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# Developing Integrated SMART Villages for Rural Transformation in Response to Sustainable Development

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## Abstract

*According to World Bank, three out of every four poor persons in developing countries live in rural areas and a big percentage of them are dependent on agriculture for their livelihoods. Climate change has had far-reaching consequences to agricultural and rural development, especially in areas that are already fragile and exposed to environmental vulnerabilities. Broadly speaking, climate change is affecting poor farmers disproportionately. Past decades have witnessed the unprecedented depletion of rich resources in villages, the eroding green cover, over utilization of chemical fertilizer, mass migration to urban areas in search of occupation, leaving children and the elderly to live in villages with poor quality of life. One of the long-term repercussions is that villages are losing their potential for job opportunities, and their ability to support sustainable livelihoods, sustainable communities, healthy living spaces and create prosperity. Reversing these trends requires talent infusion, the innovative use of science and technologies in agricultural and related occupations, the transformation of villages into self-sustaining enterprises providing market linkages, reducing post-harvest loss, and the combination of technology for sustainable development and good health. All these in turn will make agricultural and related occupations more attractive and challenging to the youth and motivate them to stay in rural areas and pursue adequate capacity development opportunities. Against this background, this project proposes a unique approach of developing green SMART (Sustainable Model for Appropriate use of resources and Resilient Technologies) villages using the skills eco-system as a driver of change. It proposes an integrated and comprehensive approach for developing green SMART villages focused on environment-friendly, science and technology-powered, and skills-driven processes involving local skills eco-systems to implement day-to-day operations.*

**Key words:** ***SMART villages, transformation, SDGs***

## Context and Issues

"Villages", as is commonly known, are areas and communities that possess intrinsic characteristics, representative of their geographical setting, people, culture and the social, ecological and economic assets they possess. They form a rich network of communities as sources of food, goods and services necessary to provide for and meet the basic needs of peoples and societies. Villages are established in rural and urban settings, and according to World Bank, three out of every four poor persons in developing countries live in rural areas and a big percentage of them are dependent on agriculture for their livelihoods (World Bank, 2007). Climate change


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has had far-reaching consequences to agricultural and rural development, especially in areas that are already fragile and exposed to environmental vulnerabilities. Moreover, on the one hand many villages are affected by under-development due to a lack of economic opportunities. On the other hand, youths are largely disinterested in taking on rural livelihoods due to the poor perception of agro-based occupations, limited skills development opportunities, lack of science and technology-based applications, limited entrepreneurial opportunities, and poor market linkages in the villages (UN, 2016). Therefore, youth in general do not see agricultural occupations as creative, aspirational, profitable and, above all, as a respectable profession that can provide better living conditions. With this in mind, we see an exodus of youth from rural to urban areas in search of alternative employment/options. Moreover, most of the developing countries generally lack a clear strategy and an enabling environment to motivate and attract youth in agriculture. Local institutions offer very limited TVET skills programmes that are pertinent to local requirements. Past decades of unsustainable development have witnessed the unprecedented depletion of rich resources in villages, the eroding of green cover, the over utilization of chemical fertilizer and mass migration, leaving children and/or the elderly to live in villages with poor quality of life. One of the long-term repercussions is that villages are losing their potential for job opportunities and their ability to support sustainable livelihoods, sustainable communities and create prosperity.

To reverse these somewhat disruptive trends requires talent infusion, the innovative use of science and technologies in agricultural and related occupations, and the transformation of villages into self-sustaining enterprises providing market linkages, reducing post-harvest loss, and combining ICT for sustainable development and good health. All these in turn will make agricultural and related occupations more attractive and challenging to the youth and motivate them to stay in rural areas and pursue adequate capacity development opportunities.

## Approaches to Green and SMART Village Development

Against this background, this paper proposes a unique approach for developing integrated SMART (**S**ustainable **M**odel for **A**ppropriate use of resources and **R**esilient **T**echnologies) villages in remote and rural areas.

The 'integrated SMART village' is an evolving concept. Several governments and international organizations have been recently engaged in the implementation of smart villages in different countries. However, there is no single model or framework being followed in such experiments. It has been observed that some of the existing initiatives focus their smart approach on the energy perceptive; for example the IEEE and Smart Villages group have helped support off-grid communities of renewable energy worldwide (IEEE, 2019; Smart Villages, 2017). Other initiatives place an emphasis on creating smart villages from environmental and climatic change perspectives using an AR4D approach for smart agriculture (Climate-Smart Villages, 2017). A few other initiatives have emphasized digital perspectives for promoting digital transformations in the rural economy by means

of digital, telecommunication technologies and innovation. Examples include Digitale Dörfer in Germany and Smart Digital Transformation of Villages in the Alpine Space, Finland, UK and Spain (smartAKIS, n.d.). Many of these initiatives are combined in different degrees and hybrid in nature (EU, n.d.) and are premised on infusing technology solutions as interventions for transforming a village to become a 'smart village'.

