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Innovations and business incubation for startups for effective technology transfer

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INTRODUCTION

In 2016 Government of India has announced the "National Intellectual Property Rights (IPR) policy (GoI, 2016a) which advocate promotion of a holistic and conducive ecosystem for catalysing the intellectual property development and protecting public interest. The policy aims at strengthening the national initiatives such as "Make in India" (GoI, 2016b), "Skill India" (GoI, 2016c), "Start Up India" (GoI, 2016d), "Smart Cities" (GoI, 2016e), "Digital India" (GoI, 2016f). The flagship programme of the Government like Start Up India aims at building a strong ecosystem for nurturing innovations and Start-ups in the country (GoI, 2016d). Under this, Atal Innovation Mission (AIM) is the action plan envisaged with the focus on promotion of entrepreneurship and innovation in sectors such as manufacturing, agriculture, health and education (GoI, 2016d; Subash et al., 2016).

India, agri-based innovation in India is mostly from publicly funded research institutions (Pal et al., 2012) till the Multi National Companies entered into Indian Markets. Innovations by public sector promise to some solutions to the current challenges faced by last mile stakeholders i.e. farmers. However the innovations across the entire agricultural production-consumption system has been the recent phenomenon. These innovations often need to nurtured in a vibrant agribusiness ecosystem. But any development of a competitive indigenous agribusiness ecosystem requires a sustainable innovation processes and entrepreneurship development plans (ACI and ETG, 2011). It is now well documented that agribusinesses through agri-entrepreneurship have immense potential to improve the livelihoods of stakeholders in agri-production consumption systems in rural regions (UNIDO, 2013).

The National Agricultural Research and Education System (NARES) which comprises of ICAR-Institutions and State Agricultural Universities has made incredible progress over the last few decades, but it needs to undergo a deep transformationwith a focus on technology creation and its delivery to other stakeholders such as farmers, producer groups, retailers, corporations, civil societies and private players. The current needs of the stakeholders warrant NARES to transform into a more pluralistic innovation system addressing the needs of the consumers (NAARM, 2014b). The success of innovations would enhance livelihoods of the stakeholders. Recognizing this, the NARES has gradually started shifting form 'a producer-driven to demand driven and market-led' agricultural research and development (R&D) system (Subhash et al., 2016).

To add to these innovations financial institutions such as the Industrial Development Bank of India (IDBI) and the Small Industries Development Bank of India (SIDBI) are lending support for innovations and also for commercialization of innovative technologies besides entrepreneurship. Also, various fiscal incentives are offered by the Department of Scientific and Industrial Research (dsir.gov.in) towards the R&D activities performed by institutions, academia, and industry for supporting, nurturing and leading their innovations towards fruition (Abhyankar, 2014).

In this transition, issues of technology transfers through commercialisation from public research, gaps of knowledge in new product development (NPD) processes for the markets and attracting entrepreneurs to this sector have started to emerge. This paper attempts to detail the existing system and practices of commercialization and incubation of innovations in

agriculture sector in India.

Concept of incubation

Incubation is a process of providing proper support system to innovative idea converted into prototype technologies/services. These propotypes required to be tested in primary market for its validation. The services required from prototype development, technology management, strategy to production, market, financial, regulatory and human resourec management are provided in the incubation process. Incubators are recognised as "technology-led and knowledge- driven enterprises" as they help in speedy commercialisation of innovations and research outputs. Technology business incubators not only help in growth of technology based new enterprises but also improve their survival rate from 30 % to 70 % (NSTEDB, 2016a). These also help in mustering support services for start-ups, finding funding such as venture capitalists, angel investors and better networking opportunities for locating good markets.

