunities in villages should be the primary focus in the context of rural development. In addition, we should focus on the upcoming opportunities in the new digital era which is likely to facilitate decentralization of economic opportunities, including in villages. Apart from reduction in disparities and a large contribution to GDP, this could lead to a more humane society in greater harmony with itself and with the nature. If successful, this could also significantly lower the stress on urban infrastructure through reduced migration, which in any case appears inescapable.

Recognizing the need for a faster development of rural sector for the overall healthy development of the nation, several countries have adopted appropriate policies for the purpose[2–6]. Apart from the agricultural-based income, efforts have been made for improvement of rural sector by developing agricultural and allied businesses[7–9]. Some examples show that the regional rural branding has helped in the development of that region[10,11]. Impact and requirement of digital technologies have also been studied from rural perspective[12]. The analysis shows that the

*For correspondence. (e-mail: pawarpm@sveri.ac.in)

digital divide is a threat to the performance of rural partnerships, which affects rural development. The studies recommend the need for a more responsive and localized approach to rural development partnerships that can enable disadvantaged groups to participate in today's digitally connected economy and society. In addition to policy-related studies, several field-based activities have been undertaken to make a difference to the life of poor people in rural areas. Some of the important Indian examples described are Chitrakoot Project[13], Lokbiradari Prakalp[14] and Bharatiya Agro Industries Foundation (BAIF)[15].

The concept of CILLAGE was evolved with a view to leverage up-to-date knowledge paradigm for capacity building and technology-enabled economic growth in rural areas. This article explains the concept of CILLAGE through its various components in which the authors have been involved. This concept is demonstrated in Pandharpur region, Maharashtra, India. The details of planning and implementation are also described here. CILLAGE is a knowledge-based ecosystem for integrated education, research, technology development and deployment as well as capacity building in rural areas. CILLAGE activities are initiated with establishing the technology demonstration and training facilities, with the technology know-how initially coming from established research institutions and with the involvement of academics engaged in research and development in the host higher technical education institution. Few relevant technologies from CILLAGE are further extended to villages in the neighbourhood by establishing a number of Advanced Knowledge-based Rural Technology Initiative (AKRUTI) hubs. These hubs enable demonstration of relevant technologies, training and skilling of local people, and facilitate adoption of technologies by them. Through AKRUTI hubs villagers are connected to CILLAGE for exchanging the knowledge demand–delivery process. High-speed internet connectivity at CILLAGE through National Knowledge Network (NKN) brings in external knowledge support from various knowledge centres of excellence to CILLAGE and the neighbourhood for facilitating better knowledge-based development. The interim impact of the project on the rural community as well as the host institution has also been assessed.

CILLAGE – philosophy

Most Indians (nearly two-thirds) still live in rural areas. There are large disparities between urban and rural areas in terms of access to quality education, average income and several other development parameters. Since education and development in rural areas are the key to bridging this divide and CILLAGE is about knowledge and technology enabled development in rural areas, it makes sense to develop new higher education campuses in rural areas in the CILLAGE mode. Even the existing higher technical education institutions could be reshaped in the CILLAGE mode. A CILLAGE linked to several AKRUTI centres around could, while pursuing its own academic and research activities, support the neighbourhood for its knowledge, technology and human resource development needs. Such an infrastructure also creates opportunities for students to study in an ambiance of real-life activity. This would make their learning more holistic and mould research on the campus to be more focused to solving problems before the society. Neighbourhood benefitting from research, development and demonstration activities of the campus is an added advantage. Such a campus should be self-sufficient in terms of facilities for education, research, development and society outreach activities on the one side and urban amenities including school education, medical, sports and entertainment facilities with employment/work opportunities for spouses on the other. It is important that through such and other possibilities, we create opportunities for competent youth to find sufficiently attractive career and entrepreneurship opportunities as well as a highly satisfying way of life in rural India. The best and motivated brains mentoring synergistic working between such knowledge domain in which there are continuous attempts to push the relevant knowledge frontiers forward and evolve new technologies relevant to the area on the one side, and the neighbourhood that is working to embrace new technological ideas on the other should accelerate rural development.