In this paper, the author proposes an integrated and comprehensive approach for developing green SMART villages, covering different dimensions including environmental, technological and network perspectives. The framework offers adapting and contextualizing strategies and appropriate technologies. The paper establishes the need to tap the intrinsic potential of the local skills eco-system and utilize them as strategic partners for an integrated development, driven by skills and powered by localized science and technology applications with latest research on Agricultural 4.0. The framework focuses on environmentally friendly, technology-powered and skills-driven processes and local systems to implement day-to-day operations. In this mode, the village becomes:

**Environmentally Smart** where it can adopt mechanisms to be:

a) Climate Smart
b) Water Smart and
c) Energy Smart

**Technology Smart** - where it can adopt mechanisms to be:

a) Technology Smart
b) Waste Smart and
c) Health Smart

**Skill and Network Smart**, where it can adopt mechanisms to be:

a) Skill Smart and
b) Network Smart

The framework acknowledges that one-size-fits-all solutions do not exist given the diversity of characteristics present in villages. Rather, this paper proposes to use the framework to adapt smart-based opportunities depending on locally specific, geographic-sensitive and specific needs of the people. The approach is based on key driving principles to a Green SMART village:

- Using skills as a driver for sustainable transformation
- Promoting sustainability as a centre-piece of development in the locality
- Adapting science and technology to transform agricultural and related occupations
- Using and preserving local natural resources and traditional knowledge
- Forming strategic partnerships with a given local skills eco-system
-

When appropriately identified and resourced, villages are good starting points for showcasing efforts to address multiple Sustainable Development Goals (UN, n.d.) and advancing development with the aim for no poverty, no hunger, good health,

quality education, gender equality, responsive consumption and production, addressing climatic change, and preserving life on land. These villages will rely on skills, adaptable technologies and build-up local management capacities as key drivers for preservation and transformation into sustainable rural communities.

The practical greening guide framework developed by UNESCO-UNEVOC International Centre in 2017 served as an inspiration to develop the framework (UNESCO, 2017). In particular, the framework elaborates on and applies the 'Greening the Community' dimension of the guide.

**Major Components of the Smart Village**

The framework guides villages in setting their course and strategic directions to become 'smart'. To enable its capabilities, villages will be supported in defining the smart components that need to be developed given the specific skills supply and jobs/enterprise available, or other latent potential that can strengthen the environmental, science-based/technological and market aspects of the village. Once defined, the skills strategies to enhance the village's capacity and the youth's skills to take on the chosen course of action will be enhanced/designed and implemented. Figure 1 outlines the composite of technical and skills-driven areas in the village that can be strengthened in each of the components.