Compared to other sectors like engineering, pharmaceuticals, ICT, machinery, consumer goods etc, and this concept is atan early stage in the agriculture and food sector. Even at the global level, there is start of evolution of a variety of agribusiness incubators and many are still at early stage levels. Table 1 enumerates some of the current models in operation. These include public sector research institutional funded types *viz.* ABI, ICRISAT, India; IAA-IPB, Indonesia; CENTEV, Brazil; and private, non-profit funded institutions like Villgro. The type of focus of these incubators is also variable. While some are focused at sectoral level (Timbali, South Africa) and seek to add value to innovative agri- products with application across the specific value chain, there are few initiatives like MLSF, Malaysia which focus only on high-technology operationsand at trans-border levels. Interestingly, there is also an emergence of incubators nurturing low cost technologies with applications impacting rural populations (Vilgro, India; Timpali, South Africa).

Incubation in Indian NARES

The processes incubation in NARES started from technology transfer process. Technology transfer from academic institutions to industry have emerged during the last two decades following the "Bayh-Dole Act of

Table 1. Types of agribusiness incubators

Types	Example	Pros	Cons
I. Agribusiness value chain/ sector development incubators	i.Fundacion (Chile) ii.Technoserve (Mozambique) iii.iundacion Jalisco (Mexico) iv.Timbali (South Africa)	i.Strong network and management basis ii.Abundant and patient capital iii.Leverage services iv.Provide linkage of smallholders to niche markets	i.Costly to start up ii.Difficult to duplicate iii.Highly dependent on external funding iv.Limited sector impact
II. Agricultural research commercialization incubators	i.ABI-ICRISAT (India) ii.IAA-IPB (Indonesia) iii.CENTEV (Brazil)	i.Access to pipeline technology ii.Strong linkage with research community	i.More production than market oriented ii.Subordinate to the research organisation to which it is affiliated
III.Technology transfer incubators	i.High TechMLSF (Malaysia) ii.Low TechVilgro (India)	i.Pioneering trans-border high technology transfer ii.Abundant capital iii.Works effectively at the bottom of the pyramid launching continuously new programs	i.Difficult to mix different high-tech culture ii.Rapid launching if new programs may diminish capability to carry out core incubator task

Source: Infodev, 2013.

Table 2. Achievement of BPDS in NAIP

S. No.	Indicator	Phase I (2009-2013)	Phase II (2013-14)
1.	Number of technologies commercialised	274	57
2.	Number of entrepreneurs incubated/enrolled	1068	150
3.	Number of incubatees graduated	87	4
4.	Number of entrepreneurs supported/ trained	2448	1295
5.	Client servicing (commitment/delivered)	1339	134
6.	Revenue generated for the BPD (` lakhs)	2230.97	202.52
7.	Amount of funding mobilized for incubates (in lakhs)	1711.05	226.68
8.	No. of consultancy assignments undertaken	161	122
9.	Farmers directly benefitted with value addition	39395	1786
10.	Number of local employment generated (direct) through incubatees	219406	567
11.	Number of mergers &acquisitions, joint ventures, tie-ups	57	59
12.	BPD surplus fund (Rs. lakhs)	187.23	39.96
13.	a. Number of applications filed for patent	265	20
	b. Number of patents granted	30	7
14.	Number of scientists trained overseas in the frontier areas of science	6	2
15.	Number of scientists trained overseas in consortium-based subject areas	387	2
16.	No. of scientists participated in conference/seminar etc. abroad	21	3
17.	Number of novel tools/protocols/methodologies developed	34	35
18.	Publications	1055	266

Note: Phase 1 consists of 5 ICAR institutes (CIFT, CIRCOT, IARI, IVRI and NIRJAFT) and 5 SAUs (AAU, BAU, HAU, JNKVV, TNAU), Phase 2 consists of 12 ICAR institutes (CIAE, CIBA, CIFA, CPCRI, CIPHET, CPRI, CRRI, IIHR, IISR, IIVR, NAARM, NDRI). Period of Phase I: 2010-13, phase II: 2013-14. Source: Karuppanchetty et. al., 2014