Best of city in a village – CILLAGE intentionally located in a rural area should have state-of-the-art research and education infrastructure as well as all modern amenities for family members of the researchers. The aim should be to attract competent researchers to work in rural areas to address the problems of the neighbourhood. We believe that it is in fact possible to do world-class, cutting-edge research while remaining focused on local problems and their solutions leveraging sound research methodology. Excitement of world-class research oriented to rural development challenges and availability of modern amenities in serene surroundings of the rural neighbourhood, should result in the coming together of a critical size of research community. This would lead to an integrated education, research and development ecosystem where the focus is on research, problem-solving and human resource development relevant to the needs of the local region. CILLAGE and surrounding AKRUTI hubs together would constitute an innovation ecosystem that, if adequately empowered, can rapidly transform the region in a bottom-up mode. Locally developed state-of-the-art solutions that are appropriate to the needs of the region and capacity building of the people in the neighbourhood would be the key outcomes from such an ecosystem that should drive the intended transformation. CILLAGE would also ensure that the technology practices in the

region remain at the state-of-the-art level through problem-oriented research and engagement with people in the neighbourhood.

A key feature of CILLAGE would be the ongoing exchange of knowledge and related resources with other knowledge partners to solve local problems. This is facilitated by a node of NKN, or by any other means of high-bandwidth connectivity located in CILLAGE and a low-cost broadband communication network (for example, WiFi) serving the surrounding region over a range of about 20–25 km. This connectivity will help get virtual presence of experts from various locations for the development of CILLAGE and its neighbourhood. Apart from access to external knowledge resources, this enables an integrated ecosystem in which CILLAGE can link its education, training and research activities with the neighbourhood as well as support a technology demonstration and deployment framework that enables and empowers grassroots people through knowledge, skills (both hard and soft) and technology inputs.

Figure 1 is a schematic representation of engagement between a CILLAGE hosted in a university or a higher technical education institution, AKRUTI hubs and rural surroundings.

While the CILLAGE–AKRUTI-based knowledge and capacity-building framework supports the region for its technology needs, together with leveraging financial inclusion framework that has already emerged, this should lead to economic development and growth in the region. Since development should be about wealth generation among other things, we should expect growth through what one may call bankable projects taken up by local people. Linkage with CILLAGE–AKRUTI should add to technology content of such projects resulting in higher benefits to the society. By incorporating proper revenue models for services rendered, CILLAGE and AKRUTI hubs should not only become self-sustainable, but also multiply themselves to other areas for larger impact. In this sense, we can realize a self-replicable development paradigm duly nurtured by the CILLAGE–AKRUTI knowledge and technology innovation domain on the one side and financial inclusion domain on the other. Initial capital investments for CILLAGE as well as for related AKRUTI hubs would, of course, have to come from public-funded human resource development programmes. This investment would anyway contribute to the primary objective of human resource development, expectedly in a much better way and in areas where it is needed most.

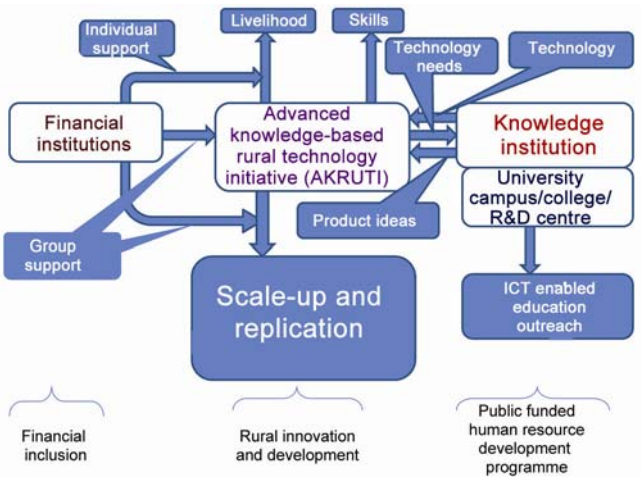

Figure 1. DNA of rural development.

By connecting NKN node or other means of high bandwidth connectivity, CILLAGE will exchange knowledge with other knowledge partners to solve their local problems. This connectivity will help get virtual presence of experts from various locations for the development of CILLAGE. This forms an ecosystem in the University that can develop and link its education, training and research activities with the neighbourhood on lines of technology demonstration framework that enables and empowers grassroots people through knowledge, skills (both hard and soft) and technology inputs. These centres owned and run by technical education institutes are linked to knowledge institutions to access relevant technology ideas and become demonstration centres for livelihood creation based on innovative implementation of these and other ideas.