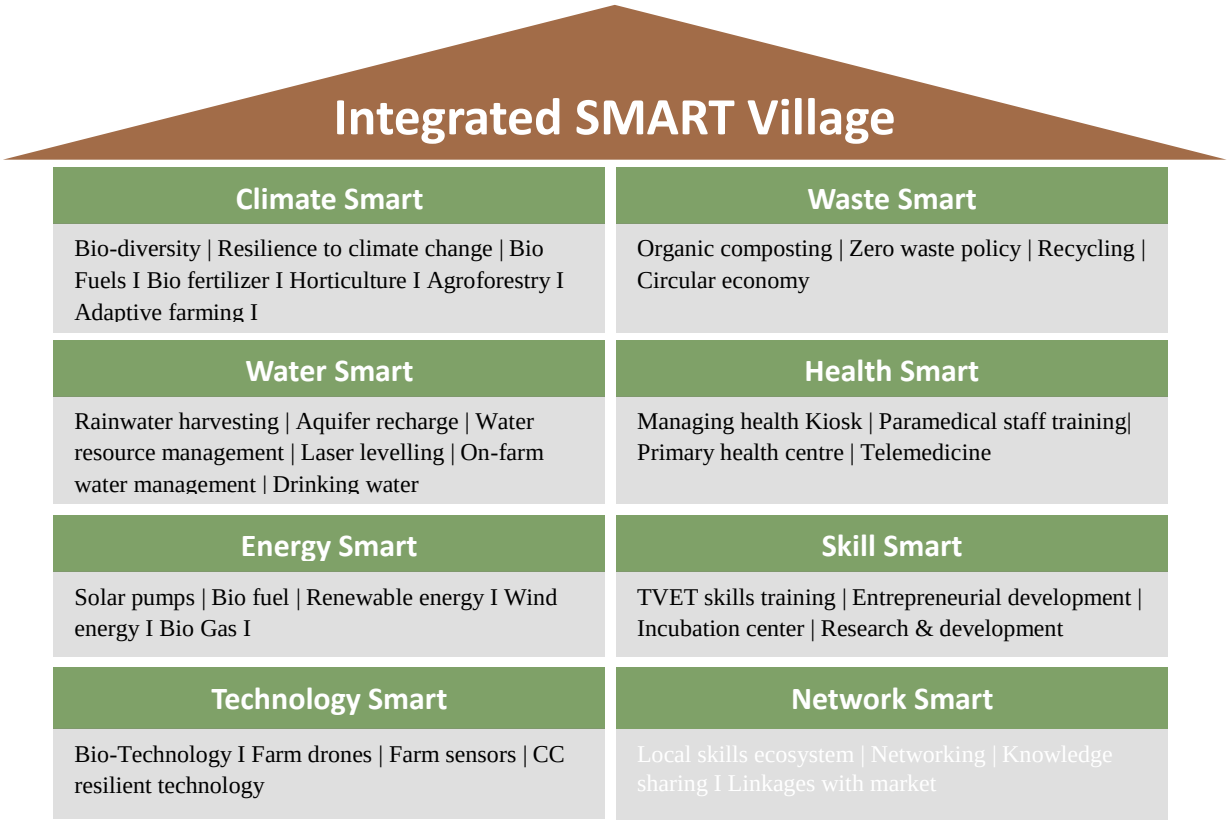


***Figure 1:*** The Major Components of Sustainable and SMART village


 

### *Climatic Smart*

Climate-friendly and economically smart agriculture as well as natural products development can be a solution to address food security under the realities of climate change. Villages can engage in: a) increasing agricultural productivity using bio technology/fertilizer/horticulture; b) building capacity to become resilient to the effects of climatic change; c) reducing their local greenhouse gas (GHG) emissions; and d) promoting eco-friendly entrepreneurial activities (FAO, 2013, 2015). Another key aspect includes community seed banking that can secure and improve farmer's access to good quality seeds that can enhance agricultural crops production (Bioversity International, 2019). Proper nutrient management can also improve soil quality and lower the emission of GHG, apart from ensuring that agriculture produce are safe for consumption (Saj & Torquebiau, 2018).

### *Water Smart*

Water access and availability are intrinsically linked to food security. Agricultural production is an area that consumes a huge amount of water. Hence, there is a need to manage water resources for agricultural production in a sustainable manner and create opportunities to recycle or harvest water for irrigation purposes. In this regard, the 'Water smart' component entails creating a balance between water availability, access and use across a range of water resources and according to principles of socio-economic, environmental and technical sustainability (Nicol, Langan, Victor, Gonsalves, 2015). This also involves innovative collection and storage for future use.

### *Energy Smart*

Energy is a key component in rural transformations, although its potential for agricultural use and creation of agro-based jobs has not been explored much. The production of energy from renewable sources such as the sun, wind, rain, waves and geothermal is an area of huge potential in villages where their supply is abundant. Renewable energy can support activities that make use of new technologies to generate bio-based fuels, solar/wind/hydro energy, or generate a mix of different gases from the use of raw materials including from agro-based activities for business or household (FAO. 2012). Recognizing that energy can be a catalyst for development is one of the driving factors of organizations such as the IEEE Foundation, which through its IEEE Smart village projects has supported more than 70 villages with solar power equipment, entrepreneurial training and education (Smart Villages, 2017).

### *Technology Smart*

This dimension entails the application of various technologies in agriculture and related occupations. The adoption of appropriate, smart technology includes using biotechnology, vermiculture technology, sensors-based applications, user-friendly methods of soil testing, renewable technology and smart technology, which now enables proper tracking of natural factors like climate change, soil composition and

weather forecasts. It includes the combination of agricultural equipment and methods with the application of ICT solutions, thereby improving databases, communication, market outreach, precision equipment, the Internet of Things (IoT), sensors and actuators, geo-positioning systems, Big Data, Unmanned Aerial Vehicles (UAVs, drones), etc. (smartAKIS, n.d.).

***Waste Smart***

Waste management can provide multiple soil benefits and support climate change mitigation. Over the years, cities and countries have introduced ways to minimize waste generation using zero-waste approaches. In some places, methods have been designed and implemented to manage waste in such a way to introduce a circular economy where products are designed with an intent to regenerate. Waste is reused/recycled or reproduced into other new products that go back to the economy (CEMR, 2014). Composts made from animal waste, household waste and agricultural by-products can produce high quality fertilizer for crops, which could increase crop yields. This can also cut down input costs and reduce GHG emissions as it reduces the need and therefore the usage of chemical fertilizers (FAO. 2015).