1980", an amendment to the patent code of United States (Young, 2005). It paved away way to claiming ownership in intellectual property on research funded by U.S. Government. Soon this led to similar initiatives in Europe (Max-Planck, 2016), UK (Lambert toolkit, 2016), South America (EMBRAPA, 2016), Malaysia (MARDI, 2016), and India (Rao and Sastry, 2004). In the Indian NARES, Indian Council of Agricultural Research (ICAR) had taken the stewardship of technology commercialization through the promulgation of IP and technology commercialization policy in 2006 (ICAR, 2006). Since 2007, the institutionalization of the policy was initiated through development of set of operational guidelines (ICAR, 2014a; ICAR, 2014b) and alsothrough establishment of a governance mechanism in a three tier mode across all the 100 institutes of all ICAR (Samuel et al., 2014).

Followed by this the incubation process started with the establishment of BPDsin NARES under National Agricultural Innovation Project (NAIP) with funding from World Bank. Under this project 10 BPD units were initially established (5 in ICAR institutes and 5 in SAUs) during 2010 for the first time in NARES. Based on the experience and with a view to up-scale across the system, 12 more BPD units were establish edduring 2013-14. The overall objective of the project grants was to initiate this new mode in NARES and internalize into the system after project is completed. Progress and achievements of all the 22 incubators are given in Table 2.

Units under BPD projects sought to provide a wide range of services ranging from incubation facilities, research support and business services such as office space, access to Information and Communication Technology (ICT) services, advisories on management, and marketing, technical, legal and financial issues (NAIP, 2014). The work in this project also evolved new partnerships between NARES institutes and technology seeking companies through technology validation, technology transfer and enterprise development processes.The focus of BPD project was on conducting training programmes for prospective entrepreneurs in commercialized technologies. A substantial amount of revenuewas also generated by the BPD units through different services *viz.* consultancy (41%), technology transfer (40%), training (3%), and membership (4%) (Fig. 1). A total of INR 2468 Lakhs was gained through this service in this project (NAIP, 2014). In terms of broader outcome of the BPD project, data indicates creation of more than

Table 3. Components of national agricultural innovation fund

Name	Innovation Fund	Incubation fund	ARYA
Targets	i.IP & TM ii. PME, iii. Grassroots innovation (GRI) Fund	50 agri-business incubators in NARES	Encouraging potential rural youth
Objectives	Best practices and single window system· Strengthen institutional mechanism to protect IP Promote creativity and innovation in ICAR· institution Supervision of intellectual assets· Capacity building in IPR and techology commercialization· Manage new knowledge Nurture grassroot innovation IP-driven handholding· Sustainable innovation management in· ICAR institutes	Strengthen and expand the agri-business incubators Promotion of viable enterprises and sustainable employment of entrepreneurs Scale up of pilots in value chain Training entrepreneurs Support technology development Money support for incubates . .	Mentor/handhold rural youth with technical and financial support Attract youth in rural areas in agriculture and allied sectors for sustainable income and employment Establish network groups for capital intensive activities Develop functional linkages between institutions and stakeholders for sustainable development of youth
Project implementation in 2016	Redesigned model of coomodity driven ZTMC Continuing ITMU Scheme PME guidelines developed and implemented Developed operating guidelines for GRI Common SOP for valuation and pricing of technologies under process	27ABIs in ICAR institutes granted and initiated· .	First phase grant for ARYAsanctioned to 25 KVKs .

Source: ICAR, 2014c.

2,00,000 jobs in agribusiness sector with benefits reaching more than 1,40,000 farmers directly or indirectly (ICRISAT Annual report 2014, 2015).