CILLAGE – implementation process

The philosophical model of CILLAGE is demonstrated with the help of public–private partnership project. Primarily, three organizations came together for this demonstration project, where each organization played a complementary role. Bhabha Atomic Research Centre (BARC), Mumbai which developed various technologies relevant to societal development essentially as a spin-off of its mainstream research agreed to provide these technologies and support for their deployment. Shri Vithal Education and Research Institute (SVERI), Pandharpur offered to host the project. SVERI located in the rural part of India and surrounded by several villages, runs diploma, undergraduate (UG), postgraduate (PG) and doctorate programmes in engineering and pharmacy. There is also a postgraduate programme in management. Most of the students registered for these courses are from villages in the neighbourhood and have agricultural background. The organization has developed good relation with the community in the Pandharpur region. Rajeev Gandhi Science and Technology Commission (RGSTC), Government of Maharashtra, which has the mandate for socio-economic development of the people through applications of science and technology decided to fund the project. The planning and implementation process is described below.

Project background

Description of problem: To improve the economic status of individuals/region as a whole, there is a need to generate wealth through utilization and value-addition of available resources. However, in the rural areas many a times, even though the resources are available, they are not utilized effectively due to lack of knowledge and required technical support. Further value-addition is thus less. Opportunities are rarely available to the rural masses to learn and use new technologies in their own area and hence technology penetration is insignificant. A large potential thus remains untapped.

Therefore, there is need for establishment of centres where efforts will be made from engineering and technology point of view to transfer some of the relevant technologies through rural entrepreneurs. These centres should have various demonstration facilities to train the entrepreneurs. Further, the centres should have a formal course structure for training in these technologies to be effective. There should be good knowledge connectivity and database development facility so that rural people will be equipped with the required knowledge and information to be able to make informed choices. Furthermore, these centres should able to develop high-tech products that address rural problems. Continued sustainability of the centre would require the facility being capable of generating a revenue stream through its services and products, while the dissemination and training activities are carried out. In the facility to be set up under the project, initially the demonstration facilities of various technologies developed by BARC would be established. During this establishment, a few full-time employees would be trained on these technologies through BARC experts along with volunteers and rural entrepreneurs. In the process, formal courses will be developed and training material in local language will be generated for future training. Facility will be developed to solve the rural problems related to water, food and secondary agricultural products.

Description of project

Objectives of the project: The planned objectives of the project are as given below:

- To develop training facility for rural and agricultural technologies and research programme for making advancement in technologies initially accessed from BARC and development of other similar technologies.
- To deploy technology from laboratories to the field through village centres of CILLAGE.
- To develop an incubation centre for high-tech products for rural and agriculture sector.
- To encourage technological workforce to get involved in local problems.
- To develop science and technology culture in rural sector.

Preliminary investigations by the organization: SVERI has carried out survey in around 50 villages of Pandharpur region in order to find out the techno-economic status of the region. It has also organized two awareness workshops to introduce the technologies and extended support for their adoptation.

Through surveys and workshops, the following points are noted:

(1) At present no training facility is available in the nearby area, so as to impart skill/knowledge to the villagers to learn new relevant technology.
(2) The villagers are in need of many services and are ready to avail them at cost. However, no service provider exists.
(3) The left out after harvesting crop is not utilized.
(4) Technology used in the processing of the crops, especially fruits, is not up to the mark.
(5) There is wastage of water in farms.

After identifying the needs of the people through survey, linking of these needs is done with the technologies developed by BARC. Table 1 provides the details of this linking in the form of projects.

Science and technology components in the project

Based on the survey carried out to understand people's needs, few technologies developed by BARC are selected to develop various products/processes. Based on the user feedback, the products/processes will be further improved upon. In the interaction among the end-users, BARC and SVERI, new products and processes will come out. This will also provide real-life problems for UG, PG and doctoral students in the region for development of products and processes useful to the rural area. Table 2 provides a brief description of these technologies. To begin with, the trainers will be trained by scientists from BARC on all AKRUTI activities. The trainers will be involved in the project right from its inception. Hands-on training will be provided to them. Further, they will interact with the end-users and conduct workshops and field demonstrations to motivate the initiation of AKRUTI at Grampanchayat level and individual level. Workshops will be supported by course material developed in English and local regional languages. The course material will be transferred to other centres and end-users through NKN facility. Constant support and guidance will be provided for ensuring sustainability of the activity.