***Health Smart***

This approach advances the possibilities for rural areas to gain access to affordable and accessible healthcare and medicine. For example it includes the use of ICTs to collect data in the villages to be able to send results to the next available hospital and make diagnoses using computer systems designed for this purpose. By having trained staff in the villages or visiting staff on a regular basis, healthcare can be improved and can add to the attractiveness and comfort of living in rural areas. Telemedicine/Kiosk is the use of telecommunication and information technology to provide clinical health care from a distance. It has been used to overcome distance-based barriers and to improve access to medical services that would often not be consistently available in distant rural communities.

***Skills Smart***

Skills and training are the key drivers for implementing the SMART village concept. Whether in the field of climate change, water management, energy provision, technology deployment, waste management or health services etc., skills plays a key role in a village' transformation to becoming smart. Forming partnerships within a given local skills eco-system – consisting of local skill training providers and research institutions, small-scale enterprise groups, cooperatives, local employers and entrepreneurs, higher learning institutions, families and local support groups for women, youth and other marginalized groups – will serve as drivers and agents of need-based capacity development. Promoting entrepreneurial skills with incubation and financing support will open new opportunities for start-ups in the rural sector.


 

### *Network Smart*

The idea behind this dimension is to increase the effectiveness of the agricultural food chain by linking farmers to markets, thereby strengthening direct linkages between farmers and domestic traders, farmers and exporters, and farmers and retailers. The focus is on connectivity, information sharing and digital solutions to shorten the distance between farms and markets for agricultural produce. A virtual network of smart villages will be established to: (a) share promising practices; (b) to cultivate new ideas; and (c) to collaborate with each other. A network smart eco-system constitutes of technological support to reach out and connect with appropriate stakeholders, with or without intermediaries. For example, with a mobile phone application farmer can directly have access to market updates or directly communicate with consumers, exporters and companies (smartAKIS, n.d.).

## Some Indicators for Measuring Success of Implementation of SMART Principles

SMART villages demonstrate different skills, employment opportunities, and practical solutions, and showcase localized technological advances. To ensure this, some indicators need to be considered to gauge if villages are fulfilling their role in terms of inclusiveness, sustainability and economic progress.

**Table 1**
*Indicators for Measuring Success of Implementation of SMART Principles*

| Components | | Specific Indicators | Common Indicators |
|---|---|---|---|
| **Environment SMART** | Climate smart<br>Water smart<br>Energy smart | Climate-friendly smart agriculture and related practices using bio-technology/ fertilize/gases produces and manages energy/water/ecological resources that are renewable or self-sustaining. Applies concepts of 'circular economy' | • Maintains a working structure and a feedback loop within the local ecosystem<br>• Produces skilled, motivated and young talents drilled on local skills innovation and enhanced traditional practices<br>• Identifies and locally adopts local technology solutions in economic activities<br>• Engages vulnerable groups in eco-friendly and appropriate innovation practices |
| **Technology SMART** | Technology smart | Makes use of technology resources that are resilient and uphold traditions and practices* | |
| | | Application of ICT in agricultural practices Uses local data responsibly | |
| | Waste Smart | Uses adaptive farming methods | |
| | | Reduces, recycles and transforms waste products and promote circular economy | |

| | | | |
|---|---|---|---|
| | | Adopts environmentally-friendly farming technologies that balance productivity to capacity and responsible land use | • Attracts and engages young people in sustainable entrepreneurial activities<br>• Plans and executes economic activities safeguarding the long-term needs of people and planet<br>• Makes use of natural resources within capacity limits |
| | Health smart | Stays abreast with developments and ways for maintaining manageable quality of standards in medical service without compromising health | |
| **Skills and Network SMART** | Skills smart | Skills development, research and development, Eco friendly entrepreneurial skill development | |
| | Network smart | Provides responsible market information and connectivity, networking with local skills eco-system for incubation and exchange of experiences | |

*Resilient technologies are those that, even in the face of adversity, keep the world healthy, safe, warm, powered, fed and secure (CES, n.d.).

## Skills as a Driver for Rural Transformation

The process for operationalizing the framework demands for the skills development of the local youth and working-age population in rural areas. Such initiatives will ensure the sustainably applied, localized, and adapted use of science and technology in traditional rural settings and economic opportunities, including in local farming, livestock raising, fishing, horticulture, water management, energy management and eco diversity. This can pave the way for engaging in smart and sustainable agricultural and agro-based practices.