Promotion of innovation and incubation

The initial success achieved in the ITMU scheme for initiation of technology transfer process in ICAR and later through the achievements through the BPD units established under the NAIP project funded by World Bank laid the basis for providing a continuum in the NARES for technology commercialization, incubation and entrepreneurship development. The experience in these two projects led to the new thinking across policy makers and NARES leading todevelopment ofNational Agricultural Innovation Fund for implementation with respect from 2015 as part of the XIIth plan activity of ICAR. Currently in operation, this has three components namely, (i) Component I - Innovation Fund; (ii) Component II - Incubation Fund; and (iii) Component III - Attracting and Retaining Youth in Agriculture (ARYA) (Table 3).

Under the component I it is clear that IPTM scheme is now into the next phase to provide a continuum of early work. The intent is to streamline the existing mechanism of R & D systems under the single window thus easing the operations. The Grass Root Innovation (GRI) is a new initiative which seeks to promote grassroots innovations to enhance and complement existing R & D efforts in agriculture (Sastry and Tara, 2014). Under the component II of the NAIF, a target of 50 agribusiness incubators has been envisaged. Till date, 24 ABIs have been granted on competitive basis.

Technology Business Incubators (TBIs)

National Science and Technology Entrepreneurship Development Board (NSTEDB) of Department of Science & Technology, Government of India has been promoting knowledge and technology intensive enterprises through Science and Technology Entrepreneur Parks (STEPs) programme since 1982.Currently 18 are in place andagriculture forms a part of the mandated areas.

Since 2000, NSTEDB initiated Technology Business Incubators (TBI) programmefor nurturing technology and knowledge based start-ups. In general, the type of services provided by TBI includes market

Table 4. List of TBIS in NARES

S.No.	Name of the Institute	Initiating Year	Trust area	Location	Name of the TBI
1	International Center for Research in Semi Arid Tropics	2003	Agri Business	Hyderabad, Telangana	Agri Business Incubator
2	National Daury Research IInstitute	2009	Dairy Technology	Karnal,Haryana	Society for Innovation and Entrepreneurship in Dairying (SINED)
3	Tamil Nadu Agricultural University	2011	Biotechnology (Food/Agri), Agri-Business (Agri-Products)	Coimbatore, Tamil Nadu	Technology Business Incubator (TBI) - Agribusiness Incubation Society (ABIS)
4	National Academy for Agricultural	2014	Agriculture and Agri-Business Research Management	Hyderabad,Telangana	Association for Innovation Development of Entrepreneurship in Agriculture (A-IDEA)
5	Indian Institute of Millet Research	2017	Millet TechnologY	Hyderabad, Telangana	Nesting Incubation and Entrepreneurship for leveraging agri-innovations in Nutri-cereals (NIELAN)
6	Indian Institute of Horticulture Research	2017	Horticulture Technologies	Bangalore, Karnataka	-
7	Indian Agricultural Research Institute	2017	Agri-Technology	New Delhi	-
8	ISAP	2017	Agriculture	New Delhi	ISAP TBI

Source: NSTEDB, 2016b and recent data collected by author from individual institute

research, developing business plan, technical assistance, other support assistance such as obtaining approvals, arranging legal and IPR services, using facilities of host institute at minimal charges and proving workspace for initial period with other ICT facilities (NSTEDB, 2016a). There are more than 112 TBIs established under NSTEDB in India (NSTEDB, 2016b). Interestingly, only three TBIs have been granted with primary focus in agriculture sector; of these two are established in ICAR and one in SAU (Table 4) till 2014. In 2017 four more TBIs in agriculture specific incubators were granted by NSTEDB. Another 20 TBIs in other sectors have nurtured technologies with plausible applications in agricultural and food sector (NSTEDB, 2016a). An infrastructure support provided by the TBI in Agri-business and Agri-Biotechnology includes wet labs, testing facilities, support equipment areas, discussion rooms, and conference rooms.