Table 1. Projects identified based on a preliminary survey carried out in the study region

People's needs	Projects identified
Farm waste management and compost manure development	Nisargruna biogas technology
Potable drinking water	Water technologies: domestic and community water filter
Soil testing not available locally	Bhabha Atomic Research Centre (BARC) soil testing kit
Farming-related training and information network	With the help of National Knowledge Network (NKN), training session of experts can be arranged at Rural Human and Resource Development Facility (RHRDF)
	Medium-range weather forecasting units will be installed
Agricultural market fluctuation	Value-addition and food preservation using foldable solar dryer and vibro thermal disinfector
Agricultural guidance and development centre in the region to solve various problems that may arise	RHRDF Centre and its staff and volunteers
Advanced seeds and crops	BARC seed variety
Help and knowledge about secondary agricultural and various supporting small-scale businesses	Radioimmunoassay test lab breeding, osmotic dehydration as fruits, laser-based land-leveller and several new technologies developed by BARC and RHRDF
Public awareness on radiations	Indian Environmental Radiation Monitoring Network for background radiation monitoring

Table 2. Technologies made available at the CILLAGE hub

Technology	Description	Advantages
Nisargruna	The two-stage biogas plant which processes the biodegradable waste from kitchen and agricultural waste.	Production of high-quality methane gas and high quality manure as a by-product. Eco-friendly decomposition of waste at remote places and high-quality manure as by-product. Production of high-quality methane gas and direct farmers towards organic farming.
Soil organic carbon testing	For proper application of fertilizers according to the nutrient requirement of crops and soil characteristics to contain higher yield.	High yield due to use of required quantity of particular fertilizers less investment for fertilizers. Direct farmers towards organic farming.
Solar drying for raisin-making/foldable solar dryer and vibro-thermal disinfector	Solar flip-flop dryer for raisin-making. These dryers are not available commercially. In addition, the technology is suitable for other fruits and vegetables, osmotic dehydration and production of self-stable foods. To avoid damage of cereals and pulses by insect apply heat at 55°–600°C for a few minutes using microwave or infrared radiation source.	Eco-friendly, rapid, non-chemical alternative of fumigation; preserves quality of grain, faster drying process; increases shelf-life up to one year. Life 15–20 years with less maintenance; can be made available in different capacities.
Water technology	To make available or provide safe and pure drinking water to users, free from contaminants.	Availability of pure water; low cost technology; removes contaminants from water such as iron, arsenic, microorganisms; improvement in health of users.
Laser land-leveler	It is an attachment provided with tractor for land levelling of large area-based on laser technology.	Uniform soil moisture distribution; improved crop yield; improves irrigation efficiency; reduces weed problems.
Weather stations	Measurement and analysis of climatic changes such as rainfall, temperature and humidity using science and technology.	Help farmers to manage field operations.
Seed bank	To make available pure and improved seed varieties to farmers by applying different processing methods like pre-cleaning, cleaning, upgrading, etc.	More uniform planting rates by proper sizing; reduces seed losses by drying; disease-free seed due to application of chemical protectants; improves seed quality; increase crop yield.
Radioimmunoassay	To measure the levels of progesterone in the blood samples of cow or buffaloes to understand ovulation cycle to help the conceiving chances.	Accurate evaluation of heat detection; evaluates response to various hormone treatments; for studying various forms of cattle sub-fertility; early identification of open animals; to generate progesterone profile of animals.

Implementation methodology

CILLAGE project implementation methodology is summarized below:

- Formulation of working modalities
  - Signing the Memorandum of Understanding with BARC for transfer of technologies and training of the trainers.
  - Establishment of common monitoring and coordination committee amongst BARC, SVERI and the funding agency.
  - Allotment of SVERI infrastructure (civil, electrical, network, etc.).
  - Selection and appointment of appropriate manpower.

- Development of demonstration cum-training facilities at CILLAGE hub
  - Transfer of technologies to SVERI from BARC.
  - Formulating the plan for establishment of facility in terms of vendors and purchase procedures.
  - Establishing facilities.

- Training the trainers by BARC scientists
  - Involving trainers right from the inception of a particular facility.
  - Hands-on training.
  - Interacting with end-users.
  - Training for course material development and database maintaining.

- Awareness camps
  - Organizing awareness camps at various locations.
  - Registering interested groups/individuals.

- Training to NGOs/Grampanchayat groups/individuals
  - Organizing training workshops along with field demonstration to initiate AKRUTI or individual venture.
  - Constant support and guidance for sustaining the activity.