Technical and vocational education and training (TVET) and skills development are key to improving the capacity of the rural working-age population and developing a new generation of skilled workforce. These capacities, once enhanced, will play an important role in enhancing productivity with sustainability approaches, employability and income-earning opportunities, enhancing food security and promoting environmentally sustainable livelihoods. Unfortunately, a large proportion of rural population especially in the developing world, remain deprived of the opportunity to access the skills and knowledge to develop their capabilities and become aware of and expand their choices in life.

Low productivity in farming-related enterprises are caused by limited opportunities to apply technological and scientific provisions, as well as entrepreneurial activities due to lack of skills and capacities as well as capital and financing.

TVET is an important element that can stabilize the supply of skills and enhance the low-skill level that exists amongst populations. Scientific and technological knowledge and skill components can be enhanced in vocational training provisions, while sustainable concepts can be applied in practical terms through modern farming methods using improved techniques, including bio-technology, biofuels,


 

organic farming, solar energy, and other skills that are relevant for the rural employment.

Logically, the path out of poverty for rural people has to be strongly connected to productivity increase and the expansion of employment in the rural economy through farming activities and rural non-farm enterprises. Literature on rural poverty supports the view that agricultural growth has historically had an important role in poverty reduction in many countries (Ravallion, 2004; Besley, & Cord, 2006).

## Operationalization Strategies

The framework is proposed for pilot experimentation and as proof of the concept for further learning. The framework is to be operationalized in different phases as necessary.

Initially, a group of villages will be identified as pilot implementation sites. The selection is based on the local government unit's willingness to collaborate, and the overall potential of its agricultural economy and other local job/entrepreneurship sectors to be enhanced and developed into becoming 'smart', using local skills and technology readiness, over a course of a 2-3 year period. These conditions will need to be determined through on-site visits, feasibility studies, interviews with the local government stakeholders, and other research-based methods as needed. Other key elements to consider are the existence of reliable TVET institutes with optimum technology-human-technical infrastructures and strong management potential. These institutes are to be mainstreamed as potential agro-digital innovation centres in the village with enhanced capacities and skills innovation agendas. The institutions will be assessed and supported to become leads for skills development and training for the local youth in the rural area. Their potential to provide opportunities will be enhanced to enable them to incubate ideas; host science and technology-based exploratory research, or project-based activities in the field of agriculture, technology adoption and other related fields; collaborate with research-oriented institutes and roll out localized capacity development programmes or extension services in the field areas for creating a SMART village. These inputs are expected to increase the abilities of villages to develop long-term enablers of SMART village development. These conditions will be determined through document reviews, tracer studies, training needs analysis and job profile reviews, labour market analysis, leading to the design of targeted skills training and institutional development and teacher training.

In this context, the local institutions will play a key role in bridging the different opportunities and provisions for supporting villages to be transformed (Figure 2).