In terms of performance, 54% of the incubate companies from 68 TBIs are valued more than INR 2 crores and 23% of them are valued at INR 1-2 crores and other 23% are valued less than INR 1 crores (NSTEDB, 2014). On the average, 62 % of the seed investment of these companies equity and 38% from debt. In 2012-13, about 32,000 employment was generated by incubates and graduate companies with an annual turnover of Rs. 1500 crores. A told of 450 patents/copyrights were also filed (NSTEDB, 2016a). All this trends indicates positive impact of TBI towards acceleration of entrepreneurship in the country.

The Canvas of Agribusiness incubation in India

The canvas of agribusiness incubation initiatives is wide and diverse with players from Government, NGOs, professional bodies and international organisation (Table 5). Most of these efforts span across all sectors with few focused on agriculture and food sector. Focus on agriculture started its footfall formally in 2000. With the recent announcement of start-up India and National IPR policy, a need for more networking across the canvas is emerging. Consolidation of efforts across diverse centers will and encourage cross learning within each sector and across sectors.

ICAR started its journey after 2006, when it announced IP and Technology Commercialization policy. In fact, the initial steps undertaken in technology transfer through IP & TM Scheme and later through

Table 5. Evolution of technology transfer commercialization and incubation in India

Year	NARES	GoI	Other initiatives
1980		STEP (DST)	
1990		Honey Bee Network	
			SRISTI (NGO)
1997			GIAN (NGO)
2000			
2001		TBI (DST)	NIF (DST)
	Vilgro (non-profit)		
2003			
2004		ICRISAT TBI	ISBA (Prof.)
2006	IP Policy document	MSME Act	
2007	IP & TM Units		
2008	BPD (Phase I)-NAIP	PMEGP	
	Capacity building		
2009	"	SINID, NDRI	
2010		MSE-CDP	
		MDA Scheme	
2011		TNAU TBI	
2012		BIRAC (DBT)	NIABI(Network)
2013	Phase II of BPD		
	Agri Investors Meet		
	ICAR Guidelines		
2014	NAIFNAARM TBI a-IDEA		
2015	ABI announcement		
2016	ABIs- 24 established	Start-up India	
		National IPR policy	
2017		IIMR, IIHR and IARI TBIs	

Note: PMEGP- Prime Ministers Employment Generation, MSE-CDP-Micro and Small Enterprise-Cluster Development Programme, MDA-Market Development Assistance, BIRAC-Biotechnology Industry Research Assistance Council, SRISTI- Society for Research and Initiatives for Sustainable Technologies and Institutions, GIAN-Grassroots Innovation Augmentation Network. Restricted to agriculture sector, NIF-National Innovation Foundation, ISBA-Indian STEP and Business Incubators Association, NIABI-Network of Indian Agribusiness Incubators. Source: Subash et. al., 2016 and additional information by author.

BPD project are in line with National IPR policy announced by GoI in May 2016. Hence, it is imperative that NARES would develop mechanisms to link with other operators in incubation and entrepreneurship space across the country.

NARES ABIs vis-à-vis other incubators in India

Subash et. al. (2016) analyzed different aspects of incubation funded by two important agencies like ICAR-NAIF and NSTEDB. Data (Table 6) indicates that the advent of ABIs has been recent and less than decade old. Focus of all ABIs in NARES is essentially on food and agricultural only. While several other incubators serve range of sectors. In terms of governance, the ABIs seem to be more bound by institutional hierarchy and processes as compared to the loose and flexibility models in other TBIs. While most ABIs are still functioning on R&D models led by R&D professionals, TBIs management teams function with professionals in the field of enterprise building.

The nascency of ABIs is further elaborated in range of network and linkages which are limited to NARES and need to be extended. The support for infrastructure for pilot plants and services is more in TBIs attracting more entrepreneurs. There is a significant need for prototype testing in ABIs. All these factors contribute to higher levels of performance in TBIs. For the ABIs, there might be a late entry into this platform but significant gains of reaching the 1,40,00 farmers, the primary stakeholders is positive indicator. The scope of employment generation in this sector also indicates strong need to complement the ongoing efforts in NARES ABIS and bring in lessons learnt in other sectors for more visibility. .