- Course material development
  - Through the above-mentioned training experience, course material development and ongoing modifications.
  - Translation of course material and technology documents in regional languages.
  - Transfer of material to other centres and end-users.

- Involvement of UG and PG professional institute students for further development of technologies/ products
  - Identification of problems for efficiency improvement/cost reduction.
  - Selection of manpower for the activity.
  - Creation of B Tech/M Tech projects.
  - Improvement of existing material/technology/ products based on modifications by UG and PG students.

Parameters for monitoring effectiveness of a project

CILLAGE project performance may be judged by the following criteria:

- Number of persons trained.
- Number of individual entrepreneurs.
- Number of AKRUTI groups connected to the centre.
- Number of products modified.
- Number of courses developed, translated and training material distributed.

Outcomes of CILLAGE

The outcomes of the CILLAGE project activities are summarized below.

Installation of demonstration and training facility

The project started with installation of a Rural Human and Resource Development Facility (RHRDF) as a demonstration and training facility in the SVERI campus as a CILLAGE epicentre. In this process, for each technology, SVERI faculty members, CILLAGE project staff, village interns and sometimes direct villagers were involved in the initial trainings by BARC scientist. In the process more than 60 SVERI staff about 30 CILLAGE project staff and more than 200 villagers participated in the initial phases of installation training. For the initial installation, more than 28 BARC scientists visited the SVERI campus. This process helped understand how to convert the BARC technology know-how document into working technology or process. Figure 2 is a photograph of the current CILLAGE campus.

Figure 2. CILLAGE Hub Centre in Shri Vithal Education and Research Institute, Pandharpur Campus, Maharashtra, India.

Village centres and training through them

Parallel to installation of demo-cum-training facilities, activities in the villages were also initiated for bringing awareness about these technologies and activities in the field were started initially with soil-testing kits, seed bank, water filters and also by guiding them to solve their routine agricultural problems. Further, technologies like foldable solar dryer, nisargaruna, tissue culture, automatic weather stations, laser land-leveller, etc. were introduced. In the process more than 100 training and awareness programmes were conducted in various villages in the six talukas of solapur district, viz. Pandharpur, Mohol, Sangola, Malshiras, Mangalvedha and Karmala. To create awareness amongst various stakeholders, several events were organized. Various activities have been introduced in more than 25 villages in Solapur district involving more than 800 farmers. Based on the response and activities, six AKRUTI centres have been established. At these centres various awareness posters and few demo-technologies are displayed. The village interns of these AKRUTI centres maintain records of interested farmers. These village interns form the link between the villagers and RHRDF. As a result of interactions with villagers and technical institute, some technologies have also been introduced at centre.

Interim impact assessment of CILLAGE project and notable cases

To assess the impact, surveys have been carried out before and after deployment of some of the technologies. A few notable changes and feelings of stakeholders are reported here.

Seed bank: Seed bank programme has become popular. In the last two years, 80 farmers have participated in the programme for three seasons. They have learned to preserve their own seeds for sowing in the next season. Also, some farmers have started selling the variety as seeds to other farmers, in turn forming their own network. The seed variety TG-51 supplied through this centre is giving better results compared to WESTERN, the other popular variety in the region. Among the volunteer farmers who participated in seed bank programme, few have shown interest in taking this activity to a professional level as their business with appropriate permissions. The impact assessment of this activity is carried out through survey before and after deployment of this programme. About 450 farmers from 20 villages participated in the survey carried out before deploying the programme. The survey analysis shows that about 66% of farmers were not cultivating groundnut crop in the region due to unavailability of good variety of seed (47%) and low yield (41%). In the survey, questions were also asked about the groundnut variety and about standard cultivation practices of the same. About 87% of farmers expressed the need for appropriate guidance for the best groundnut cultivation practices. After deployment of the groundnut seed variety TG-51 through 80 volunteer farmers, a survey was carried out amongst them. Table 3 presents a summary of positive responses compared with other varieties in the market.

Soil testing kit: Soil organic carbon testing kit helped bring awareness among the farmers about the importance of soil organic carbon. The indication of low soil organic carbon, alerted farmers to start utilizing the practices to improve the same, which includes use of organic manure, changing of new crops, etc. These kits brought further awareness about soil testing and more detailed analysis of soil parameters, viz. NPK, conductivity, pH, etc. More than 500 farmers participated in training and testing soil organic carbon. The impact assessment survey before deploying the technology shows that not more than 10% farmers had awareness about soil testing, its importance and the practices to be adopted for improving soil organic carbon. After deployment of the programme, it was noted that awareness level had increased to 53% and there was improvement in adopting the practices for improving soil organic carbon. More awareness in this matter would not only contribute to higher output and improved quality but also to better moisture retention leading to more efficient water use.