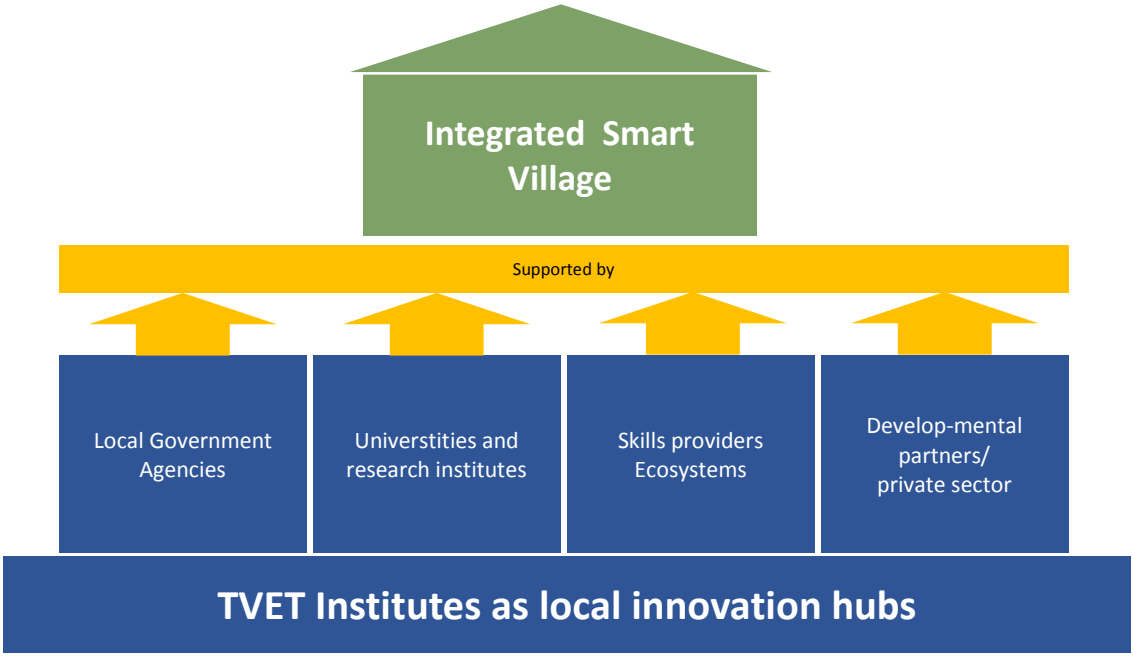


***Figure 2**:* TVET Institution with Skills Ecosystem Acting as the Local Innovation Hubs

Partnerships and building networks will be strategic resources for the project experimentation to take up, backed up by local government and other partners such as local skills training providers, research organizations, private sectors or small- and medium-enterprises, development partners and institutes of higher learning that serve the region/locality. Typical activities of such local innovation centres have been depicted in Figure 3, (Majumdar, 2019).