Table 6. Comparison of ABIs and other incubators in India

	Parameters	ABIs through NAIF	TBIs from NSTEDB
I.	General information		
	i.Objective	Strengthen the ABIs created through NAIP, support potential agri technologies of NARES towards enterprise development, capacity building of agri entrepreneurs.	Creating technology based new enterprises, facilitation of transfer of technology, employment generation and economic development
	ii.Nature	Non-profit unit at public sector R&D institute; institutional funding only project	Both profit and non-profit organisations exists. More than two third TBIs are promoted by government; few promoted by banks and private company
	iii.Sources of funding	ICAR supported project	Central government, host institute, financial institute, private sector companies/colleges etc.,
	iv.Year of starting	ABIs started in 2016, Initial experience: BPD (2008-14)	Varying, First started in 1980s (STEPs), 2000(TBI, Vilgro)
	v.Thrust areas	Agriculture and food sector	Diverse - ICT, Manufacturing, Biotechnology, Agriculture, healthcare; Rural, electronics etc
	vi.Linkage with start up India	Not yet	Forms part of the startup India hub
II.	Governance		
	i.Governance Structure	It a project based mode with control by the sponsoring agency. A internal screening Committee at institute level and steering committee at ICAR	Promoted by Central Government and have less control on day today activities. There is a Governing/ Advisory Board and Executive management team at TBI
	ii.Management Team	More R & D personnel	Business management teams, (professional and technical experts)
	iii.Monitoring and Evaluation	Exist	Review mechanism of NSTEDB is through a National Expert Advisory Committee
	iv.Selection	Selection through screening selection panel and then presentation	Prescribed format exists. Selection is through a pre-screening followed by review by
	v.Mentoring	Exists	Exists
	vi.Legal Status	No independent legal status; works as a part of the ICAR institute	Not for profit registered societies/section 25 company
	vii.Link with TTO	Strong linkage with R & D & technology within ICAR institutes	Have linkage with R & D within and outside the institute
	viii.Best practices	Not yet	Exists
III.	Services provided		
	i.Infrastructure	Documented in application but not specified	Specified: Range from 5000 to 25,000 sq.ft
	ii.Prototype testing	Still in nascent stage	Have established large facilities and outsource services
	iii.Decisions	Top driven; Institute head	Empowered at TBI level, more flexibility and autonomy
	iv.Funding of new ventures	No seed support	Have seed support, have a weak support from ,Angel investors, VCs but improving over years
	v.Partnership	Still in infancy	Partnership with international organisation, Co-funding partnerships
	vi.Networks	Within ICAR	Diversity of industry, academia
IV.	Performance and outcomes		
.	Graduates; type of firms	i. 91 graduated in 2010-2014 ii. 20% of them were start ups, 48% (mid-level firms), 21%(Large firms)iii. More than 2,00,000 employment generated*Base on previous efforts (BPD project)	i. 500 tenants graduate every year ii. 60% of them technology based start ups iii. 32,000 employement estimated*Based on TBI (NSTEDB). Similar trends exits in other TBIs

Source: Subash et. al., 2016

CONCLUSION

In present socio-economic dispensation there are more opportunities for nurturing and building new enabling platforms for agri-business and agri-entrepreneurship in the country. Considering the large diversity of players in the entire agricultural production-consumption systems, focused attempts needed for improving the system through R & D and entrepreneurship development. It is important that NARES take forward this initial traction in a more objective manner and become part of larger canvas operating in the country in different programmes like startup India, Make in India etc. Accelerating technology transfer process can trigger more agri-based start-ups, and attract more entrepreneurs across the country. The study indicates that most of the successes achieved by the NARES has been through funding from projects. For a long term sustainability, it might be necessary to build in more functional and financial autonomy to accelerate incubation and entrepreneurship in the agribusiness ecosystem.

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