Foldable solar dryer (FSD): Through AKRUTI centres the women self-help groups are taking interest in FSD for drying various products. The drying process using FSD was utilized to develop few food products. Training on these processes was given to self-help groups to utilize FSD for their improved livelihood. Self-help groups have started making food products traditional to the region using the FSD provided to them, and they are getting good market response for their products. Training camps are also organized for fabricators to fabricate FSD; one fabricator has taken up this activity for his livelihood. Through this programme, a systematic recipe book in

Table 3. Summary of impact assessment survey of Seed Bank programme

Factors assessed	Percentage of positive responses
Germination quality	71
Resistance to diseases	76
Soil health improvement	57
Price and demand for the variety	77
Average yield more than 14 quintals/acre (average yield of earlier variety is 12 quintals/acre)	72
Average yield more than 16 quintals/acre	20

Marathi, the local language, has been developed for making various products using FSD. At the CILLAGE centre, the existing FSD has been modified to bring down the manufacturing cost. Aluminum FSD costing Rs 20,000 is now modified to poly-FSD, which costs only around Rs 4000. This reduction in cost has made it affordable for self-help groups to buy the FSD. This has resulted in a boost in home-made products by self-help groups for which management students of SVERI are exploring the market and also helping the self-help groups in the marketing of their products.

Nisargruna: One-tone plant installed in the CILLAGE campus is being run with the help of farmers in the vicinity, who provide cowdung and take manure for their farms. This plant has minimized the waste management problem at the SVERI campus. The gas is utilized for cooking food in the hostel mess. There is saving of more than 20 LPG cylinders per month through this programme. Human resources of SVERI and project were trained for installation of Nisargruna. Further, to promote biogas plants in the region a feasibility study was carried out and a 2 m^3 pre-fabricated biogas plant design was selected. Five farmers have agreed to install this plant so that the gas as well as organic manure can be utilized in their farms.

Water filters: It was observed that rural people do not purchase water purifiers. The commercial water purifiers need more maintenance, as the candle needs to be replaced every three months. Therefore, low-cost water filters based on ultra-filtration membrane technology of BARC were installed in more than 250 locations. These filters are deployed through a local entrepreneur who has also participated and learned to fabricate these water filters at RHRDF facility. The survey before deployment shows that more than 87% of people were getting bad quality water and more 75% of people reported falling sick due to drinking poor quality water; young children were the most affected. The survey carried out after deployment of technology shows that the health problem was reduced by about 40–60%.

Drying of grapes: According to the suggestions given by farmers in the region, grape drying facility based on solar and vacuum drying has been set up. Development of the process for grape drying has been realized and the drying period of 12–15 days is now reduced to three days. The energy consumption minimization and economical viability study is under progress.

Tissue culture: Tissue culture lab has been installed to respond to growing demand from the region. There is a heavy demand for banana plants and farmers have to wait for at least six months after the order is placed. The tissue culture lab has a capacity of 1 lakh plants. In the process of installation, 10 farmers who have shown interest in tissue culture have participated in the training programme. This facility will be utilized for developing rare varieties of banana.

Laser land-leveller (LLL): Availability of this technology has created great amount of interest amongst the farmers. For training and demonstration programme, more than 50 farmers participated and another 30 more farmers have registered their request to utilize the LLL facility to level their farms.

Conclusions

The concept of CILLAGE as a knowledge-based development driver is demonstrated for rural development with the help of an existing academic institution located in a rural region. It is clear that linking education and neighbourhood development together creates an innovative ecosystem that is conducive to both improving quality of education as well as nurturing development. The experience of transforming the CILLAGE concept from idea to reality has led to learning a number of lessons which are summarized below:

- To make the CILLAGE concept successful, the role of knowledge institution acting as a hub is essential. This institution should have initial collaboration with the rural community around. As the hub institution was a technological institute, the existing human resource became useful for adoption of rural technologies provided by the knowledge partner, BARC. Further, the modifications or adaptations in the technologies during deployment process were also done by the faculty members of the hub institute.
- This hub should conduct detailed survey to identify the local needs and the solutions required. The problems identified should be grouped according to the amount of time required to deploy the requisite technology solutions, e.g. short term (one year), moderate term (two years) or long term (three years).
- The solutions identified should be studied with respect to available products, technologies and know-how. If solutions are available in the form of products, then all the pros and cons of these products should be studied for acceptability of the products in the region. If required, necessary region-specific modifications should be suggested and implemented in these products. If solution is identified in the form of technology, the time required for converting into products and its economical viability should be studied. These products should be selected as a part of research and incubation problem for CILLAGE, which can be solved with the help of knowledge partners.
- Technical group, viz. faculty members and research students of the institution, should participate to provide

technical support for these products considering them as their research problems. This will help in providing new solutions to the CILLAGE centre and in turn the technical group will become big knowledge partner of CILLAGE along with developing greater technological capability in the institution.

- Digital high-speed internet connectivity has helped in direct linkage of the rural community with the CILLAGE hub as well as the knowledge partners located far away. Further, this connectivity has helped access available advanced solutions to solve the regional problems.

It would be necessary to implement such a programme under the guidance and supervision of mentor knowledge institutions with the right experience and proven track record. We need to create a panel of such knowledge institutions and entrust them with the development of such a programme at different locations in the country. It is believed that the sustainability strategies described above will be instrumental in spreading the reach of development and related benefits to the neighbourhood in a sustained manner. It is believed that 100 such CILLAGEs, each linked with 100 AKRUTI hubs, can transform the rural domain in the country.

1. National Accounts Statistics: Manual on Estimation of State and District Income, 2012; http://sdp.gov.in/writereaddata/sources-method2012.pdf
2. Naldi, L., Nilsson, P., Westlund, H. and Wixe, S., What is smart rural development? *J. Rural Stud.*, 2015, **40**, 90–101.
3. Li, Y., Long, H. and Liu, Y., Spatio-temporal pattern of China's rural development: a rurality index perspective. *J. Rural Stud.*, 2015, **38**, 12–26.
4. Johansen, P. H. and Chandler, T. L., Mechanisms of power in participatory rural planning. *J. Rural Stud.*, 2015, **40**, 12–20.
5. Dzanku, F. M., Transient rural livelihoods and poverty in Ghana, *J. Rural Stud.*, 2015, **40**, 102–110.
6. Chapple, K. and Montero, S., From learning to fragile governance: regional economic development in rural Peru. *J. Rural Stud.*, 2016, **44**, 143–152.
7. Seuneke, P., Lans, T. and Wiskerke, J. S., Moving beyond entrepreneurial skills: key factors driving entrepreneurial learning in multifunctional agriculture. *J. Rural Stud.*, 2013, **32**, 208–219.
8. Steiner, A. and Atterton, J., Exploring the contribution of rural enterprises to local resilience. *J. Rural Stud.*, 2015, **40**, 30–45.
9. Martin, S., Rieple, A., Chang, J., Boniface, B. and Ahmed, A., Small farmers and sustainability: institutional barriers to investment and innovation in the Malaysian palm oil industry in Sabah. *J. Rural Stud.*, 2015, **40**, 46–58.
10. Eugenio-Vela, J. S. and Barniol-Carcasona, M., The relationship between rural branding and local development. A case study in the Catalonia's countryside: Territoris Serens (El Lluans). *J. Rural Stud.*, 2015, **37**, 108–119.
11. Lee, A. H. J., Wall, G. and Kovacs, J. F., Creative food clusters and rural development through place branding: culinary tourism initiatives in Stratford and Muskoka, Ontario, Canada. *J. Rural Stud.*, 2015, **39**, 133–144.
12. Erdiaw-Kwasie, M. O. and Alam, K., Towards understanding digital divide in rural partnerships and development: a framework and evidence from rural Australia. *J. Rural Stud.*, 2016, **43**, 214–224.
13. http://www.chitrakoot.org/
14. http://lokbiradariprakalp.org/
15. http://www.baif.org.in/

ACKNOWLEDGEMENTS. We thank Rajiv Gandhi Science and Technology Commission, Government of Maharashtra, for financial support. We also thank BARC, Mumbai and other laboratories of the Department of Atomic Energy, Government of India for providing technologies and also support for establishing these technologies.

Received 22 August 2016; accepted 25 August 2016

doi: 10.18520/cs/v112/i04/750-758