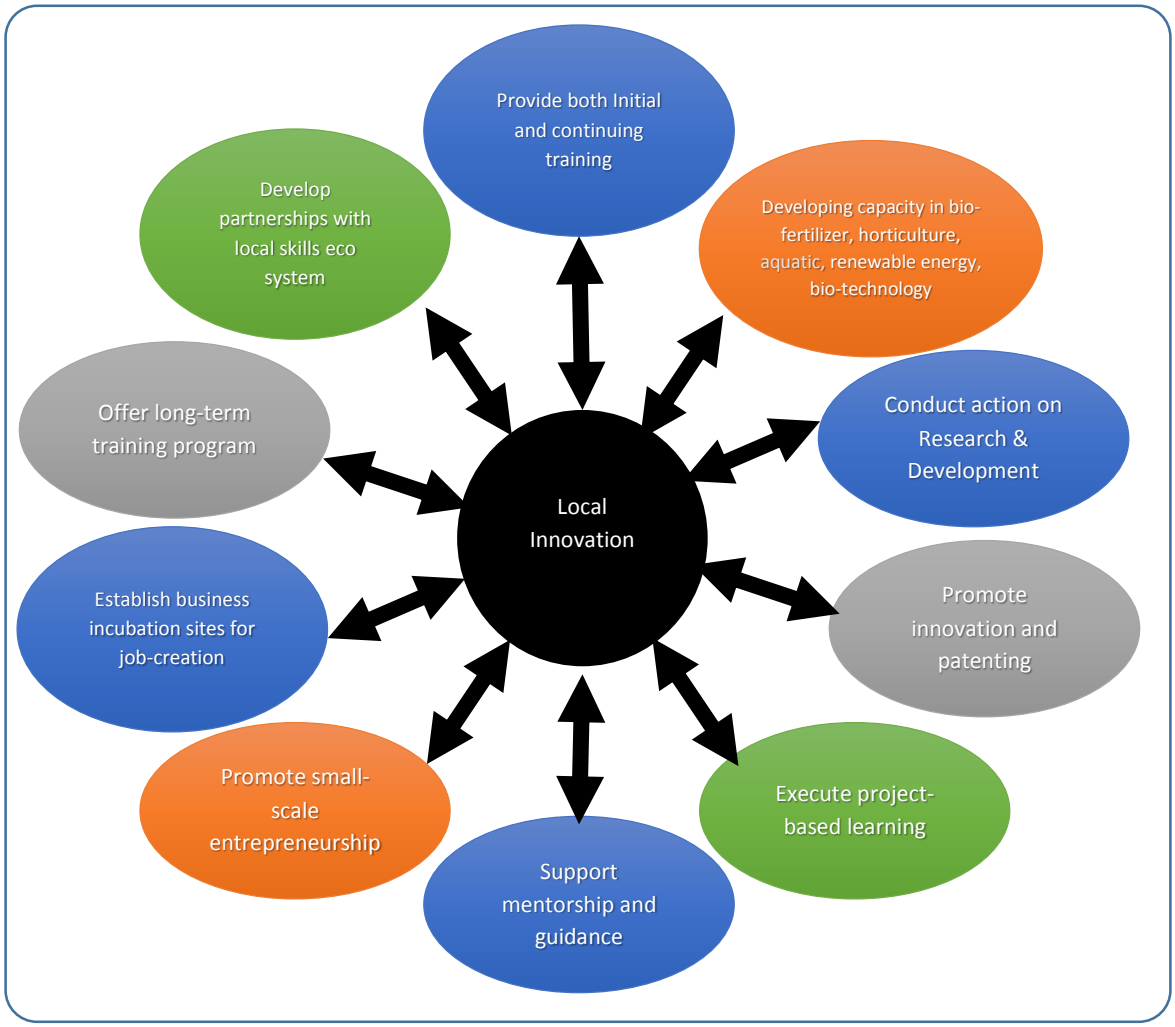


***Figure 3**:* Typical Activities of Local Innovation Centres

Subsequently, local innovation can take place in collaboration with different actors. Together, they work with TVET institutions acting as hubs to perform functions that are supportive of key coordinating processes and results. Actors involved in crafting local policies and allocating resources, building capacity of trainers and teachers, conducting research, delivering training, and job creation in traditional or innovative areas, will collectively frame the condition for collaboration and mutual engagement (Figure 4). In this setting and through these collaboration mechanisms, all pilot sites will be supported and reinforced through teacher development, advance skills training, advanced research and development, and the development of innovation and management skills at the Central Institutes, which will act as national resource centres for all local innovation hubs.

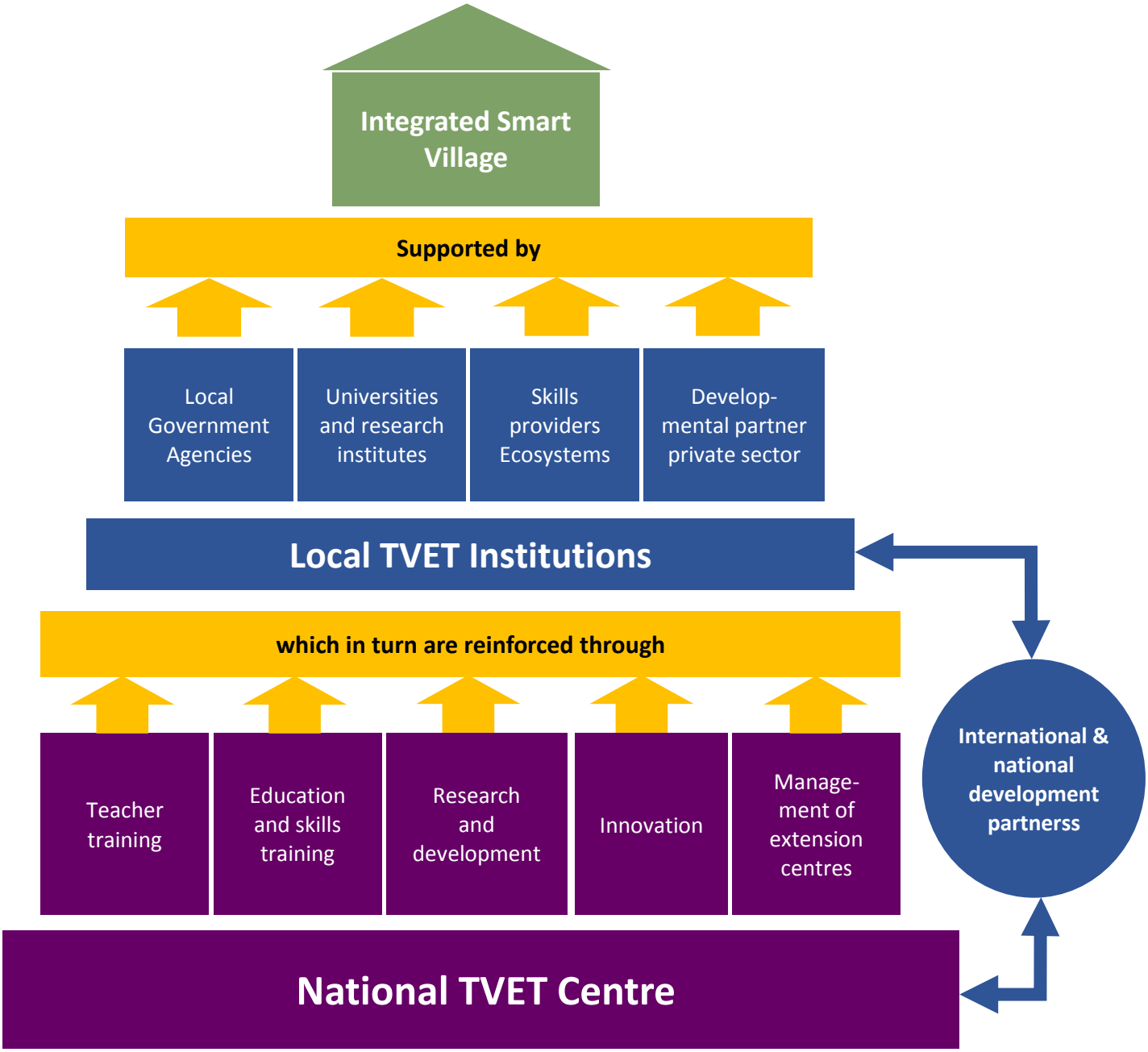


***Figure 4:*** Local Innovation Hub Supported by Central Institute

**Results of Intervention and Potential Application**

The project's implementation in a network of villages is expected to result in the increase of capacities and collection of data for further analysis. The capacities of those that have potential to contribute to development in this setting are developed, which enables the positive transformation of practices in the villages through smart interventions. As a result, the project sites will be able to demonstrate new forms of developments for which, through SMART principles, enable the:

- Promotion of science and technology in agricultural and related occupations for sustainable development
- Enhancement of the image of agricultural and related occupations to youth, women, girls and other vulnerable groups
- Establishment of partnership with local skill eco-systems
- Exploration of entrepreneurship and market linkages with small towns and cities to enhance sustainability and avoid overcapacity
- Acceleration of the role of rural areas in low-carbon circular economy
- Promotion of digital and local technology adoption in rural society and economy
- Improvement of health and prosperity of the peoples and communities within the territory/jurisdiction
- Integration of sustainability, safeguards local culture and traditions with local development process and skills transmission

Once successfully tested and implemented, the model will have a number of benefits including the improved livelihoods of the people, reduced migration to cities and other countries for employment, transmission of local and indigenous skills as ways to preserve traditional knowledge and heritage, the support of women and girls' empowerment, and implementation of sustainable, organic and good agricultural practices. In addition, it will improve the quality of life, promote bio-diversity and support the development of balanced eco-systems that will benefit economies and societies in the long-term.

**Pilot Project Implementation**

The area where the first pilot project initially is proposed to be undertaken broadly falls under the Sunderbans Delta region in India/Bangladesh border in Asia. Subsequently it will be expanded in the Africa region in particular where climatic change has affected the farmers very drastically. In case of first pilot project site selection, Sundarbans (literally beautiful forest) features in the list of UNESCO's 209 natural heritage site in the world for supporting "an exceptional level of biodiversity in its terrestrial, marine and aquatic habitats", with nearly 40% of its area under the world's largest mangrove forest. While the forest cover and the wildlife in it have been widely depleted by human encroachment and activity in last decades, the precarity of lives and livelihoods in the area continued. The changing temperature of water and increased salinity and acidity in the soil, frequent cyclonic

storms, low economic opportunities has already impacted[1] the region's biodiversity and agricultural occupations according to studies by the Marine Science Department of Calcutta University (UNESCO, n.d.).

As a result, the inhabitants have long been known to be exposed to extreme poverty and disease, making life extremely challenging. The lack of economic opportunity meant that landless and poor farmers were compelled to take up dangerous occupations like encroaching on tiger reserves for collecting honey or firewood, illegal timber felling and catching shrimp fingerlings from the rivers for the end-use of inland prawn cultivators. In many cases residents are migrating *en masse* to towns and cities for job opportunities and better quality of life. The local government has identified livelihoods – with a focus on agriculture, fisheries and forestry, water supply and sanitation, disaster risk management and erosion control, energy needs, transportation, education and awareness creation including skilling, infrastructure including rural roads and communication networks, water sources and preservation of ecological balance, socio-economic and allied development – as a key driver for change.

The project is proposed to be implemented by the **Vivekananda Institute of Biotechnology, Shree Ramakrishna Ashram, Neempith (VIBSRAN)**, an NGO promoted by the Ramakrishna Mission, Nimpith, State of West Bengal, India. The Centre's extensive work in promoting scientific farming methods among local youth and women as well as its research in the fields of agriculture, horticulture, biodiversity, natural products and biotechnology for the last 40 years has put them in the lime light in national and international agencies.

## Conclusion

Strategies for rural transformation for sustainable development need a multidimensional approach. Building basic capitals for sustainable growth, employment generation and poverty alleviation in rural areas could benefit from:

a) Building human development through vocational education and training, to improve the quality of life, promote economic competitiveness and advance actions to combat climatic change.

b) Strengthening knowledge and information capital through access and ability to use the latest science and technology advancements. Innovative skills and market information systems and farming techniques could extend abilities of communities and societies in food security, promote health and protect the environment.

c) Supporting financial capital that are in favor of the poor and rural development can go a long way. Micro-enterprises, provision for micro-credits, and stronger rural banking systems and rural community enterprise creation are just few of the interventions possible.

At the heart of the SMART village approach is the capacity development of people in the village and communities, backed by a strong pool of technical and vocationally-trained people in an environment where multi-stakeholder engagement could become drivers of change (Majumdar & Basu 2010; Majumdar, 2019). TVET is essential to equip people of all ages with the necessary skills to build a sustainable future, ensure the ability to provide for oneself and one´s family, as well as support the economy of the country and advance society through constant learning and development.

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